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# ICFICE 2022

## THE 14TH INTERNATIONAL CONFERENCE ON FUTURE INFORMATION & COMMUNICATION ENGINEERING

**12-14th January, 2022**
Ramada Jeju City Hall, Jeju

Proceedings QR Code

KIICE
THE KOREA INSTITUTE OF INFORMATION AND COMMUNICATION ENGINEERING

Ministry of Science, ICT and Future Planning

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# Welcome Message from General Chair

Dear respected scholars and professionals,

On behalf of the conference committees, it is my great pleasure to welcome all of you to ICFICE2022, the 14th International Conference on Future Information & Communication Engineering that is being held in Jeju Island, on 12th-14th January, 2022.

As new and diverse technologies continue to appear after the COVID-19 pandemic, it is now an era in which everyone should study technology.

As the spread of vaccines and the development of therapeutics become visible, it is time to think about life after the pandemic. Humanity, who has been living in a pandemic for about two years, is no longer the same as before. Our ICT researchers and companies are paying attention to the desires of people who are accustomed to a world that crosses online and offline, virtual and reality, and are preparing more diverse and interesting technologies and services than ever before.

Information and communication researchers should select six industries (metaverse, streaming, ESG, AI, network, finance) where pent-ups are concentrated and predict and prepare for changes in IT technology trends and the future.

As the general chair of ICFICE2022, I am pleased to announce that notable papers have been published here and several have been published in relevant SCOPUS indexed journals, including JICCE, to share their work with researchers around the world. We would like to thank the Program Committee and Organizing Committee members, keynote speakers, judges and authors who contributed to the success of this conference. I hope this conference will be a meaningful and happy time for you.

Dr. Seong-Yoon Shin
General Chair of ICFICE2022

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Ramakrishna Kakarala (Singapore)

# Conference Schedule Overview

## ◉ 12th January, 2022

**• Registration**

- Time : 15:30 ~ 16:30 (12th, January, 2022)
- Place : Meeting Room B(B2), Ramada Jeju City Hotel, Korea

**• Opening Ceremony / Keynote Speech**

- Time : 16:30 ~ 18:00 (12th, January, 2022)
- Place : Ball Room(B2), Ramada Jeju City Hotel, Korea
- Keynote Speech

  Title : Scalable Predictive Analysis using Multiple GPUs leveraging Big Data
  Speaker : Prof. Jongwook Woo
  (California State University College of Business&Economics, USA)

**• Dinner**

- Time : 18:00 ~ 20:00 (12th, January, 2022)
- Place : Restaurant(1F), Ramada Jeju City Hotel, Korea

## ◉ 13th January, 2022

### • Registration

- Time : 9:40 ~ 12:00 (13th, January, 2022)
- Place : Meeting Room B (B2), Ramada Jeju City Hotel, Korea

### • Chair. Meeting

- Time : 10:20 ~ 10:40 / 13:00 ~ 13:20 (13th, January, 2022)
- Place : Ball Room (B2), Ramada Jeju City Hotel, Korea

### • Technical Session

- Time : 10:40 ~ 12:00 / 13:20 ~ 15:30 (13th, January, 2022)
- Place : Ball Room / Meeting Room A(B2), Ramada Jeju City Hotel, Korea

### • Lunch

- Time : 12:00 ~ 13:00 (13th, January, 2022)
- Place : Restaurant(1F), Ramada Jeju City Hotel, Korea

## ◉ 14th January, 2022

### • Business Benchmarking

- Time : 9:30 ~ 13:30 (14th, January, 2022)
- Place : KAKAO Corp.

| ICFICE 2022<br>THE 14TH INTERNATIONAL CONFERENCE ON FUTURE INFORMATION & COMMUNICATION ENGINEERING | |
|---|---|
| 13th January, 2022, Ramada Jeju City Hotel, Korea | |
| Technical Session :<br>**ORAL** | **Session IS-A**<br>Prof. Sungkwan Youm (Wonkwang Univ.) |
| 10:40<br>~<br>12:00<br>(BALL ROOM) | **IS-1** |
| | **IS-2** |
| | **IS-3** |
| | **IS-4** |
| | **IS-5** |
| Technical Session :<br>**ORAL** | **Session CA-A, MD-A**<br>Prof. Se-woon Choe (Kumoh National Institute of Tech.) |
| 10:40<br>~<br>12:00<br>(MEETING ROOM A) | **CA-1** |
| | **CA-2** |
| | **CA-3** |
| | **MD-1** |
| | **MD-2** |
| 12:00<br>~<br>13:00 | **Lunch Break** |

* IS : Intelligent Information System
CA : Communication System and Application
MD : Multimedia and Digital Convergence

<table>
<tr><td colspan="2">ICFICE 2022<br>THE 14TH INTERNATIONAL CONFERENCE ON FUTURE INFORMATION & COMMUNICATION ENGINEERING</td></tr>
<tr><td colspan="2">13th January, 2022, Ramada Jeju City Hotel, Korea</td></tr>
<tr><td>Technical Session :<br>ORAL</td><td>Session IT-A, DA-A<br>Prof. Jongwook Jang (Dong-eui Univ.)</td></tr>
<tr><td rowspan="5">13:20<br>~<br>14:20<br>(MEETING ROOM A)</td><td>IT-1</td></tr>
<tr><td>IT-2</td></tr>
<tr><td>IT-3</td></tr>
<tr><td>IT-4</td></tr>
<tr><td>DA-1</td></tr>
<tr><td>Technical Session :<br>ORAL</td><td>Session IB-A, NS-A, BI-A, SC<br>Prof. Jongtae Lee (Seoul Women’s Univ.)</td></tr>
<tr><td rowspan="5">14:30<br>~<br>15:30<br>(MEETING ROOM A)</td><td>IB-1</td></tr>
<tr><td>IB-2</td></tr>
<tr><td>NS-1</td></tr>
<tr><td>BI-1</td></tr>
<tr><td>SC-1</td></tr>
</table>

※ IT : IT Convergence Technology
DA : Database and Internet Application
IB : IoT and Big Data
NS : Networking and Services
BI : Biomedical Imaging and Engineering
SC : Semiconductor and Communication Services

# ICFICE 2022

THE 14TH INTERNATIONAL CONFERENCE ON FUTURE INFORMATION & COMMUNICATION ENGINEERING

13th January, 2022, Ramada Jeju City Hotel, Korea

| Technical Session : **POSTER** | **Session BI-B, IT-B, IB-B**<br>Prof. Semin Kim(Jeonju National University of Education)<br>Prof. Choong Ho Lee (Hanbat National Univ.) | | |
|---|---|---|---|
| 13:30 ~ 14:00 (BALL ROOM) | **BI-2** | **IT-10** | **IT-17** |
| | **BI-3** | **IT-11** | **IT-18** |
| | **IT-5** | **IT-12** | **IT-19** |
| | **IT-6** | **IT-13** | **IB-3** |
| | **IT-7** | **IT-14** | **IB-4** |
| | **IT-8** | **IT-15** | **IB-5** |
| | **IT-9** | **IT-16** | |
| 14:00 ~ 14:20 | **Coffee Break** | | |
| Technical Session : **POSTER** | **Session IS-B, NS-B, CA-B, MD-B, DA-B**<br>Prof. Sung-Hwa Han(Tongmyong Univ.)<br>Prof. Kwang-Seong Shin(Wonkwang Univ.) | | |
| 14:20 ~ 14:50 (BALL ROOM) | **IS-6** | **IS-13** | **MD-6** |
| | **IS-7** | **NS-2** | **MD-7** |
| | **IS-8** | **NS-3** | **MD-8** |
| | **IS-9** | **CA-4** | **MD-9** |
| | **IS-10** | **MD-3** | **DA-2** |
| | **IS-11** | **MD-4** | **DA-3** |
| | **IS-12** | **MD-5** | |

* BI :Biomedical Imaging and Engineering
IT : IT Convergence Technology
IB : IoT and Big Data
IS : Intelligent Information System
NS : Networking and Services
CA : Communication System and Applications
MD : Multimedia and Digital Convergence
DA : Database and Internet Application

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<tr><td colspan="4">13th January, 2022, Ramada Jeju City Hotel, Korea</td></tr>
<tr><td>Technical Session :<br>POSTER</td><td colspan="3">Session IS-C, IT-C, CA-C, NS-C, IB-C<br>Dr. Daehwan Kim(ETRI)<br>Prof. Jin-Ho Chung(University of Ulsan)</td></tr>
<tr><td rowspan="4">15:00<br>~<br>15:30<br><br>(BALL ROOM)</td><td>IS-14</td><td>IT-21</td><td>NS-5</td></tr>
<tr><td>IS-15</td><td>IT-22</td><td>IB-6</td></tr>
<tr><td>IS-16</td><td>CA-5</td><td></td></tr>
<tr><td>IT-20</td><td>NS-4</td><td></td></tr>
</table>

* IS : Intelligent Information System
IT : IT Convergence Technology
CA : Communication System and Applications
NS : Networking and Services
IB : IoT and Big Data

# 13th January, 2022

## Session IS-A : Intelligent Information System

**Session Chair :** Prof. Sungkwan Youm
(Wonkwang Univ.)

**10:40~12:00**

**IS-1** : **Analysis of Pet Activity Using Sensor Data with a Machine Learning Algorithm**
Ali Hussain, Sikandar Ali, Abdullah, Athar Ali, M.Mohsin, and Hee-Cheol Kim
(Inje University)

**IS-2** : **Classification of Algae Plant Using Deep Learning**
Abdullah, Ali Sikandar, Ali Hussain, Ali Athar, M.Mohsin, and Hee-Cheol Kim
(Inje University)

**IS-3** : **Design of Optimal Dwelling Time Scheduling for Package Tour by Machine Learning-based Prediction Model**
Aria Bisma Wahyutama, Byung Wook Kim, and Mintae Hwang
(Changwon National University)

**IS-4** : **A Performance Evaluation of the Alpha-Beta filter Algorithm with different Learning Modules ANN, DELM, CART and SVM**
Junaid Khan and Kyungsup Kim (Chungnam National University)

**IS-5** : **Multi-Criteria Decision-Making (MCDM) theory Based Ranking of Retirement Homes with its Facilitated Services**
Prommy Sultana Hossain, Junaid Khan, and Kyungsup Kim
(Chungnam National University)

## Session CA-A : Communication System and Applications

## Session MD-A : Multimedia and Digital Convergence

**Session Chair :** Prof. Se-woon Choe
(Kumoh National Institute of Tech.)

**10:40~12:00**

**CA-1** : **Developing Waqf Land Information System for the Government of Cianjur District**
Tarmin Abdulghani[1], Cucu Solihah[1], and Rita Rijayanti[2]
([1]Suryakancana University, [2]Changwon National University)

**CA-2** : **Designing of Mobile Interface for Thesis Management System by Enterprise Portal**
Asep Somantri[1] and Rita Rijayanti[2]
([1]Pasundan University, [2]Changwon National University)

**CA-3** : **Design of Self-Evaluation Model for Smart City in Bandung**
Aisyah Nuraeni, Yiyi Supendi, and Daniel Rohmatulloh
(Langlangbuana University)

**MD-1** : **A New Segmentation and Extraction Method for Manchu Character Units**
Aaron Daniel Snowberger and Choong Ho Lee (Hanbat National University)

**MD-2** : **Binary Gender Perspective on IVML Prototype Using Kansei Engineering Approach**
Nur Faraha Bte Hj. Mohd. Naim (University Malaysia Sabah)

## Session IT-A : IT Convergence Technology

## Session DA-A : Database and Internet Application

**Session Chair :** Prof. Jongwook Jang
(Dong-eui Univ.)

**13:20~14:20**

**IT-1** : **Analysis of Robust Anomaly Detection Using Convolutional Neural Network with Industrial Load Power Data**
Rita Rijayanti, Kyohong Jin, and Mintae Hwang
(Changwon National University)

**IT-2** : **Deep Learning Based Object Identification Integrated in a ROS system**
Cubahiro Roland, Donggyu Choi, and Jongwook Jang (Dong-eui University)

**IT-3** : **Trends in Mobile Ransomware and Incident Response from the Perspective of Digital Forensics**
Min-Hyuck Ko, Pyo-Gil Hong, and Dohyun Kim (Catholic University of Pusan)

**IT-4** : **Sleep Analysis from Polysomnography Signals Using Consumer Device and Machine Learning Approach**
Md Ariul Islam Mozumder, Muhammad Mohsan Sheeraz, Ali Athar, and Hee-Cheol Kim (Inje University)

**DA-1** : **Diffusion Factors of Business Intelligence Systems in Corporates**
Yaeri Kim and Jongtae Lee (Seoul Women’s University)

## Session IB-A : IoT and Big Data

## Session NS-A : Networking and Services

## Session BI-A : Biomedical Imaging and Engineering

## Session SC : Semiconductor and Communication Service

**Session Chair :** Prof. Jongtae Lee
(Seoul Women's Univ.)

**14:30~15:30**

**IB-1 : Investigating Handgrip Strength for the Detect of Cognitive Impairment**
Hyungsin Kim[1] and Yuyi Park[2]
([1]Kookmin University, [2]Seoul National University)

**IB-2 : Real-Time Recovery and Object Detection of Compressed Sensed Data**
Hye-min Kwon[1], Hyun Ahn[1], Yonggeol Lee[1], NakMyoung Sung[2], Mingoo Kang[1], and Jeongwook Seo[1] ([1]Hanshin University, [2]KETI)

**NS-1 : Analysis of 5G AKA vulnerabilities through 5G simulator**
SeoWoo Jung, Seunghwan Yun, and Okyeon Yi (Kookmin University)

**BI-1 : Design of an Orthogonality Sampling Method in Microwave Imaging for a Fast Identification of a Small Anomaly**
Seongje Chae[1], Young-Deuk Joh[2], and Won-Kwang Park[1]
([1]Kookmin University, [2]Gyeongin National University of Education)

**SC-1 : Macro-modeling of P-type Feedback Field-Effect transistor**
Jong Hyeok Oh[1], Faraz Najam[2], and Yun Seop Yu[1]
([1]Hankyong National University, [2]National Disability Insurance Agency)

## Session BI-B : Biomedical Imaging and Engineering

## Session IT-B : IT Convergence Technology

## Session IB-B : IoT and Big Data

**Session Chair :**
Prof. Semin Kim (Jeonju National University of Education)
Prof. Choong Ho Lee (Hanbat National Univ.)

**13:30~14:00**

**BI-2 : Predicting Localization of Pneumothorax - Collapsed Lungs using Deep Learning**
Akbarali Otakhanov, Athar Ali, and Hee-Cheol Kim (Inje University)

**Session Chair :**
Prof. Sung-Hwa Han(Tongmyong Univ.)
Prof. Kwang-Seong Shin(Wonkwang Univ.)

**14:20~14:50**

**IS-6** : **Design of Minimal Codes for Distributed Systems**
Dongsik Jo and Jin-Ho Chung (University of Ulsan)

**IS-7** : **Establishment of Smart Factory Advancement of Automobile Parts Manufacturing Companies**
Hyoung-Hwan Kim[1], Jung-Yee Kim[2], and Doo-Jin Park[2]
([1]SUNSOFT, [2]Tongmyong University)

**IS-8** : **Intelligent Transportation System based on an Edge AI**
Young Woo Jeong, Hyun Woo Oh, Su Yeon Jang, and Seung Eun Lee
(Seoul National University of Science and Technology)

**IS-9** : **Fuel cell-based electric powered ship power operation algorithm design**
Jong-Hak Lee, Ji-Hyun Oh, and Jin-Seok Oh
(Korea Maritime and Ocean University)

**IS-10** : **A study on the power control system algorithm for HEPS applying ML methods**
Ji-Hyun Oh, Jong-Hak Lee, and Jin-Seok Oh
(Korea Maritime and Ocean University)

**IS-11** : **An Experimental Analysis of Factors for Effective Subset Selection During Training Neural Networks**
Hayoung Park, Young Han Lee, Dong Hyung Seong, and Choongsang Cho
(KETI)

**IS-12** : **Reducing speaker error rate in multi-speaker speech synthesis with GST**
Dong Hyun Seong, Ha Young Park, Choong Sang Cho, and Young Han Lee
(KETI)

**IS-13** : **False Identification of Personal Computer by Altered EFI-SMBIOS**
Hyo-Joong Suh[1] and Hoyoung Hwang[2]
([1]The Catholic University of Korea, [2]Hansung University)

**NS-2** : **A Deep Learning Method for Human Activity Classification using Wearable Sensors**
Jong-Hoon Youn[1] and Teuk-Seob Song[2]
([1]University of Nebraska at Omaha, [2]Mokwon University)

**NS-3** : **Introduction of Freshness Ratio of Information**
Yutae Lee (Dong-eui University)

## Session IB-C : IoT and Big Data

**Session Chair :**
Dr. Daehwan Kim (ETRI)
Prof. Jin-Ho Chung (University of Ulsan)

**15:00~15:30**

**IS-14 : Computer Vision-based System Design for Classifying Workplace Dangerous Situation**
Taejun Lee[1], Hyeonock Song[2], SungEui Yang[1], Mingyu Kim[1], and Hoekyung Jung[1]
([1]PaiChai University, [2]Dasom Information)

**IS-15 : Implementation of Multi-LSTM Model for Water Level Prediction**
Minwoo Cho[1], Hangil Kim[2], Jieun Lee[1], Hyesoo Lee[3], and Hoekyung Jung[1]
([1]PaiChai University, [2]Korea University of Media Arts, [3]KISTI)

**IS-16 : Efficient Computer Aided Foot Stress Fracture Detection**
Joon-Sung Park[1], Doo Heon Song[2], Young Woon Woo[3], and Kwang-Baek Kim[1]
([1]Silla University, [2]Yong-in Art and Science University, [3]Dong-eui University)

**IT-20 : Shortest distance algorithm based path detection system in case of flash flood**
Sungwoo Jeon[1], Sungock Lee[1], Changsu Kim[1], Soyoung Kang[2],
and Hoekyung Jung ([1]PaiChai University, [2]KISTI)

**IT-21 : Analysis of User's Emotional Responses in Interactive Immersive Display**
Hyun-Rin Park[1] and Noo-ree Kim[2], and Hyun-Jun Choi[2]
([1]Gwangju University, [2]Mokpo National Maritime University)

**IT-22 : Fall detection system applying parameters processed by accelerometer data to long-short term memory**
Seung Su Jeong[1], Nam Ho Kim[2], and Yun Seop Yu[1]
([1]Hankyong National University, [2]Korea Polytechnic)

**CA-5 : Various Positions of Optical Phase Conjugator in Dispersion-managed Optical Link for WDM Transmission**
Soon-Nuy Kweon[1] and Seong-Real Lee[2]
([1]Korea National University of Welfare, [2]Mokpo National Maritime University)

**NS-4 : Indoor Position Learning Technique for Smartphone Environments based on Fuzzy Logic and Wireless Raw Signals**
Seunggyu Byeon (Silla University)

**NS-5 : Q-learning based MAC protocol for CR networks**
Hyung-Kun Park (KOREATECH)

**IB-6 : A study on big data analysis related to 'Digital literacy' using newspaper media in South Korea**
Sung-ae Kim (Duksung Women's University)

# Session IS-A

## Intelligent Information System

# Analysis of Pet Activity Using Sensor Data with a Machine Learning Algorithm

**Ali Hussain[1], Sikandar Ali[1], Abdullah[1], Athar Ali[1], M.Mohsin[1], and Hee-Cheol Kim[2*]**

[1]Institute of Digital Anti-Aging Healthcare, Inje University, Gimhae 50834, Korea,
[2]College of AI Convergence/Institute of Digital Anti-Aging Healthcare/u-HARC,
Inje University, Gimhae 50834, Korea
**[Email : *heeki@inje.ac.kr*]**

## Abstract

In recent years, the safety and wellbeing of companion animals such as dogs has become a major concern. It is critical for humans to comprehend a dog's activity routine as well as its emotional behavior in order to determine its well-being. A wearable, sensor-based device is ideal for such purposes since it can track the dogs in real time. However, the question of what sort of data should be utilized to detect activity patterns and emotional patterns, as well as another: where the sensors for data collection should be placed, and how can the system be automated, remains unresolved. Machine learning may be used to do pet activity analysis with high accuracy. Machine learning is based on data, which is critical for analyzing animal activity data. We collected data for the study of animal behaviors using wearable devices such as accelerometers and gyroscopes. The data was collected using these sensors, and the activity of dogs was evaluated. For such purposes, a wearable sensor-based system is appropriate, as it will be able to monitor the dogs in real-time. The primary goal of this research was to create a system that could identify activities using accelerometer and gyroscope information. As a result, we devised a system based on the information gathered from ten dogs of various breeds, sizes, ages, and genders. We used five distinct state-of-the-art algorithms, including Random Forests (RF), Decision Tree (DT), Multilayer Perceptron (MLP), XGBoost, and Gradient Boosting Machine (GBM). The Gradient boosting machine performed well in detecting pet activity. While detecting the various actions, we attained an accuracy of 90.431 percent.

**Index Terms:** Pet Activity detection, Machine learning, Feature Engineering, Activity detection.

## I. INTRODUCTION

In the era of this fast-growing computer's development, embedded systems, and activity recognition through wearable sensor devices, the inexpensive sensors have become one of the most important part of our routine and are being applied to many areas of our life including health management, medical monitoring, rehabilitation, action recognition, and remote control [1-4]. The Wearable sensors combining embedded systems and acceleration and gyro sensors have been established for activity recognition and are used in everyday life

* Corresponding author

and sports activities. The benefits of the acceleration and gyro sensors combined with embedded systems in the wearable instrument for motion monitoring and recognition is that no exterior environment sensors like camera, infrared sensors, or radar are required for these wearable instrument [5-7]. additionally, with their tiny size, low cost, lightness, and lessen power consumption, acceleration, and gyro sensors in wearable devices give a solution to recognize the sports activity. According to Khalifa et al., KEH (kinetic energy harvesting) may help to overcome the battery problem in wearable devices. KEH is chiefly used as a generator and a Human activity recognition sensor, lessen the power consumption by the sensor. The results show that activity detection from the KEH could overcome system power consumption by 79% [5].

The paper structure is arranged as follows: Section II elucidates the related work. Section III shows the methodology used for this research work. Section IV represents the result and discussion of the present work.

## II. Related work

In the previous studies, many researchers tried to use different type of machine learning algorithms for dog activity detection, and they used sensor data. They also extracted statistical features from the sensor data. A few of the past work have been mentioned below.

Cassim Ladha et al. proposed a method to detect the activity of dogs. They used accelerometer plate form to record the dog behaviors in naturalistic environments. For this purpose, a statistical classification framework was used for the detection of dog's activity. They did an experiment on 18 dogs and the model was able to detect the different activities with an accuracy of 70% [8].

Tatsuya Kiyohara et al. proposed a method for activity detection. They used an off-the-shelf acceleration sensor for the activity detection. They used the Dynamic time Wrapping technique for activity detection. They observed that it was difficult for the statistical method to distinguish between different activities like jumping [9].

## III. Methodology

For this research study, data has been collected from 10 different dogs. All dogs were different in breed, age, gender, and size. The data was collected for ten different activities; namely, Stay, Walking, Sitting, Eating, Sideway, Jump, Nose work, Running, Down and shaking, respectively. For the activity detection, accelerometer and gyroscope wearable sensors were used. The sensors were placed at the neck and tail of the dogs fastened using straps. The dataset was quite huge in size therefore the sensors sampled the data at a frequency of 33.3 Hz. The data that was obtained was having enormous amount of noise, as the signals were generated from the dogs. Therefore, to lessen the amount of noise, a lowpass Butterworth filter was used. In the Butterworth filter, 6th order was used with the cutoff frequency of 3.667 Hz. The order of the filter was select on the basis of blocking the maximal noise. The cutoff frequency was chosen on the basis of the data exploratory data analysis. Therefore, after filtering and noise removal of the data, a common feature engineering was performed to fetch out the crucial features from the data. For the feature engineering, on the accelerometer and gyroscope data, ten features for each axis were performed. The derived features were, standard deviation, mean absolute deviation, mean, minimum, maximum, interquartile range, energy measure, skewness, and kurtosis. We used ADASYN method to balance the classes due to the imbalanced of data between the classes.

## A. Feature Engineering

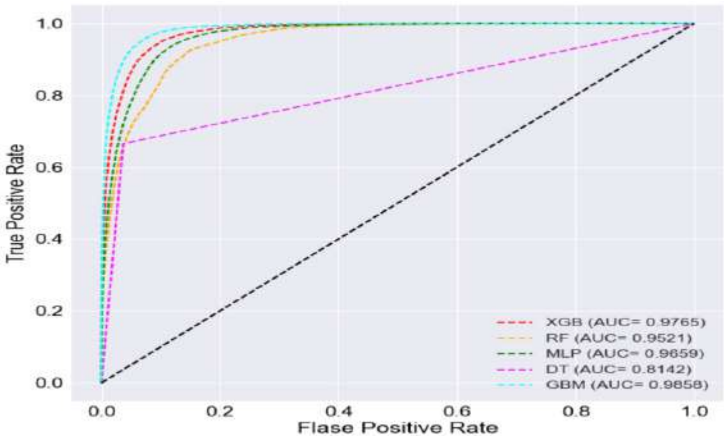
Feature engineering has also been done to extract the most relevant and important features from the pool of data. For the feature engineering, on the accelerometer and gyroscope data, ten features for each axis were performed. The derived features were, standard deviation, mean absolute deviation, mean, minimum, maximum, interquartile range, energy measure, skewness, and kurtosis.

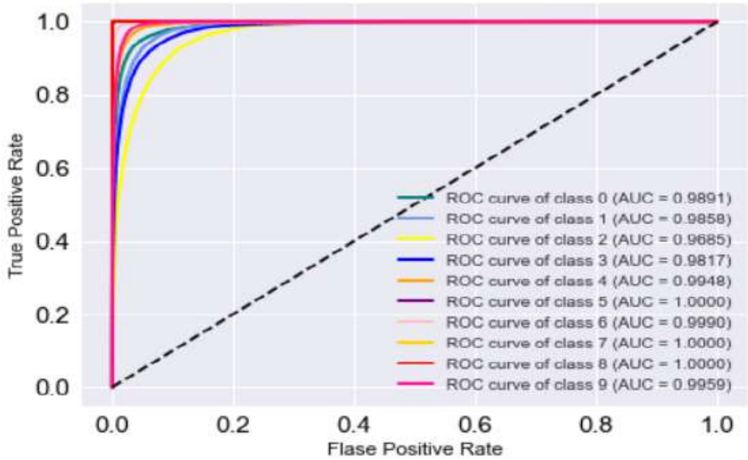
**Table 1.** Statistical features

| No | Feature | Explanation |
|---|---|---|
| 1 | Mean | The mean was calculated for each 33 samples fold. |
| 2 | Standard Deviation | The Standard Deviation was calculated for each 33 samples fold. |
| 3 | Median Absolute Deviation | The Median Absolute Deviation was calculated for each 33 samples fold |
| 4 | Minimum | The Minimum was calculated for each 33 samples fold |
| 5 | Maximum | The Maximum was calculated for each 33 samples fold |
| 6 | Energy Measure | The Energy Measure was calculated for each 33 samples fold |
| 7 | Inter Quartile Range | The Inter Quartile Range was calculated for each 33 samples fold |
| 8 | Signal Magnitude Area | The Signal Magnitude Area was calculated for each 33 samples fold |
| 9 | Skewness | The Skewness was calculated for each 33 samples fold |
| 10 | Kurtosis | The Kurtosis was calculated for each 33 samples fold |

# IV. RESULTS AND DISCUSSION

Python programming language used for this research work to conduct the experiment. The dataset was divided into two-parts (80% data for training and 20 % data for testing). Machine learning algorithms like RF, DT, XGB, MLP, and GBM were used in this research work. The algorithms were evaluated by different performance methods such as accuracy, precision, recall, f1-score, and ROC-AUC curve used to check the performance measures of the algorithm. The gradient boosting machine algorithm showed good performance with 89.1331% accuracy. Figure 5 shows the ROC-AUC score of different machine learning algorithm, and figure 6 shows the ROC-AUC score of different classes using GBM algorithm.




## V. CONCLUSION AND FUTURE WORK

In this research work, we applied different machine learning algorithms for pet activity detection. The Gradient Boosting Machine algorithm outperformed other algorithms. This algorithm showed 89.1331% accuracy. This algorithm can be used for the real time for pet activity detection.

In Future research work we will collect more data and add more classes for pet activity detection and apply advance machine learning and deep learning techniques such as CNN and LSTM.

## ACKNOWLEDGMENTS

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# Classification of Algae Plant Using Deep Learning

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## Abstract

Algae growth is an automatic process, and it is very dangerous for aquatic life and human health when its growth concentration is increased. Harmful algae bloom (HAB) is arisen due to change in climate and temperature, additionally, it is found in the lake, river, pond, and freshwater reservoirs. It is necessary to monitor and take the possible solution to stop their growth. It consumes sunlight, then produces a toxin and harmful compound, which destroy the ecosystem of aquatic life. To identify and recognize HAB by a human being is a tedious and expensive task. Advanced computer vision, machine learning, and deep learning play a vital role to do this job accurately. In this paper, we present algae classification using a transfer learning technique based on a convolution neural network (CNN). The microscopic algae image data having four classes are used to train VGG16, in which the upper layer of the model learn general feature and the lower layer model extract specific feature from the trained model. Based on the extracted feature, the trained model classifies the images into Closterium, Cosmarium, Scenedesmus, and Spirogyra. The accuracy of our proposed model is 96%, which depicts the model is robust and reliable for classification.

**Index Terms:** Classification, deep learning, HAB, Pre-train model, Transfer learning

## I. INTRODUCTION

Algae plants bloom having a heavy impact on aquatic life and other water-dependent creature. Algae normally grow in ponds, surrounding lakes, rivers, and channels of water supplies. Algae growth in low concentration in any aquatic environment does not much effect, while when its concentration is increased, it destroyed the aquatic environment and caused the illness of human beings. It is a very difficult task to monitor consistently the harmful algae bloom (HAB) event by a human being. HAB growth is normally due to change in weather,  high temperature, change in carbon dioxide concentration, and abundance of nutrients. The large algae plants' bodies float on the surface of the water, which creates a lifeless zone and water bodies did not get enough oxygen to live. It produces various types of harmful toxins namely amnesic, paralytic and diarrhetic toxins [1]. It is a

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serious problem, so it is necessary to monitoring constantly and take action to stop the HAB growth. The current methodology of algae blooms required main power and a huge budget. Artificial intelligence especially computer vision plays a vital role to address this problem based on drones' cameras [2], satellites and cameras under the water [3]. In this work, we used the transfer learning method to recognize and classify algae plants into four classes. For this work, we used four various pre-train models and output accuracy is acceptable and comparable with the existing model result. This paper is organized in the following sections: Section 2 presents the literature review, section 3 illustrates the methodology, section 4 gives an overview of the result, and discussion similarly sections 5 and 6 represent conclusion and future work respectively.

## II. RELATED WORK

The HAB is a natural process, and it covers a large area in the form of colonies, it produces harmful toxins and bioactive compounds, which destroy aquatic life and other creatures. HAB is mostly grown in a freshwater reservoir, coastal waters, and ponds. It blooms is very harmful to aquatic life and human health. To address this problem various research is conducted to monitor and identify algae bloom to reduce their growth. The study is conducted to reduce to minimize and control the effect of HAB to make safe the drinking water system and biological condition that the bloom exhibits is crucial to devise effective ways of controlling water system [4]. Aerial images like multi-spectral and hyper-spectral are very useful, which are taken by drones or satellites to monitor the algae bloom in a large area. Furthermore, the study also elaborates the unintentional growth of algae in fresh drinking water to make proper prevention and caution by water management resources [5-6]. The study also concludes that the traditional method used visual inspection based on the microscope is extensively used in algae plant classification, while it is old and needs too much manpower to perform these tasks. The subjective process affects the output result of the experiment.

The main factor of HAB is studied [7] which include changing of climate environment, high temperature and variation in PH value, In addition, the concentration of algae bloom decide that it is harmful or not. The low concentration of algae plants is not directly harmful, while its concentration increases it produces harmful toxin compounds and reflects the sunlight, which badly affects the inside environment of water. It consumes sufficient oxygen and stops to passed through it and caused the death of water bodies [8].

Recently the automation-designed based systems are used to monitor and identify its growth. Advance machine learning and deep learning-based method are extensively using to handle this problem. In addition, especially convolutional neural network (CNN) is popular to the processed image or video data effectively. The study was conducted to classify the species that belong to algae species or non-algae species [9], in which they used CNN model to train by using the data which are collected from water pipeline and the model accuracy is 99%. The real-time monitor algae bloom is also discussed [10], which helps to collect the true knowledge about algae bloom based on the computer vision method. This study also concluded that a robust system for algae bloom can be developed using a region-based fully convolution network (R-FCN).

## III. METHODOLOGY

The microscopic images are used in this experiment. The dataset consists of 400 images and each class has 100 algae species namely Cosmarium, Closterium, Spirogyra, and Scenedesmus. The data is too low, and it highly affects the training accuracy of the deep learning pre-train model. We have used a traditional data augmentation method to enhance the quantity of data. Furthermore, we have labeled the images according to their corresponding class. Figure 1 depicts the microscopic images of algae plants used for the experiment in this work. The transfer learning technique is very popular and more suitable for classification. It improves the robustness and reduces the time consumption of training. The VGG16 pre-train model is the combination of three main layers convolutional layer in which kernels are used to perform convolution,

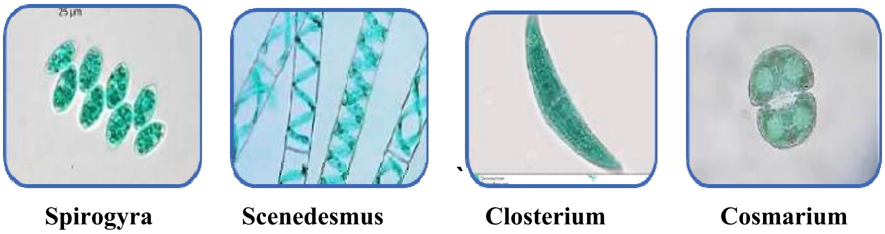



**Fig. 1.** Microscopic images of Algae plant

similarly pooling layer which helps to reduce complexity and provide the best feature from a pool of features, and finally, connected layers, which properly combine all the layer outputs. The hyperparameters can be adjusted according to output performance. In this experiment, Relue is used as an activation function similarly 0.001 is its learning rate, batch size and epoch are 12 and 10 respectively. The microscopic images are resized by 256 X 256 according to architecture requirements. The input data is split into two sets with a ratio of 80:20. The training sets contain 80% data, and the testing set contains 20% of the total dataset. Figure 2 illustrates the full overview of the algae plant classification process.

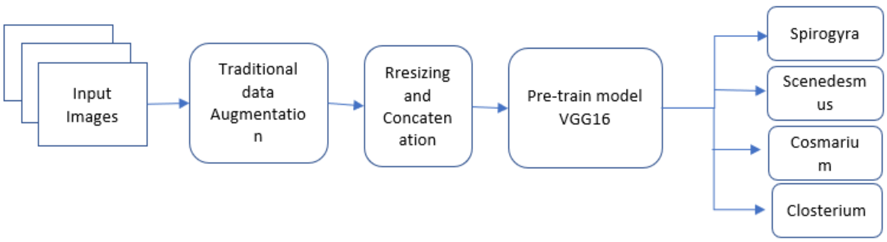
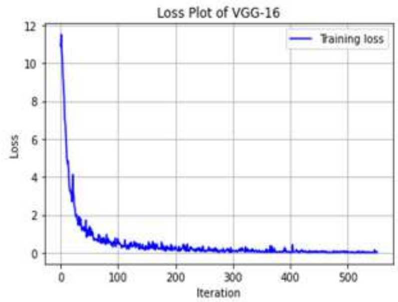



**Fig. 2.** work flow of Block Diagram

## IV. RESULTS AND DISCUSSION

The high variation in input data makes the task tedious and complex. It is also possible to improve image quality by using advanced image processing techniques. In this work, the model is trained using the algae species dataset to classify it according to its respective classes.



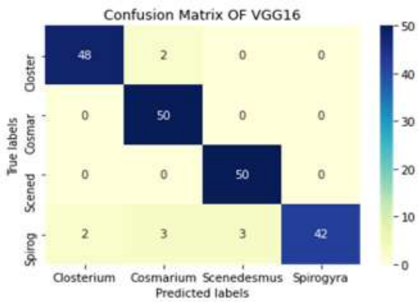




**Fig. 3.** Confusion matrix of VGG16 **Fig. 4.** Loss plot of VGG16

Figure 3 represents the confusion matrix of VGG16 in which true labels and predicted labels show good output results, similarly, figure 4 illustrates the loss plot of VGG16. The overall accuracy of our suggested model is 98%, which shows the output accuracy is quite good and it will highly contribute to developing computer-based algae bloom monitoring system.

## V. CONCLUSION

The harmful algae bloom creates a dangerous situation for water bodies and other creatures. So it is necessary to take action against its blooms and it is possible by continuously monitoring the pond, lake, and especially freshwater reservoirs. It is very complex and difficult to perform this task by a human being, while advanced machine learning and deep learning play an important role in this regard. The various method is adopted by different people to address this problem, but still the advanced Artificial intelligence (AI) model provides a more robust and simple technique to solve this problem easily. In this paper, we have used VGG16 pre-train model, which is already trained on the well-known dataset. We freeze a few top layer parts and train the model on our custom dataset, which learns specific features and classifies the algae species according to respective classes accurately. The automatic computer-based monitoring system is very helpful to identify the HAB and take action against them to stop their growth. In this experiment, the pre-train model performance is 98%. This is quite good, and it will contribute to building a real-time system.

## VI. FUTURE WORK

The featured work includes detecting algae bloom based on the object detection technique. In the future, we used Yolo5 to detect HAB for microscopic images, similar we can apply the same technique for video data or real-time streaming data, furthermore we explore more advanced techniques, which can help to handle real-time data.

## ACKNOWLEDGMENTS

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# Design of Optimal Dwelling Time Scheduling for Package Tour by Machine Learning-based Prediction Model

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## Abstract

In this paper, we proposed a design of Machine Learning-based prediction to create an optimal package tour scheduling as one of the primary features in the Package Tour Management Application. This application will be implemented in web and mobile applications and used by the tour guide and travel agent before the tour starts and while the tour is ongoing if urgently needed. By utilizing the Random Forest Algorithm to solve Regression problems, this concept is proposed to help increase tourism management efficiency. This paper also shows the system architecture as well as the data and information flow with the addition of User Interface design for both applications to explain how Machine Learning-based prediction will work in this particular case.

**Index Terms:** Machine Learning-based prediction, Package Tour, Random Forest Algorithm, Tour Scheduling.

## I. INTRODUCTION

Machine Learning which considers as a subfield of Artificial Intelligence, is a technology that enables the computer to learn automatically from a given data. To works, the machine learning systems have to store the learned information as a model, in a hypothesis which is a knowledge representation structure. Furthermore, generalization of the training data is required for the hypothesis, and to obtain a valid generalization, the hypothesis must be simpler than the data itself [1].

This paper will use the Regression model for deciding the dwelling time with Random Forest Algorithm. Random Forest Algorithm can be used to solve Regression problems, eliminates the need for cross-validation, and can impute missing values [2]. The Random Forest is categorized as ensemble learning due to its characteristic to 'ensemble' multiple Decision Trees to increase the final accuracy value of the prediction [3]. This characteristic results in the capability of Random Forest to convert the high-variance model to the low-variance model.

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The remainder of this paper is organized as follows. Section II will discuss the system architecture and design. Section III will discuss the challenges and issues. Lastly, Section IV will present the conclusions and future studies.

## II. ARCHITECTURE AND DESIGN

This section will discuss the datasets feature, the system architecture, and the interface design in the form of a storyboard.

### *A. Datasets Feature*

For Machine Learning to do the prediction correctly, selecting the features in the datasets is crucial. Based on what was stated in [4], the features of the dataset proposed in this paper that will be used for predicting the dwelling time are age, gender, health condition, weather condition, group type, tour experience, selected tourism spot and tourism spot attractions.

### *B. System Architecture*

This Machine Learning based prediction will be mainly implemented in mobile applications, however, this proposed system will be also implemented on web applications for further convenience of the tour guide to generate the prediction. Therefore, it has to be accessible by both applications.

Flask can be used to centralized the Machine Learning model. According to its official website [5], Flask is a light web WSGI (Web Server Gateway Interface) application framework specifically built for Python. Flask will open the Python Machine Learning model then route it to the designated web page with a certain method i.e., Post or Get. To accommodate the mobile application, Flask has an extension called Flask-RESTfull that supports building REST APIs. Using the REST API, the mobile application can request to send data for the Machine Learning and receive the predicted results to be shown on the application.

The Machine Learning Regression model will receive tourist data along with its features mentioned in Subsection A Dataset Feature from the Database as the main input and will generate the prediction accordingly. After the prediction has been generated, it will be stored in the database. Then, the web application can get the data directly from the database due to its native connection, while the mobile application can get the data from the REST API provided by Flask's Restful extension.

The data and information flow from the database to the mobile and web applications are depicted in Fig. 1 below.

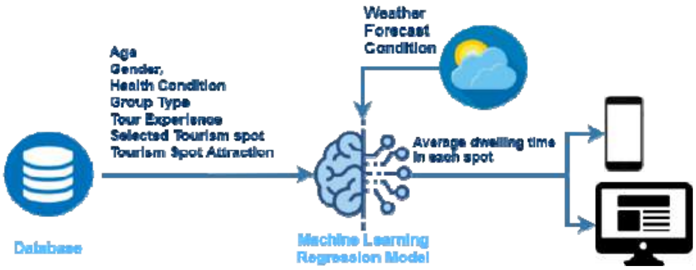


**Fig. 1.** Data and Information Flow

## C. User Interface Design

The interface design for the proposed system will be divided into mobile and web applications, which is depicted in Fig. 2 below.

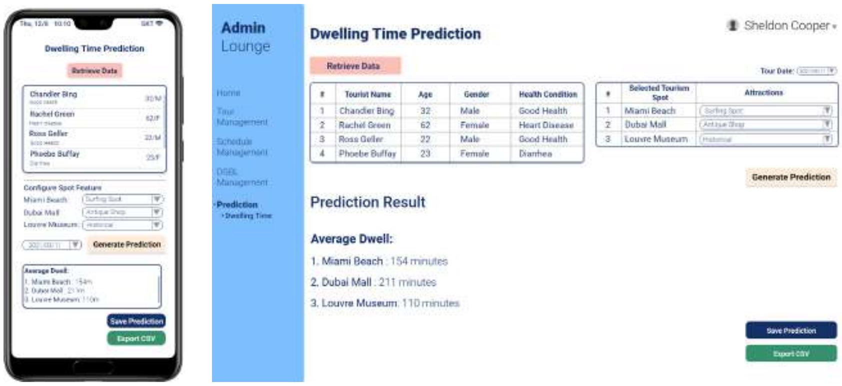


**Fig. 2.** User Interface Design for Mobile Application and Web Application

Mobile and web applications will have similar behaviour for showing the predictions. To generate the dwelling time prediction, the tour guide has to click the ‘Retrieve Data’ button to get the data from the database and click the “Generate Prediction” button to show the predicted dwelling time for each selected tourism spot after choosing the tourism spot attractions. The weather condition forecast will be retrieved automatically according to the date set by a tour guide or travel agent. The results will be in the average dwelling time prediction of all the tourists that joined the tour. In addition, there will be options for the tour guide to export the predicted result as a CSV file.

# III. CHALLENGES AND ISSUES

This section will discuss several identified challenges and issues for the proposed system.

### A. Model Accuracy

In Machine Learning, achieving high accuracy prediction requires a good quality dataset. Inaccuracy of weather condition forecast potentially impact the final prediction result, however, creating good quality data sets will make room for the weather condition forecast error, giving a smaller impact on the final prediction result.

The challenge is to obtain the data set with desired parameters. One of the solutions is to have a collaboration with well-established tour and travel agents. Moreover, after the data set is obtained, the next challenge is how to perform good data cleaning and Exploratory Data Analysis of the raw dataset to be suitable to work with the selected Machine Learning model, which in this case is Random Forest Algorithm.

### B. Scalability and Security

The model must be able to handle multiple requests simultaneously and the dataset will also grow throughout time, which will result in a problem for scalability. Security could also be an issue because it still contains private data of each tourist such as their health condition.

The challenge is how to make the model scalable in terms of processing many samples and handling multiple requests simultaneously, while still give dependable results and securing the data to prevent irresponsible parties to abuse the data set.

## IV. CONCLUSIONS AND FUTURE STUDIES

This paper proposed a prediction based on Machine Learning to predict how long the tourist has to stay in one tourism spot or refer to as dwelling time. The Machine Learning algorithm used in this proposed system is Random Forest because it works well with a supervised learning Regression model to predict the dwelling time. The features for the dataset proposed in this paper is consist of Age, Gender, Health Condition, Weather Condition, Group Type, Tour Experience, Selected Tourism Spot, and Tourism Spot Attractions.

The Machine Learning model will be implemented in mobile and web applications by utilizing Flask for web application and FLASK-RESTful extension for providing REST API to the mobile application.

For future studies, this concept can be combined with other concepts such as Geofence technology to monitor tourist movement [6] and Digital Game-based Learning (DBGL) methodology for the tourist to learn about the tourism spot that they are going to visit [7].

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# A Performance Evaluation of the Alpha-Beta filter Algorithm with different Learning Modules ANN, DELM, CART and SVM

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## Abstract

In this paper a new learning to prediction algorithm is implemented by using four different combinations of algorithms for the accuracy enhancement of the alpha beta filter algorithm and tuning the parameters of α and β in dynamic conditions. The designed proposed system uses the Support vector machine (SVM), Artificial Neural Network (ANN), Deep Extreme Learning Machine (DELM) and Classification and regression tree (CART) as four different learning algorithms and then these learned parameters trained by the machine learning algorithms tuned to the α-β filter algorithm as a prediction module and give the final predicted results. The performance of the proposed α-β filter with different learning algorithms is evaluated by the MAE and RMSE. The proposed system provides better accuracy results as evaluated with the conventional alpha beta filter algorithm.

**Index Terms:** Alpha Beta Filter, Artificial Neural Network, SVM, CART

## I. INTRODUCTION

State-of-the-art progress in technology, artificial neural network (ANN), deep extreme learning machine (DELM), classification and regression tree (CART), support vector machine (SVM) algorithms and other machine learning advancement helped in boosting the living standard in one way or another way. These methods are mainly based upon knowledge and the data that is extracted from the existing and past data in order to make progressive decision for future to minimize losses and such a way to achieve maximum benefit [1]. When we want benefit from these algorithms to achieve maximum progress first, we trained the algorithm from historical data, the more the data availability the more accurate the results. When the training stage of such algorithm is finished then the algorithm is ready for use in designed application. But here one issue arose that these algorithms are designed for specific task and environment therefore the performance of these algorithm degraded with the passage of time and changing its operational settings. Numerous well- known algorithms are used [1] such as DELM, ANN, CART, SVM algorithms and stacked generalization [2]

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technique is proposed to improve the accuracy for prediction and classification problems.

When this machine learning technique is attached with any algorithm the performance may increase in one way or another way, we applied these four algorithms as learning module to the alpha beta filter to boost the performance of the filter. The alpha beta filter is a most simplified form of linear observer which is used for estimation of the problem and application control. This filter is simply derived from the Kalman filter algorithm. Kalman filter is most complex, but this alpha beta filter is very simple to use in different application.it also give better performance as compared with the other filters.

Junaid et al. [1] proposed a technique based on DELM to increase the accuracy of the alpha beta filter algorithm. Shah et al. [3] uses the bat algorithm and alpha beta filter algorithm for parameters preferences and optimization of energy consumption in smart home and used the deep extreme learning machine.li et al. [4] proposed a method named adaptive alpha beta filter and attached with the robust BPNN and the method used for innovative target tracking.

In this research, a new learning to prediction algorithm is implemented by using four different combinations of algorithms for the accuracy enhancement of the alpha beta filter algorithm and tuning the parameters of α and β in dynamic conditions. The designed proposed system uses the Support vector machine, Artificial Neural Network, Deep Extreme Learning Machine and Classification and regression tree as four different learning algorithms and then these learned parameters trained by the machine learning algorithms tuned to the α-β filter algorithm as a prediction module and give the final predicted results. The performance of the proposed α-β filter with different learning algorithms is evaluated by the MAE and RMSE. The proposed system provides better accuracy results as evaluated with the conventional alpha beta filter algorithm.

## II. SYSTEM MODEL AND METHODS

We have proposed the four algorithms such as DELM, ANN, SVM and CART and added to the alpha beta filter.

The first method we have proposed is the Artificial Neural Network. In the learning module, we have used the ANN [5]. Inputs to the ANN are the temperature sensor values and humidity sensor values. The outputs of the ANN are the alpha beta values in prediction module. In the prediction module, we have used the alpha beta filter. Inputs to the alpha beta filter are the temperature sensor values, to get sensor reading module gets the sensor temperature reading data and give as input to the compute delta temperature module. The outputs of the compute delta temperature module are used as inputs to the predicted real temperature module and updated velocity. Inputs to the previous updated state module are the predicted real temperature and initial state module values. The previous updated velocity module takes the updated values module and initial velocity state values as inputs. The predicted real temperature module takes the computed delta temperature, the estimated temperature, and the alpha values as inputs and produces the real temperature value. In the second method we have used the DELM and attached with the alpha beta filter algorithm. Third algorithm are also very popular method, we proposed is support vector machine (SVM) algorithm that was primarily developed and work for binary classification problems. Fourth and last method we have proposed is classification and regression tree (CART) algorithm.

Complete proposed model of learning to an alpha-beta filter with SVM, FFBPNN, DELM and CART algorithms is shown in Figure 1.

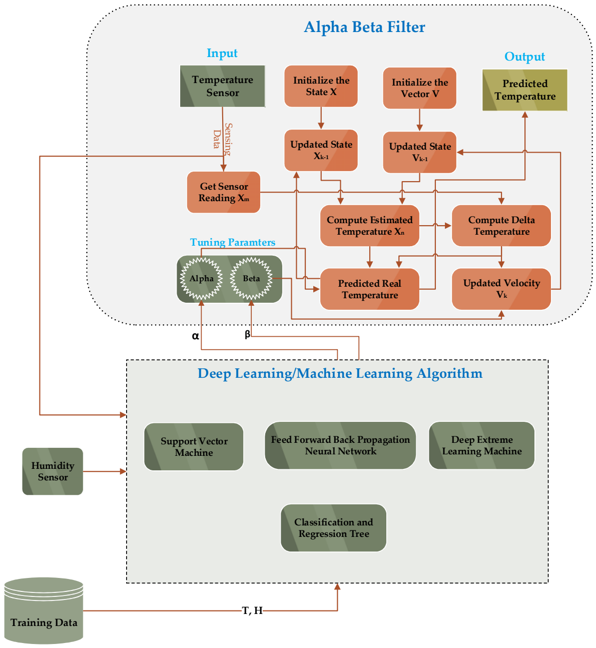


**Fig. 1.** Complete proposed model of learning to an alpha-beta filter with SVM, ANN, DELM and CART algorithms.

## III. RESULTS

We have implemented our algorithms results in MATLAB version R2015a, and the dataset we have used for the alpha beta filter algorithm is taken from [1] and the data is comprised of hourly temperature and humidity values for a one year and they observed the temperature and humidity in hourly intervals. For the performance evaluation the Root Mean Square Error and Mean Absolute Error is calculated for the conventional alpha beta filter and the new proposed learning method to the alpha beta filter. For the conventional method we obtained the RMSE 5.216 and MAE with 3.951. when we applied the ANN with two inputs two outputs and ten neurons in the hidden layer and the best results, we obtained 3.605 and 2.610 with RMSE and MAE respectively. The other methods of the alpha beta filter algorithm with Deep extreme learning machine, Support vector machine and classification and regression tree results is shown in Table 1.

**Table 1.** Comparison of the Conventional Alpha Beta Filter and proposed method in terms of RMSE and MAE

| Measure | Conventional Alpha Beta Filter | Learning with ANN | Learning with DELM | Learning with SVM | Learning with CART |
|---|---|---|---|---|---|
| **RMSE** | 5.216 | **3.605** | 3.901 | 4.015 | 4.188 |
| **MAE** | 3.951 | **2.610** | 2.811 | 3.218 | 3.415 |

## IV. DISCUSSION AND CONCLUSIONS

Prediction accuracy of any algorithm is always a challenging task. In this paper we proposed a new learning to prediction algorithm method such as ANN, DELM, SVM and CART for the accuracy improvement of the alpha beta filter algorithm and tuning the parameters of $\alpha$ and $\beta$ in dynamic conditions. The designed proposed system uses the Support vector machine, Artificial Neural Network, Deep Extreme Learning Machine and Classification and regression tree uses as a learning algorithm to the alpha beta filter algorithm to increase the prediction accuracy of the filter. The performance of the proposed $\alpha$-$\beta$ filter with different learning algorithms is evaluated by the MAE and RMSE. We have compared the results of these four algorithms for the alpha beta filter algorithm and the best accuracy results we have achieved from ANN is 3.605 and 2.610 as evaluated with the conventional alpha beta filter algorithm which is 5.216 and 3.951 in terms of RMSE and MAE.

## ACKNOWLEDGMENTS

This work was supported by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government (MSIT) (No.2020-0-01441, Artificial Intelligence Convergence Research Center (Chungnam National University))

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# Multi-Criteria Decision-Making (MCDM) Theory Based Ranking of Retirement Homes with its Facilitated Services

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## Abstract

Traditional informal long-term care toward our elder memebrs of the family is becoming increasingly difficult to maintain with the declining family sizes and the migration of their children to big cities. It has become a common phenomenon to seek for establishments that provide such care towards elderly. However, the majority of the services provided by these institutions are ineffective for inhabitants. As a result, choosing the services that contribute the most to a senior citizen's quality of life at a retirement home is a difficult and time-consuming task that necessitates deliberation among a group of specialists and consideration of numerous conflicting criteria. In our proposed method we propose Fuzzy MCDM methods to distinguish the most important services required in a retirement home to prolong the stay of the senior citizens. We integrated the fuzzy logic with two of MCDM methods; AHP and TOPSIS to overcome the challenges of computing weights of multi criteria in terms of accuracy. We also used our suggested methodologies to a case study in Dhaka City to demonstrate the applicability of the proposed method to the assessment problem. When compared, the findings to our methodology with existing methods; PROMETHEE and Fuzzy VIKOR. Our proposed method had lowest computational time and produced comparable conclusions similar to the case study. Which implies that our proposed method is efficient and feasible.

**Index Terms:** Fuzzy AHP; Fuzzy TOPSIS; Multi-Criteria Decision-Making; Retirement homes. Science, etc.

## I. INTRODUCTION

The current economic downturn has forced many low-income families to relocate their senior members to retirement homes, where they will be better cared for. However, the majority of these homes are not built to provide the services required for the comfort and care of the senior residents. Based on multiple published studies and expert interviews [2-4], [6], seven significant parameters that impact the comfort of an elderly have been identified: management, environment, rescue & resource protection, guidance, online

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payment, IoT enabled services, and transportation. In this paper we proposed a fuzzy MCDM method that combines fuzzy AHP and a fuzzy TOPSIS. First we obtain the fuzzy weights for the defined factors that influence the selection of the retirement homes with the help of fuzzy AHP and than rank the alternatives based on the weights of criteria by using fuzzy TOPSIS. Then we compared our finding with results obtained from the case study and measured the performance of the proposed method to the exiting techniques available in terms of the number of services to be considered simultaneously.

## II. SYSTEM MODEL AND METHODS

In this paper we propose a fuzzy MCDM approach to solving the problem of the unanticipated influence of one criteria on the other when computing the weight of a single criterion. We adopted fuzzy logic integration with AHP and TOPSIS. Fuzzy AHP is able to deal with ambiguous or imprecise data using a single grade. While Fuzzy TOPSIS displays human decision-making that is both simple and efficient, and it allows decision-makers to assess the relative performance of the choices.

### *A. Fuzzy AHP*

Traditional AHP techniques cannot accurately replicate the human thoughts, even though the purpose of AHP method is to develop expert knowledge and the effects induced by other criteria should be taken into consideration when computing the weights of single criterion in term of accuracy. To solve this problem fuzzy weights are used, for criteria that approximate human reasoning, and is more accurate than the traditional AHP approach that produce fixed value judgements. Fuzzy AHP can be performed in simple steps;

**Step 1:** Construct the hierarchical framework of evaluation criteria that explains the choices of retirement home theory. Following this we aggregate the experts learned knowledge, using triangular fuzzy number (TFN) [3],[4], by calculating the evaluated priority of sub criteria under the main criteria that is completed by the $K^{th}$ expert in the survey. Next used pair-wise comparison of the criteria of $K^{th}$ expert to form the positive reciprocal matrix [2].

**Step 2**: Using the Buckley's [2] row generative mean approach for normalization and weight calculation of triangular fuzzy positive reciprocal matrix we can state the eigenvector that would reflect on the fuzzy weights of criteria. Than we use the α-cut approach [8] to compute the fuzzy weights of the hierarchical framework's assessment, Then apply the row geometric mean normalization technique on the positive reciprocal matrix when $\alpha$=1 [5].

**Step 3**: Finally, obtain the modulation coefficients and modulation positive reciprocal matrix of lower and upper boundaries to justify the resultant weights for fuzzy integer [5]. Lastly collect all the information from the $K$ expert to calculate the fuzzy weights of each $i^{th}$ criterion [5].

### *B. Fuzzy TOPSIS*

To overcome the shortcomings of the classical TOPSIS method we use the fuzzy weights of criteria obtained from fuzzy AHP and rate the elements in term of linguistic scale [4], the algorithm can be performed in 3 step process;

**Step 1:** The numerous criterion scales is transformed to a similar scale using linear-scale transformation [2]. Since most of the criteria examined are benefit criteria, the normalized fuzzy decision-making matrix and can be generated. Additionally, to increase the effectiveness of the suggested technique, fuzzy linguistic ratings are constructed to detect the normalized TFNs with values between [0,1].

**Step 2:** Calculate the Fuzzy Positive-Ideal Solution ($A^+$) and the Fuzzy Negative-Ideal Solution ($A^-$) and calculate the distance between each alternative, $A^-$ and $A^+$ [4].

**Step 3:** Produce the preference ranking of all feasible choices through proximity coefficient equation. This would reflect the similarity between FPIS and FNIS solutions. As the coefficient approaches 1, an alternate $A_i$ would be closer to FPIS and far from FNIS. Finally, chose the optimal option from the collection off viable alternatives.

## III. RESULTS

Following the construction of the hierarchical structure of assessment criteria, 5 distinct old-age homes were selected and facilitated with different combination of the identified services. 50 experts were asked to fill out a questionary by denoting the importance of the available services within the facility. The knowledge of the experts were then aggregated to establish the priority of criterion considered by each experts through the fuzzy AHP strategy. Which is than used by fuzzy TOPSIS to rank the alternatives. Nine-level of fuzzy linguistic variable were constructed by using the scale of relative importance, Satty [2]. Which is used to determine the fuzzy weights that matched the evaluation criteria. Later, fuzzy TOPSIS decision making approach was used to distinguish the ranking of the design options. The ranking order of the five combinations of relative services demonstrates that the alternative $A_4$ is most suitable option under different number of combination of the services ($\lambda$=1, $\lambda$=2,…, $\lambda$=n). As a result the most required services indicated through the findings were Management, Rescue & Protection and Transportation under any combination. This is supported by the result of the case study and literature review. Furthermore, when we compared the computation time of our proposed model to the exiting methods like Fuzzy VIKOR and PROMETHEE. Our method was able to produce result at the lowest computation time under any given parameter, Fig 1.

## IV. DISCUSSION AND CONCLUSIONS

This study presents a Fuzzy MCDM technique that makes use of an innovative fuzzy AHP and fuzzy TOPSIS. Most retirement homes are built with little regard for the requirements of their residents. The proposed method was applied to a real-world example involving the design of a retirement home with its facilitated services. A numerical assessment was carried out, and the suggested fuzzy MCDM method was clearly proved to be feasible and efficient. The findings suggest that future studies might effectively apply the suggested approach to explore additional decision-making challenges, architects could uses the knowledge to design the retirement homes in a effective manner and community of senior citizens would now be able to make an informative decision when choosing the next retirement home

### *A. Figures*

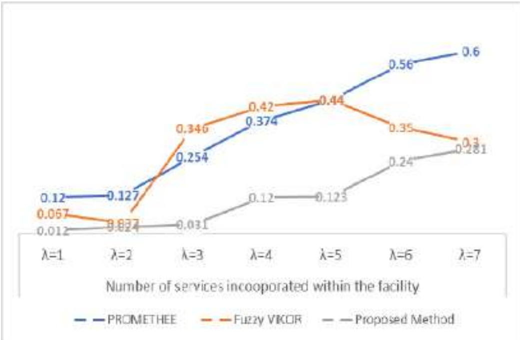


**Fig. 1.** Comparison of the suggested technique to existing approaches in terms of computation time for various numbers of criteria to be considered simultaneously.

### *B. Abbreviations*

AHP - . analytic hierarchy process
TOPSIS - technique for order preference by similarity to ideal solution

## ACKNOWLEDGMENTS

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# Session CA-A

## Communication System and Applications

# Session MD-A

## Multimedia and Digital Convergence

# Developing Waqf Land Information System for the Government of Cianjur District

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## Abstract

Waqf is Philanthropy activity in scientific understanding, engaging religious, social, and economic dimensions, particularly devoted to Public Welfare. To support the purpose and benefits of Waqf and/or to protect Waqf Land Assets from possible lawsuits that potentially adjust the function of Waqf, legal certification for individuals, legal entities, and organizations is required. Proposing waqf land requires long bureaucracy and is weak in validation. In fact, the early submission is directed to the Bureau of Religious Affairs as the technical officer of the Ministry of Religious Affairs, the Indonesian Waqf Agency as the curator, and the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency as the verifier regarding the land ownership status and/or the issuer of Land Waqf Deed. To resolve this, the authors developed data management information system that integrated overall institutions' detailed data. The proposed method is Waterfall through requirements analysis, designing, and implementation in related institutions. The system verified physical and registered certificates; accordingly, was applied in the government area as web application, following positive response upon the success in simplifying, shortening regulatory stages, and performing accuracy.

**Index Terms:** Land Certificate Proposal for Waqf Land, Waqf Land, Waqf Land Certificate, Waterfall Method, and Web Application.

## I. INTRODUCTION

Waqf philanthropic is an "economic corporation," in which, employed as potentially growing capital. Further, developing Waqf promotes collective benefits for the public welfare, to the point that Waqf encourages future investment and develops productive assets. In practice, donating assets in the form of land, automatically changes the ownership status on waqf objects. Therefore, the initially stated private ownership is altered into collective ownership. This is to preserve the waqf object permanently; in addition, providing sustainable benefits serves as the unique characteristic of the Waqf. This is in line with the objective of Waqf, to allow individuals to share private property with society; thus, encourages social welfare.

In reserving the objective and benefits of Waqf, a protective action against a lawsuit that potentially changes the function of Waqf is indispensable; therefore, legal certificates are

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required to protect the land of Waqf against practicable maltreat on the function of Waqf. There are three priorities in protecting the benefits of Waqf: related to the stakeholder, in this case, is the regulator [1], waqf managers (nazhir), and the community, and/or the party (parties) yielding Waqf (waqif) [2], issues related to the limited national budget for waqf certification, as one of the challenges in the case of uncertified waqf land [3].

## II. THE SYSTEM MODEL AND METHOD

The study method was delivered in Waterfall Model [4]; the stages in developing the Information System in Proposing Waqf Land Certification are as follows.

1) Design requirements for the system and application modules in the Office of Religious Affairs, the Indonesia Waqf Board, the National Land Agency, and the Ministry of Religious Affairs.
2) Implement and/or verify each unit that utilizes a web-based application; thus, the application is accessible at anytime and anyplace.
3) Integrate modules and/or verify the system comprehensively, as related to the overall process.
4) Maintain the system for waqf land.

The information was collected through observation, survey, and interviews with the institutions applying the system to propose waqf land certificates.

## III. RESULTS

The finding reported the occurrence of data sequence as generated from the input by The Indonesian Ministry of Religious Affairs, in which the data was under the requirement. The certificates, however, are issued in case no error emerges within the data.

1) The Ministry of Religious Affairs is responsible for organizing the government affairs concerning religious matters and assisting the President in conducting the governance over the nation [5].
2) The Office of Religious Affairs, Waqf land proposal is initially proposed to the Office of Religious Affairs, as the technical officer of the Ministry of Religious Affairs. The office of Religious Affairs, in fact, is responsible for part of the job descriptions performed by the Indonesian Ministry of Religious Affairs in district and municipal areas concerning Islamic religious matters within district areas [6-8]. Additionally, the decision of the Ministry of Religious Affairs No. 18 of 1975 concerning the ministry's decision No. 517 of 2001, and the Government Regulation No. 6 of 1988 concerning the organizational constitution on the Office of Religious Affairs in district area, have explicitly and straightforwardly stated the responsibility of the Office of Religious Affairs as the Official Maker of the Waqf Pledge Deed [8].
3) The Indonesian Waqf Board is established as one of the independent institutions whose responsibility is to support the government in accordance to the job and function in promoting and developing national Waqf, as stated in Waqf Regulation No. 41 [9]. According to article 47, the Indonesian Waqf Board is defined as an independent institution whose responsibility is to encourage Waqf in Indonesia [10].

4) According to the Presidential Regulation No. 17 and 20 of 2015, The Ministry of Agrarian Affairs and Spatial Planning/ National Land Agency is the ministry assigned to organize overall matters regarding agrarian/land and spatial planning within the government; accordingly, to assist the President in conducting the governance over the nation [11].

## IV. DISCUSSION AND CONCLUSION

### A. Use Case System

In the system, four modules were designed with different functions, as presented in fig.1. The modules included data input module by The Office of Religious Affairs; The Indonesian Waqf Board Module, to verify the requirements; and The National Land Agency, to verify the status and land location, in which the certificate is issued in case the data is complete.

The Indonesian Ministry of Religious Affairs Module monitored the process of proposing Waqf land certificates and monitors the overall data, categorized as complete submission and ongoing submission.

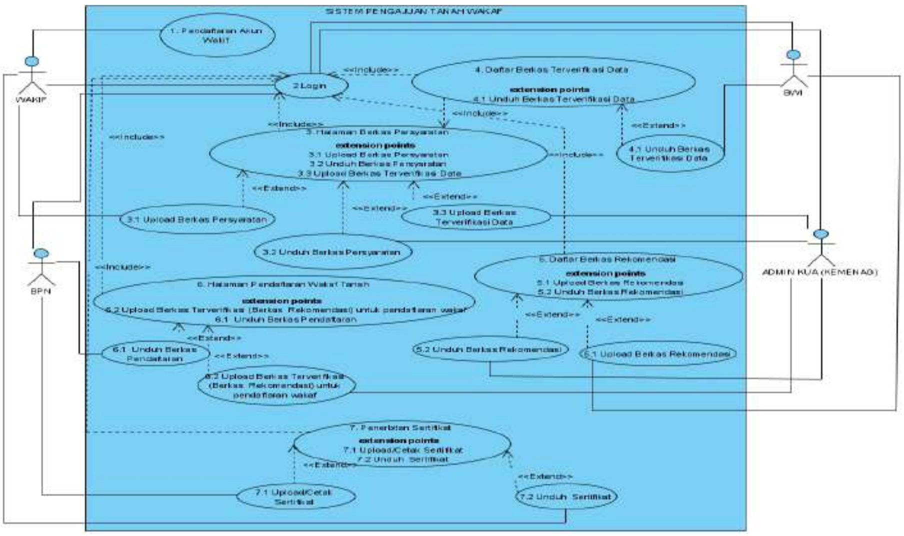


**Fig. 1.** Use Case System in Proposing Waqf Land

The requirements for proposing land certificates to the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency were displayed in spatial data [12]. This was to present the terrestrial data comprising coordinates, as well as non-spatial data.

The waqf land certificate proposal within the system was displayed in the form of complete requirements, as presented in file and location display, as well as a land blueprint in the form of spatial data [13-15]. Further, this spatial data was validated by the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency.

## *B. Application of Waqf System*

The relation table within the system is the implementation of the data, which has been specifically saved in a database in the category of general requirement data.

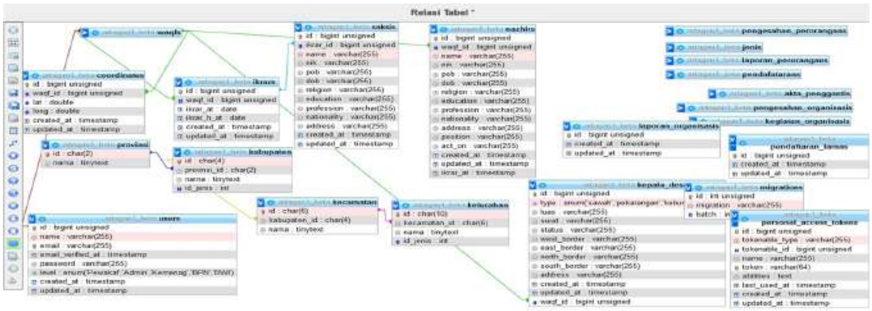

**Fig. 2.** Table Relation

The dashboard of the Waqf system for proposing waqf land, displayed the overall data within the process. The category, however, included the approved submission, ongoing submission, and denied submission of Waqf land.

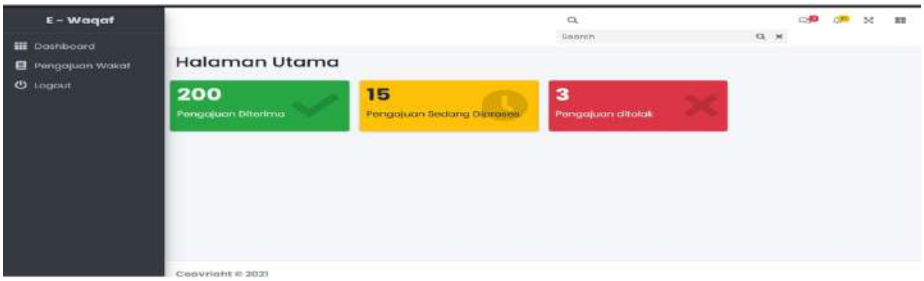


**Fig. 3.** Blueprint and location for waqf land

The data for denied submission is to be returned to the Office of Religious Affairs for revision and or completion.

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# Designing of Mobile Interface for Thesis Management System by Enterprise Portal

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## Abstract

The COVID-19 pandemic situation has encouraged every university to provide virtual services to their students, such as registration, teaching and learning activities, examination, and graduation. The virtual services must be supported by collaboration between divisions at the university such as academics, facilities and infrastructure, human resources, and finance. An enterprise portal is an enterprise-scale application that covers all or part of the organization's divisions and interacts with each other to meet each other's data and information needs. SIKAPETA is an enterprise-scale portal to access thesis services only through the website. The use of smartphones to access thesis has become an unavoidable necessity. In order to provide more optimal services, the university is expected to be able to provide services via mobile applications for its students. This research was conducted using innovative methods to describe enterprise portals that can show interactions between divisions through existing information technology infrastructure and prototyping methods to design informative mobile application interfaces.

**Index Terms**: Enterprise Portal, Mobile interface, Mobile prototyping, and Thesis

## I. INTRODUCTION

Numerous methods are used to design mobile application interfaces with various approaches to produce designs that are stated according to user needs, but what if the required mobile application is an extension of the existing services on the website platform. This research does the design by utilizing an enterprise portal in the form of a website called SIKAPETA and is used as a requirement to design an application interface on a mobile platform. This is considered important because there are many services on the website whose notifications can only be seen if the user logs into the website. Some services are needed to provide real-time information by the user, so this is why mobile applications are important because they can provide notifications anywhere and anytime. Based on these things, this research was conducted to expand services from websites to mobile applications using the prototyping method and utilizing SIKAPETA as an enterprise portal.

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## II. SYSTEM MODEL AND METHODS

The system model that is the object of this research is an enterprise-scale application website called SIKAPETA. The interaction between SIKAPETA users involves students, thesis supervisors, TU Staff, Academic Coordinators, and Financial Managers who are interrelated with each other taking care of student thesis guidance activities starting from registration to graduation.

The method chosen to solve the current problem is the prototyping method used to design a mobile application interface that runs to make the application interface. Even then, it is not provided for all users because the current mobile application service is only needed by thesis supervisors and students

### *A. SIKAPETA As Enterprise Portal*

An enterprise portal is one of the solutions to integrate dispersed applications and data, as well as to support business goals [1]. Enterprises today have broad interconnections, namely, all internal and external enterprise value chains, including consumers, partners, suppliers, governments, and communities, connected to information technology systems [2]. Broad connectivity will enable supply chain networks, customers, and other entities worldwide to plan and make decisions interactively [2].

SIKAPETA (*Sistem Informasi KP dan TA*) is a website portal that acts as a means of information technology created to support practical work (*Kerja Pratek*) and thesis (*Tugas Akhir*) services at a university (KP stands for *Kerja Praktek* and TA Stands for *Tugas Akhir*) [3]. SIKAPETA has services provided for thesis supervisors, students, administrative staff, academic coordinators, and financial managers [4]. The SIKAPETA service described in this study is limited only to thesis Supervisors and Students because SIKAPETA itself is being developed, and mobile application services are needed by thesis Supervisors and Students. The services provided for students are as follows 1) Making guidance notes; 2) Seminar schedule information; 3) Seminar/trial registration; 4) View seminar/trial result. Then the services provided for thesis supervisors are as follows 1) See the list of KP/TA participants; 2) Seminar/trial schedule information; 3) Input the result of the seminar/trial; 4) Ratification of the minutes of guidance

### *B. Prototyping*

Developers use prototypes to get feedback and experience about systems that are not yet fully built. The prototyping process does not follow a specific set of rules: A prototype can be used to explore whatever information is most relevant to the developer at a given stage. A prototype does not need to be polished or finished; because it can be made in any form, which can get feedback on design decisions. The earlier the decision is tested, the easier it is to consider the insights generated in further development.

A prototype is an early version of a software system used to demonstrate concepts, try out design options and generally find out more about a problem and its possible solutions [5].

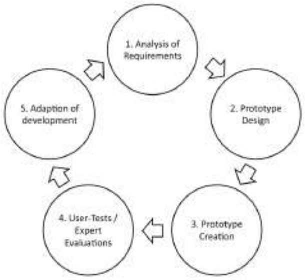


**Fig. 1.** Usability Engineering Lifecycle

The cycle begins with an Analysis of Requirements for the current status of the product and planning the iteration cycle at the next stage. Based on this, the prototype is designed to meet the identified requirements, in other words, ask questions about the current status of the product [5].

## III. RESULTS

### *A. Requirement Analysis*

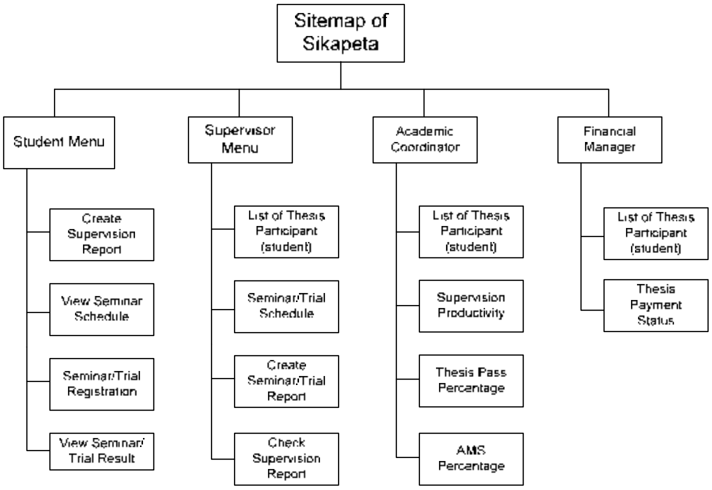


**Fig. 2.** Sitemap of SIKAPETA

Based on the implementation stages of the Prototyping method, the design of the mobile application interface for Thesis Management System services can be started with the requirement analysis stage, and then the analysis begins by describing the services provided by the SIKAPETA portal.

There are four services, namely thesis supervisors, students, academic coordinators, and financial managers, but the scope of mobile application development is currently only needed for thesis supervisors and students. The other part is still using the website platform and does not require a mobile application.

### B. Prototype Design

This interface is made in Indonesian, and the design is done by making a mobile device interaction design using the Balsamiq Wireframe application version 4.2.1.


**Fig. 3.** Supervisor Menu

The menu on Fig. 3 is the menu for the thesis Supervisor who has logged in. In accordance with the needs analysis results, there are four services that can be accessed by the thesis supervisor, such as information about the seminar/thesis trial schedule, thesis participants, creating seminar/trial report, and checking Supervision Report.


**Fig. 4.** Student Menu

The menu in Fig. 4 is the menu for Students who have logged in. There are four services that Students can access, such as creating supervision reports, seminars/ trial registration, viewing seminar schedules to attend participant seminars as a requirement for seminar registration, and viewing the results of seminars/trials.

## IV. DISCUSSION AND CONCLUSIONS

Designing an interface for a mobile application using a prototyping method involving an enterprise portal turned out to be very doable. However, not all services on the website can be made on a mobile platform because it depends on the requirements needed by the user. In addition, the prototyping method (Fig. 2) used in this study has been carried out up to stage two and can still be continued in the next stage. In addition, the interface design can be continued for all services provided by SIKAPETA on the mobile platform with the additional feature of using a pin code or scanning QR code for each data verification process.

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# Design of Self-Evaluation Model for Smart City in Bandung

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## Abstract

Smart City Self-Evaluation is used to measure the implementation of smart the city independently. This measurement aims to determine the level of stability of the cities application to make improvements or stimulation in achieving the desired smart city goals by utilizing Information Technology and Technology (ICT) and can be innovative potential in solving various urban challenges in all fields. This research focuses on designing self-assessment software to simplify data collection as smart city assessment entry. This study uses an object-oriented concept with development requirement analysis, software design, and design evaluation for the research stages. The result is a software design consisting of process business, use cases, and user interface tailored to the needs of the local government of Bandung in supporting the smart cities concept.

**Index Terms**: Design, Smart City, Self-evaluation, Bandung, Object Oriented

## I. INTRODUCTION

City is the center of human civilization with various facilities and facilities provided. Its existence continues to develop into a magnet for residents to come and stay in urban areas. In 2025 Indonesia is currently around 59.35% of the population living in urban areas is estimated to be 67.66% and will reach 82% in 2045[1]. As the population grows, City continues to grow significantly and raises problems such as housing, education, health, public services, etc. And to solve the problem, various solutions have been developed, one of which is the concept of Smart City [2].

The performance of local governments to be faster, responsive, innovative, and trustworthy solutions for rapid development of cities and regencies in Indonesia requires. To bring this speed, like it or not, the Regional Government needs technological assistance. The Government of Indonesia has implemented a Smart City initiation policy that utilizes Information Technology and Technology (ICT) which is one of the technologies that has innovative potential to solve various urban challenges effectively on all sides of the Regional Government [3].

The City Regional Government has carried out various initiatives and has a Grand Design towards a Smart City that focuses on the use of ICT to ensure effective and efficient use of resources, city administration, public services and can solve various city challenges using innovative, integrated solutions, and sustainable to provide infrastructure and provide urban services that can improve the quality of life and meet the needs of the population [4]. The

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problem is that cities have not been able to carry out an independent evaluation of the implementation of a smart city in a measurable manner according to the city's needs [5]. However, it requires advanced support for the development and operation of applications in a complex and dynamic environment [6].

Through this study, a software design will be developed that can assist in collecting data on the evaluation indicators for measuring the implementation of smart cities so that the city gets an initial picture and can determine strategies in increasing the value of implementing smart cities following city goals.

## II. SYSTEM MODEL AND METHODS

RAD (Rapid Application Development) was chosen as a system development model because it requires a little time in its development and analysis of the requirement has been identified. Tailored with the pressman says that the application of the RAD method will run optimally if the application developer has formulated the needs and scope of application development [7].

While the system development model uses UML (Unified Modeling Language), which can help analysts define, visualize, and document software system models, including their structure and design, by meeting all software requirements and helping analyze and design appropriate solutions. [8].

The following are the stages of the research that has been carried out

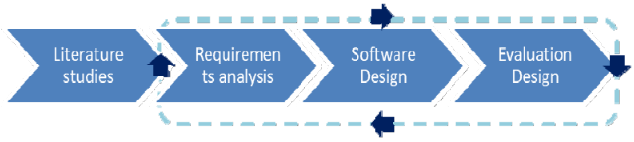



**Fig. 1.** Research Stages

## III. RESULTS

### *A. Process Business*

There are 8 stages in smart city self-evaluation process business.

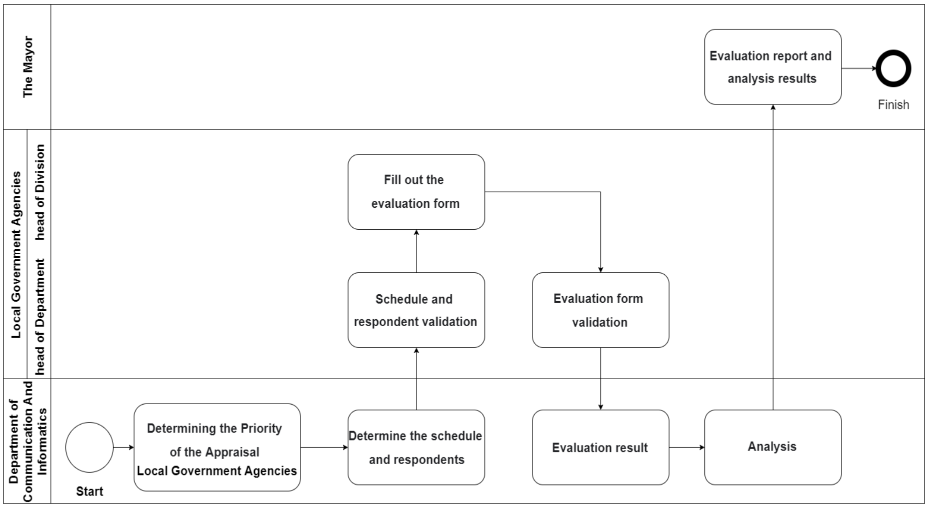



**Fig. 2.** Process Business for Bandung Smart City self-valuation model

## *B. Use case*

There are 10 use cases and 4 actors in smart city self-evaluation.

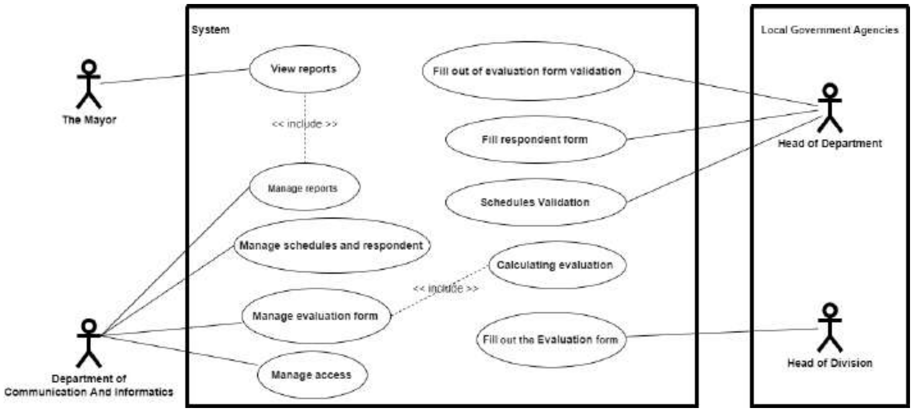
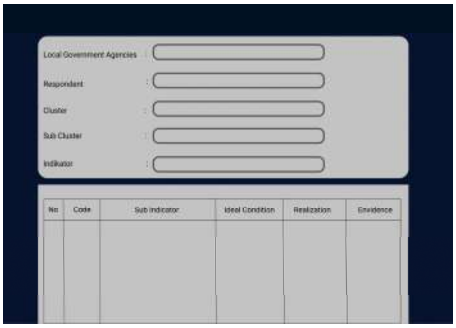



**Fig. 3.** Use case for Bandung Smart City self-valuation model

### C. User Interface design


(a)




(b)

**Fig. 4.** User interface design for Bandung Smart City self-valuation model, dashboard (a), evaluation form(b)

## IV. CONCLUSIONS

Based on the research that has been done, it can be concluded that:

a. Design application following Bandung Smart City Evaluation Model.

b. Design through the stages of literature study, requirements analysis, software design and evaluation.

## ACKNOWLEDGMENTS

We would like to thank Institute of Research of Langlangbuana University, Bandung City Government, and Bandung Communication and Informatics (Planning, Evaluating and Developing ICT resources).

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# A New Segmentation and Extraction Method for Manchu Character Units

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## Abstract

Manchu is a script that is written vertically, from top to bottom, with each letter in a word connected by a central stem. Since there are no spaces between the letters in a given word, a preprocessing method is required in order to extract the individual character units from a given word before any kind of character recognition can be performed.

In this paper, we describe a preprocessing method that effectively divides Manchu script words into individual character units. Unlike existing research that first removes the central stem of a word in order to recognize the remaining pieces to the left and right of the stem, or attempts to perform recognition tasks on whole words and not the individual characters within the words, this method cuts each vertical word horizontally into recognizable character units. Character recognition can then be applied to the individual units that are separated out from each word. The effectiveness of this method was verified on multiple images of Manchu script.

**Index Terms**: Manchu Characters, Character Recognition, Preprocessing, Pattern Recognition

## I. INTRODUCTION

The Manchu language was once a language of great importance. It is the traditional language of the Manchu people who live in Manchuria in Northeastern China. In 1644, when the Manchus conquered China, they established the Qing dynasty, China's final imperial dynasty, and the Manchu language became the dynasty's lingua franca, enabling trade and business to be conducted by people who did not share a common first language. Although Manchu was once one of the most important official languages in China, for nearly 270 years, today it is nearly extinct. But, given the language's prominence during the Qing dynasty, its widespread adoption as lingua franca, and the lengthy time period during which official documents were produced in it, the language still holds great historical significance.

With the development of optical character recognition (OCR) technology, by which images of handwritten or printed text can be encoded into a digital format, interest in recovering Manchurian and Chinese history through the scanning and character recognition of Manchu documents has increased. However, as the script is written vertically, with no spaces between letters of the alphabet, pre-processing is required to separate the character area and the units that make up the characters before being able to recognize the characters.

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In fact, studies for recognizing Manchu characters have been actively conducted since the early 2000s, but there has been a limit to the accuracy of the recognition rate to an error in character unit extraction. Therefore, due to the fact that Manchu is written vertically and the words typically contain a vertical and central stem that connects all the letters, one method proposed uniformly removing the central stem of Manchu words in recognition tasks in order to pay attention to and recognize the remaining pieces on both sides of the stem [1].

However, even though the central stem is removed from the word in order to separate out individual character units, there may be an error in character recognition. Therefore, another method has proposed recognizing units of Manchu words themselves rather than breaking the words down into individual character units in order to avoid possible errors in character recognition [2]. In this method, each individual word that is surrounded by whitespace becomes the object for recognition. This method of extracting individual words can then be applied to machine learning, and a method of individual word extraction and transformation has been proposed in order to generate a large amount of training data for word recognition [3].

In this paper, we propose a new method of extracting individual units of Manchu characters that can help increase the recognition accuracy of the characters. Unlike the previously proposed method of removing the central stem of a word, this method separates Manchu words horizontally without removing the central stem. Each Manchu word is instead divided based on the narrowest portion of the stem so that even if the stem passes through the center of a character unit, the unit can be extracted as it is.

## II. EXISTING MANCHU CHARACTER EXTRACTION METHOD

Fig. 1 displays the previously mentioned existing method to separate and extract individual Manchu character units [1]. In this method, because Manchu words are written vertically and a central stem passes through each individual character unit, the central stem is removed, and the remaining pieces in both directions are recognized as a unit. In this case, an arc-shaped pattern or curved form in the central stem may be mis-recognized due to its incorrect separation into two patterns rather than one.

## III. SUGGESTED MANCHU CHARACTER EXTRACTION METHOD

A page of Manchu script is shown in Fig. 2. Each line of the script is written vertically from top to bottom, and the script reads from left to right. The words in each line of script are likewise written vertically. The following steps are performed in order to extract the character units from each word within each line of text.

First, the image is binarized so that the value of each white background pixel becomes 1 and the value of each black pixel containing the script becomes 0. Then, as shown in Fig. 3, the image is inversed (changing 1s to 0s, and vice versa) so that it can easily be scanned in Python for non-zero values which would be the location of pixels containing the script. Salt and pepper errors are then removed by erosion and expansion. The image is then scanned from left to right and non-zero values are detected and recorded. The image is then cut and separated into lines of text wherever a vertical line of pixels with all 0 values changes to a line containing 1s (the left side of the line of script), and vice versa (the right side of the line of script).

After a page containing the Manchu script is separated into lines of the script, the same non-zeros scanning method is performed in a top-down manner on each line of script in order to further divide the lines into words. Finally, each separated word is scanned again from top to bottom and divided at the point that contains the narrowest width of the word. In other words, the lines of pixels in the word that contain the fewest non-zero values within a given threshold are cut into separate character units.

## IV. EXPERIMENT RESULT

This Machu character extraction algorithm was written in Python. Fig. 4 displays the cumulative number of non-zero pixel values in an image that is 459x748 pixels in dimension.

The results displayed in Fig. 4 indicate that the image of Manchu script in Fig. 3 can be divided into 13 lines of text. The separation points are as follows [left cut point, right cut point]: [[13, 42], [46, 76], [80, 110], [114, 144], [148, 178], [182, 211], [217, 245], [251, 279], [284, 313], [319, 347], [353, 381], [385, 415], [419, 448]]. Scanning the first cut line of Manchu script in the same manner, but this time in a vertical manner, the first word, as shown in Fig. 5 can be extracted. In this way, all the words in each line can be extracted.

When the first word is then scanned vertically, there are no locations where the number of pixels becomes 0 because all the letters are connected by the central stem of the word. Therefore, the locations in the word that contain the narrowest width of pixels within a given threshold becomes the cut point for each character unit. Fig. 6 displays a graph of the number of pixels in each vertical line of the word, and the cut points for the first word shown in Fig. 5 can be visualized at 7, 14 (to 15), and 25, with between 3 to 4 pixels in width each. The final result of this character separation results in 4 cut characters and is shown in Fig. 7.

## V. CONCLUSION

In this paper, a new method for effectively extracting Manchu characters from images of Manchu scripts was proposed. Unlike the existing method, which divides Manchu words vertically, this method separates Manchu words into character units horizontally, and without first removing the central stem of the word. After binarizing and inverting the image of Manchu text, each line of the text is extracted by scanning the image vertically for script pixel values. Each line of the text is then scanned horizontally and words are extracted. Each word is then scanned horizontally and character units are extracted at the narrowest points within a given threshold value.The validity of this proposed method was verified with multiple pages of Manchu script text.

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## FIGURES

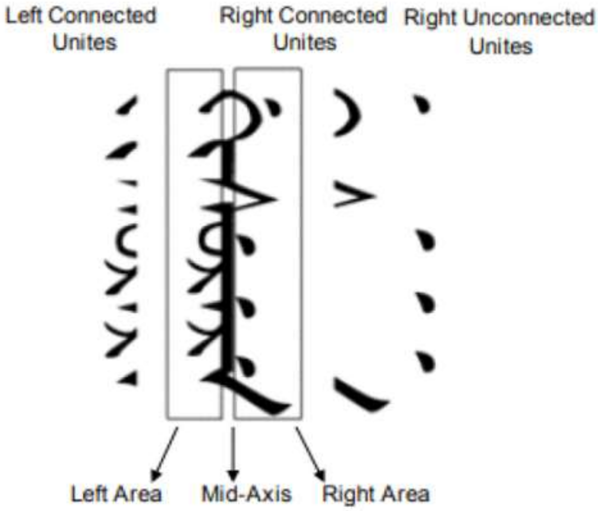


**Fig. 1.** Comparison between service disruption periods in each protocol: impact of link delay between local mobility anchor (LMA) and mobile access gateway (MAG)

**Fig. 2.** A page containing Manchu characters

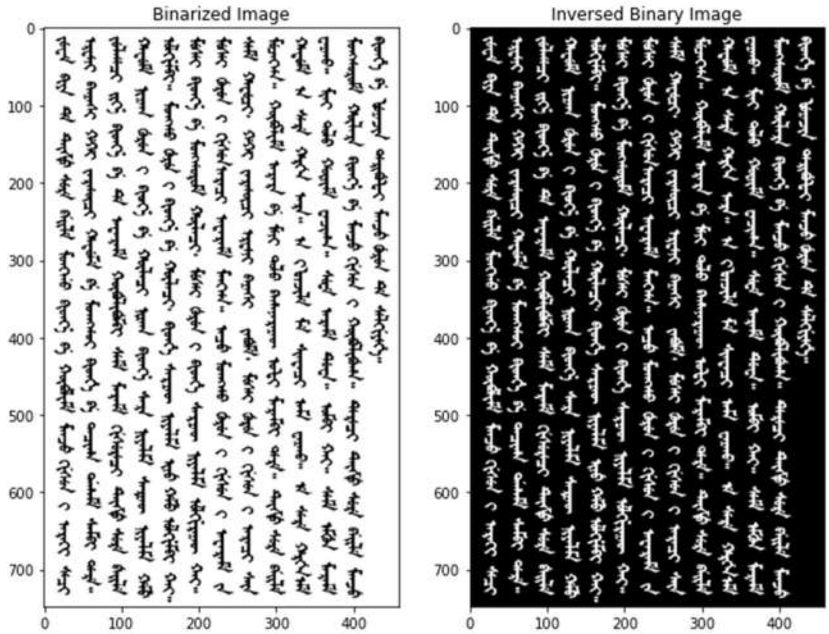


**Fig. 3.** A binarized image of Manchu text (white background, black text) and its inverse (black background, white text)

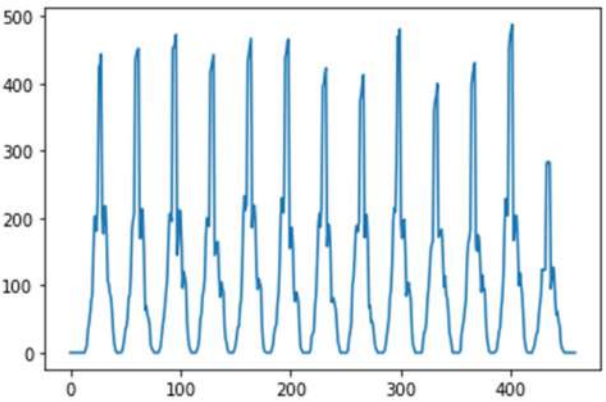


**Fig. 4.** The number of non-zero pixel values in the inverse binary image of Manchu script when scanning for non-zero values in a horizontal direction

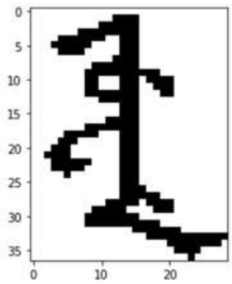

**Fig. 5.** The first word extracted from the leftmost column

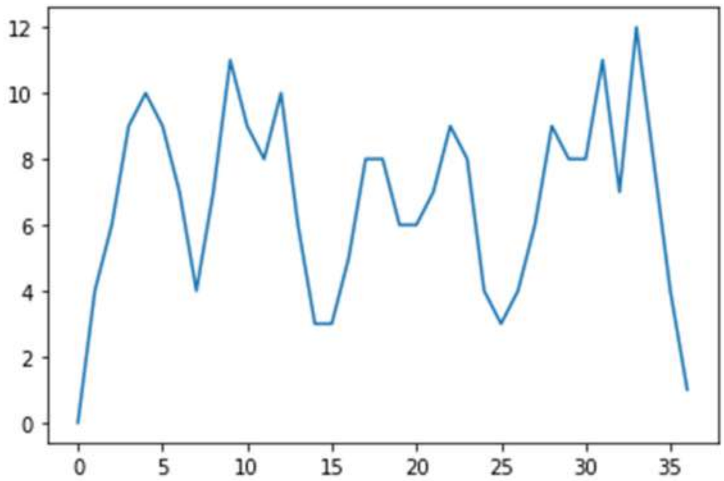

**Fig. 6.** The pixel widths of each line of the first word of the script when scanning vertically from top to bottom. The narrowest widths of the word are between 3-4 pixels in width and are determined to be cut points for the word at 7, 14, and 25

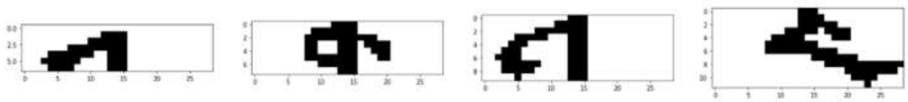

**Fig. 7.** The final result of the extraction of character units from the first word of the Manchu script

# Binary Gender Perspective on IVML Prototype Using Kansei Engineering Approach

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## Abstract

This paper examines the response of the users' feelings derived from gender perspective under human-computer interaction (HCI) toward interactive video mobile learning known as IVML prototype. The IVML prototype was developed for the Android platform channel allowing users to install and utilize the app for m-learning purposes. This paper aims to measure the level of feelings response toward the IVML prototype and examine the differences in gender perspectives and identify the most responsive feelings between male and female users as the prominent feelings. The feelings response was then extracted from user experience, user interface, and human-computer interaction concerning gender perspective using the Kansei engineering approach as the measurement method. The statistical results may show the possibility of having different emotional reactions from a male and female standpoint toward the IVML prototype or perhaps have a similar emotional response from one to another.

**Index Terms:** Mobile Learning, IVML; Kansei Engineering, Gender, User Experience, Human Computer Interaction

## I. INTRODUCTION

Educational videos have been widely used for years and are considered an effective medium to deliver audio-visual information to learners. Many research conducted on educational video for instance the potential of video-based education in several fields including medicals, economics, sciences, and et cetera. As agreed by Denny, Vahidy, Vu, Sharrief, and Savitz in their study, the educational video is much more effective in increasing knowledge rather than the written materials in a way that the video-based educational tool could help improve stroke literacy in hospitalized stroke patients [1].

In addition to that, interactive video mobile learning can be considered as one of the alternative forms to extend the capability and availability of video mobile learning. The cue points' interaction feature allows learners as the users to have added user control aside from the standard interactions such as play, stop, rewind, and forward buttons. Referring to Cresswell, Loughlin, Coster, and Green's study, based on their preliminary evaluation on video-based learning for organic and analytical chemistry, they found out that from the way respondents interact with the educational video, they were looking for interactive learning opportunities. Their behavior in rewinding, pausing, and reviewing suggested that they are looking for the key sections [2]. However, the response of user feeling toward interactive educational video is not yet a prominent subject in this study. There is not much study related to emotions derived from video style can be found so far whereas the learners' learning style should be taken into consideration when examining the emotions toward different types of videos [3].

Despite that, there are different methods to capture emotion in human-computer interaction (HCI) depending on the research aims and research perspectives such as Kansei engineering and sentiment-specific emotion recognition technologies. Kansei engineering known as KE has the capability to examine the user's feelings toward the product design features by quantitatively translating the human emotion requirements and identify the connection between emotions and the product design [4]. Where else the sentiment-specific emotion recognition technologies are based on the sentiments detection followed by analyzing the sentiments expressions under different modality such as text, speech, visual and multimodal displays [5]. Another way to identify the emotion and analyze it is through the psychological signals where the emotions are defined with arousal and valence levels as an emotional classifier. [6] However, both sentiment-specific emotion recognition and psychological signals for emotional classifier are for HCI systems usability rather than the correlation to product design. Hence, this study opts for the KE approach to analyze the relationship between emotion and product design.

In gender aspect, most researches focus on gender are inclined to female perspective rather than male perspective in a way that the percentage keyword of women in the research title is exceeding the keyword of men hence leaves the impressions that gender matters to women alone, and this need to be reflected [7]. Furthermore, a gender perspective in HCI has developed into a complex topic in research studies wherein some researchers pointed out the focus study in HCI should include another gender aside from the binary gender that consists of male and female. As mentioned by Keyes, the HCI were given critiques for failing to consider or include the transgender perspectives in research [8].

However, this study will focus on the binary gender but can be used as future work for those who are interested to explore transgender perspectives. The focus of this research is to investigate the response of the feeling derived from the usability of the IVML prototype, compile a checklist of prominent emotions based on user experience (UX) and user interface (UI) in HCI through a pilot testing and identify the responsive feelings between male and female users.

## II. THE IVML PROTOTYPE DEVELOPMENT

It is known that the multimedia elements such as audio, graphics, video, text, and animation when effectively combined into one video can contribute to enhancing the way information delivered. Video-based collaborative learning helps learners to understand the concepts based on the visualization of the real-world situations that the video provides [9]. Media diversity plays a significant role in increasing the aids for learners to process the information while less diversity leads to limitation in understanding the contents [10]. Thereof, applying the HCI design with a touch of UI and UX in educational video mobile learning could leverage the media diversity by expanding the standard interactive element and the flexibility that it could provide in the mobile learning platform.

Hence, an IVML prototype was developed for the Android platform to widen the standard interaction by providing a cue points feature that allows leap action between time points in video timelines for mobile devices such as smart phones. The cue points feature allows learners to skip and jump to the key sections of the educational video. Aside from adding the cue points feature in the application, the IVML prototype also provides links to videos on YouTube and a quiz section to test learners' comprehension of the topic. The IVML prototype is an application that acts as a side note for one subject in a form of audio-visual information, targeting students as users where they can install the application and learn from it then uninstall the application once they are done.

The module used in this IVML prototype is a basic web programming that consists of HyperText Markup Language (HTML), Cascading Style Sheet (CSS), and JavaScript (JS). The approximation of this video is in 10 minutes where the timeline was divided into six targeted cue points representing each of the topics. The HCI design for the IVML prototype focuses on UI and UX usability. Fig. 1 shows the IVML prototype application executed on the Android platform for pilot testing.

## III. METHODOLOGY

### *A. Analytical Techniques*

A survey was conducted using a quantitative method to obtain the responses of the feelings from users for user interface and user experience. There are 44 respondents involved as users in the pilot test wherein 10 feelings data was presented for 22 users per gender. The feelings measurement level begins from a 1 to 5 rating scale work as an indicator wherein each may incline to positive or negative emotion. Three different analysis techniques were used in analyzing the feelings data. Each of these analytical techniques has its own purposes.

The first analytical technique used for analysis is the KMO and Bartlett's Test. The KMO and Bartlett's Test helps to analyze the data adequacy whether if the variables are acceptable enough to be analyzed. The second analytical technique is the Principles Component Analysis (PCA). The PCA helps generate the potential emotion factor and extrude the low communalities which help to reduce the unnecessary data. The third analytical technique is the Descriptive Statistics Analysis (Frequency). The Descriptive Statistics Analysis helps discovers the most prominent feelings based on the statistics frequency generated from the data figures. Table 1 show the analytical techniques used in analyzing the data.

### *B. KE Measurement Design Framework*

A framework was designed to execute the emotion treatment using the KE measurement. The steps begin with the data collections that consist of feelings variables, respondents, and a product sample. A pilot testing was conducted based on these data wherein 44 users with 22 males and 22 females tested the IVML prototype. A questionnaire was given to them after the pilot testing to project their feelings. The feelings data was then analyzed to sample out the adequacy value of the feelings variable before next analysis begins.

Referring to Fig. 2, the data collection derived from the feelings, respondents, and product sample will go through the Factor Analysis KMO for adequacy sampling and then proceed to the PCA extraction method to extrude the low communalities variables for data reduction and protrude the high communalities. These feelings variables then used for descriptive statistics analysis to identify the most responsive feelings based on the statistics data frequency and to assess the value of Mean acquired from rating scales and the respondents.

### *C. Performance Metrics*

The Mean value in Descriptive Statistics Analysis (Frequency) expresses the average numbers of the feeling's rating scale. Below is the Mean formula to obtain the Mean value from the total rating scale and total respondents:

$$\frac{\text{Total Rating Scale}}{\text{Total Respondents}} = \text{Mean Value}$$

The Mean formula and the interpretation example of Ɲ as a Mean Value in respondents' feelings are presented as follow:

<u>Example of Data Collection:</u>
Total Respondents = 5

<u>Students Rating Scale:</u>
*Positive* = 5, *Almost Positive* = 4, *Moderate* = 3, *Less Negative* = 2, *Negative* = 1

<u>Example of Situation:</u>
Respondent A feel *Negative*, Student B feels *Moderate*, Student C feels *Positive*, Student D feel *Less Negative* whilst Student E feels *Almost Positive*.

Thus, the conditions are:
Student A = 1 Student B = 3 Student C = 5 Student D = 2 Student E = 4.

<u>Mean Formula:</u>

$$\frac{1+3+5+2+4}{5} = \text{Ɲ}$$

$$\frac{15}{5} = \text{Ɲ}$$

$$3 = \text{Ɲ}$$

Condition Statements:

Mean Value = Ɲ, and if Ɲ = 3 then Ɲ is moderate therefore the average feelings of students are moderate.

## IV. RESULTS AND FINDINGS

### *A. KMO Bartlett's Test*

The KMO and Bartlett's Test was conducted on 44 students whereby these students were divided into two groups based on their gender. The treatment was done to each group of gender as shown in Table 2 for males and females.

The value between 0.50 to 0.70 are considered as average, the value between 0.70 to 0.80 is considered as good, the value between 0.80 to 0.90 are considered as great and the value of 0.90 and above are considered as excellent. The KMO and Bartlett's Test significance value must be less than 0.05 for correlated variables that occurred. Therefore, the Factor Analysis is appropriate for these data.

### *B. Principal Components Analysis (PCA)*

The communalities range is from 0 to 1 where 0 means no variance and 1 means high variance. If the number is less than 0.5, it is considered low communalities and should be removed from the analysis. However, the PCA results variables for both genders are relatively high which indicating a good result.

### *C. Descriptive Statistics Analysis (Frequency)*

Table 4 signifies the results of Descriptive Statistics Analysis Frequency for IVML prototype between male and female users. Based on the results, the IVML prototype manages to stimulate positive feelings from both genders except for feeling convenient to the male group and feeling appealing to a female group where the result frequency show feeling neutral.

The mean values above 3.50 or below 3.00 for each feeling presented strong total rating scales inclination from the total respondents. Therefore, the mean value projected for both groups does show a strong inclination to each respective feeling.

## V. DISCUSSION AND CONCLUSIONS

The pilot testing of the IVML prototype was conducted to evaluate the feelings respond from the binary genders toward the usability of HCI in the product design of the IVML prototype under UI and UX design perspectives. Based on the positive feelings reactions from both genders, it shows that the IVML prototype product design capable to leave the impression of a mutual feeling in both genders of not being a boring application, a creative product design, interesting to utilize for mobile learning, almost necessary to have one, almost satisfied the need for video mobile learning and the application is user-friendly.

Even so, there are still a bit differences in feelings respond on both genders such as the feeling of appeal and convenience. From male users' perspective, the IVML prototype product design is almost appeal, almost fun, and almost refreshing to them but when it comes to being convenient, they felt neutral. While from female users' standpoint, the appeal of the IVML prototype was seen as neutral but they do feel that the application, in general, is almost convenient, fun, and refreshing to them.

Thus, this concludes that the IVML prototype can instigate the positive feelings responses from both genders in which both group respondents almost have mutual response toward this type of product design.

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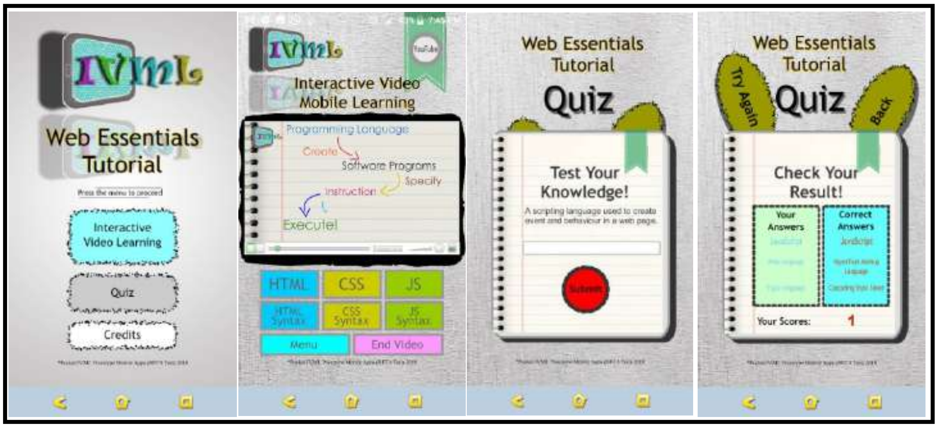


**Fig. 1.** Prototype on Android Platform

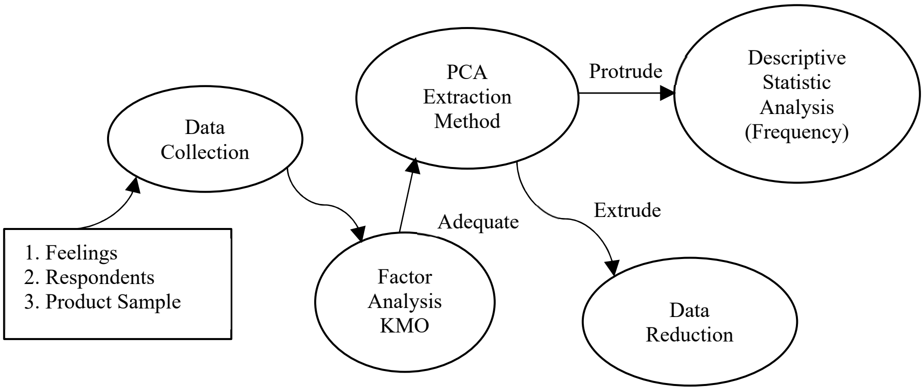


**Fig. 2.** Kansei Engineering Measurement Design Framework

**Table 1.** Analytical Techniques

| Analysis Method | Action |
|---|---|
| KMO and Bartlett's Test | Sampling the adequacy value of feelings variable used in research experiment to verify whether the value is acceptable (in reference to the standard KMO value) before proceeding to analysis. |
| Principal Component Analysis (PCA) | PCA extraction method to extrudes the low communalities feelings from analysis and protrude the potential emotion factor. This feelings reduction can be done through feelings extraction. |
| Descriptive Statistics Analysis (Frequency) | Identify the most common feelings respond towards UI and UX design of IVML prototype on both genders. |

**Table 2.** KMO and Bartlett's Test for Male and Female Groups

| Male | |
|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | .658 |
| Sig. | .000 |
| **Female** | |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | .557 |
| Sig. | .000 |

**Table 3.** Principal Component Analysis (PCA) for Male and Female Groups

| Male | | |
|---|---|---|
| | **Initial** | **Extraction** |
| Appealing | 1.000 | .767 |
| Boring | 1.000 | .665 |
| Convenient | 1.000 | .734 |
| Creative | 1.000 | .686 |
| Fun | 1.000 | .589 |
| Interesting | 1.000 | .816 |
| Necessary | 1.000 | .608 |
| Refreshing | 1.000 | .899 |
| Satisfied | 1.000 | .605 |
| User-Friendly | 1.000 | .840 |
| **Female** | | |
| | **Initial** | **Extraction** |
| Appealing | 1.000 | .858 |
| Boring | 1.000 | .879 |
| Convenient | 1.000 | .861 |
| Creative | 1.000 | .825 |
| Fun | 1.000 | .835 |
| Interesting | 1.000 | .734 |
| Necessary | 1.000 | .714 |
| Refreshing | 1.000 | .830 |
| Satisfied | 1.000 | .814 |
| User-Friendly | 1.000 | .882 |

**Table 4.** Descriptive Statistics Analysis (Frequency) for Male and Female Groups

| Male | | | | |
|---|---|---|---|---|
| **Types of Feelings** | **Level** | **Frequency** | **Total Rating Scales** | **Mean Value** |
| Appealing | Almost Appealing | 8 | 79 | 3.59 |
| Boring | Not Boring | 9 | 50 | 2.27 |
| Convenient | Neutral | 7 | 78 | 3.55 |
| Creative | Creative | 10 | 94 | 4.27 |
| Fun | Almost Fun | 9 | 94 | 4.27 |
| Interesting | Interesting | 13 | 98 | 4.45 |
| Necessary | Almost Necessary | 9 | 80 | 3.64 |
| Refreshing | Almost Refreshing | 8 | 82 | 3.73 |
| Satisfied | Almost Satisfied | 8 | 81 | 3.68 |
| User-Friendly | User-Friendly | 9 | 86 | 3.91 |
| **Female** | | | | |
| **Types of Feelings** | **Level** | **Frequency** | **Total Rating Scales** | **Mean Value** |
| Appealing | Neutral | 8 | 77 | 3.5 |

| | | | | |
|---|---|---|---|---|
| Boring | Not Boring | 11 | 46 | 2.09 |
| Convenient | Almost Convenient | 7 | 79 | 3.59 |
| Creative | Creative | 11 | 97 | 4.41 |
| Fun | Fun | 10 | 91 | 4.14 |
| Interesting | Interesting | 12 | 96 | 4.36 |
| Necessary | Almost Necessary | 8 | 87 | 3.95 |
| Refreshing | Refreshing | 10 | 86 | 3.91 |
| Satisfied | Almost Satisfied | 8 | 83 | 3.77 |
| User-Friendly | User-Friendly | 10 | 93 | 4.23 |

# Session IT-A

## IT Convergence Technology

# Session DA-A

## Database and Internet Application

# Analysis of Robust Anomaly Detection Using Convolutional Neural Network with Industrial Load Power Data

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## Abstract

This paper proposes to analyze a robust anomaly detection method for load power data in industrial fields by integrating decomposition and convolution neural networks. The research initially examined the decomposition of the load power data to ensure it can work effectively with complex patterns and simple neural network architecture. We analyze all possible conditions to capture multiscale information effectively from load power data graft to attain an abnormal state. Since labeled data is limited under periodic data conditions, we investigated data of augmentation method for decomposed components periodically and frequency ranges by adding label values and weights in the loss function; then exploiting the anomaly data to ensure a high-predictive score to detect anomaly condition on load power.

**Index Terms**: Anomaly Detection, Convolutional Neural Network, Decomposition, Robustness, Load Power Data

## I. INTRODUCTION

With the rapid development of IoT applications in every aspect, real-time time series anomaly detection is required in many real-world applications, such as predictive maintenance, intrusion detection, fraud prevention, cloud platform monitoring, management, business data monitoring, etc. Detection of time series anomalies has been studied for a long time. However, none of the existing algorithms can work well in large-scale applications. The mind reason is time-series data in real-world scenarios is quite diverse. It contains temporal dependencies and may present more complex patterns, such as unexpected trend changes and annual shifts and fluctuations, and labeling anomalies is challenging, and consequently, fairly limited labeled data are available.

Robustness is an attribute of resilience that measures the system's behavior under non-standard conditions [1]. Robustness is the degree to which a system operates properly or correctly in the presence of extraordinary inputs or stressful environmental conditions. As the triggering robustness in anomaly detection could even impact the system in the worst-case scenario, detecting this type of anomaly detection is of utmost importance [1].

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This paper proposed a method to analyze the robustness of anomaly detection for load power data is, integrating time series decomposition with a convolutional neural network. Systematically investigate data augmentation methods for time series in decomposed components in time and frequency domains. Then analyze a network based on U-Net, an encoder-decoder architecture with skip connections to extract multiscale features from time series.

The rest of this paper is organized as follows. Section II provides an analysis of Convolutional Neural Networks related to time series data. In section III, we describe the proposed methods of this research. Finally, in the IV section, our conclusions are summarized.

## II. CONCEPT OF CONVOLUTIONAL NEURAL NETWORK FOR ANOMALY DETECTION WITH TIME SERIES DATA

### *A. Convolutional Neural Networks (CNNs)*

Several concepts such as Recurrent Neural Networks (RNNs) and Short-Term, Long-Term Memory (LSTM) networks are ideal for temporal dependency modeling, have been proposed to detect time series anomalies [2]. However, the challenge for this network is how to deal with seasons, especially long seasons, in general. For example, it proposes establishing a shortcut connection to study seasonality directly, but time-series data from different season lengths are generally undermined. In contrast, Convolutional Neural Networks (CNNs) have limited application in time series classification and clustering and, more recently, in anomaly detection. CNN's are popularly known to work on spatial or 2D data, but it is can also work for 1D data. Instead of extracting spatial information, we can use 1D convolutions to extract information along the time dimension, allowing CNN to be used in more general data types, including texts and other time-series data. CNN learns by batch, by patterns within the time, and it can be useful when we have missing data or abnormal data, and it can also look forward; in other can check data from a broader perspective and can be used for implementation of multiple target data.

### *B. Decomposition*

We apply a robust period algorithm to detect the periodic time series and estimate its period length based on our proposed method. Then the decomposition stage to check the appropriate robustness level consists of 4 main steps: noise removal, trend extraction, seasonal extraction, and final adjustment. Note that this is an alternating algorithm because it is difficult to directly separate the trend and seasonal components. In particular, bilateral filtering was introduced to eliminate input time series denoise. In the trend extraction step, we assume the seasonal component has been extracted initially. The least absolute deviation loss function (LAD) is introduced in this regression problem to handle outliers strongly, where we focus on the residual component as input to the neural network.

### C. Encoder-Decoder Network

Time series anomaly detection is a point-wise dense prediction problem. In other words, for a time series x = $\{x_t\}$ $N_t$=1, the goal is to produce a sequence of the same length y = $\{y_t\}$$N_t$ =1 where {0, 1} denotes whether it is an anomaly or not [2-3]. Notice this dense problem shares many similarities with the image segmentation problem in computer vision, where a pixel-wise inference is needed. In addition, to encode the complex patterns of the time series, it is necessary to consider local and global information (or multiscale feature), which leads to the use of a skip connection that preserves the local information from the encoder layer by concatenating to the decoder input. To archive the result, we will adopt an encoder-decoder network architecture with skip connections, known as the U-Net structure [3].

### D. Data Augmentation

Data augmentation, which generates artificial data for training, is an effective way to improve performance in deep learning, particularly when the amount of training data is limited [4]. Currently, tiny work has been done on data augmentation for time series data. Data augmentation techniques were specifically designed for time-series after our robust decomposition in time and frequency domains. Note that the labeled data in time series anomaly detection is generally limited. In time series anomaly detection, the anomalies generally occur sequentially. Selecting and labeling the data points are allowed, which are utilized as anomalies for this training dataset.

## III. PROPOSED METHOD FOR ANALYZING ROBUST ANOMALY DETECTION USING CNN

Fig.1 presents the proposed method to analyze anomaly detection using CNN for power data loading. The steps are divided into two major parts.

The first focuses on introducing the target of robustness based on the decision-making approach, and the second focuses on validating this approach under different test conditions or various sets of scenarios in the test scenarios based on decomposition, data argumentation, and encoder and decoder network. The target is related to a number of machine's time-series load power data in an industrial environment. The data obtained will be used as simulation material utilizable in detecting performance. For testing, scenarios are required, for instance, with a point as a relative point, where the performance of the building against two indicators is equal to the margin of robustness.

The next stage is to assess whether the conditions are appropriate by implementing all scenarios and indicators based on the CNN concept with overall parameters required for the decomposition process, encoding decoding, and argumentation. The target is to conclude whether the CNN algorithm for time series data does robust or not; additionally, it attains a considerable level of accuracy and performance to be applied in an industrial environment.

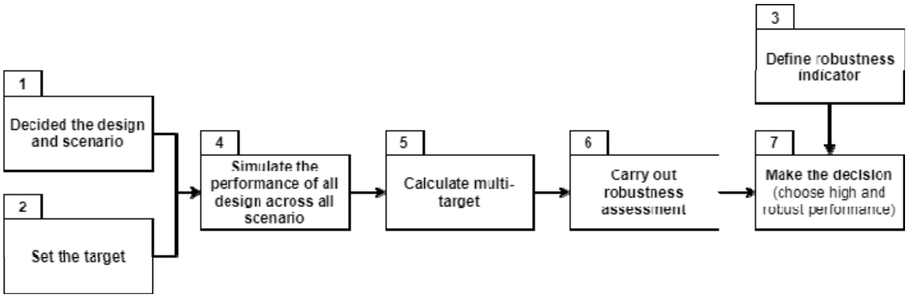


**Fig. 1.** The proposed method for establishing robust anomaly detection

## IV. CONCLUSION

This paper analyzes a robust anomaly detection method for power data by integrating a robust decomposition and a neural network to detect load power's multivariate time series anomaly.. These are considered as the key techniques, such as stochastic variable connection, applied to other time series modeling tasks. Accordingly, entity-level anomaly detection results assist the operation engineers in discovering and promptly troubleshooting abnormal behaviors of device load power. Furthermore, the advantages of the concept are to achieve high performance and high efficiency and possess the ability to handle complicated patterns and lack of sufficient labels; further, it suggests a practical and effective approach to load time-series monitoring data in the industry. By investigating data of augmentation method for decomposed components periodically and frequency ranges, adding label values and weights in the loss function, exploiting the anomaly data to ensure a high-predictive score to detect anomaly condition on load power based on time series decomposition for time series, data can be archived.

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# Deep Learning Based Object Identification Integrated in a ROS system

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## Abstract

Deep learning has known revolutionary improvements since the last decade, hailing as one of the fields with promising achievement for the future. Its different architectures have been applied in various fields such as medical imagery, game programming, bioinformatics, etc. Robotics has been closely dependent on human inputs, proving a deficiency in autonomous decision making. In this paper, we bring the potential of deep neural networks to a ROS-based navigating robot system. Deep Learning technology in robot navigation helps to improve the vision capacities of the robot among other things. In the paper we use the convolutional neural network (CNN) algorithm for image classification, which is one type of neural network architectures available. CNN is based on features extraction across multiple layers and is convenient for perceptual tasks. The implementation has been tested on a Turtlebot3 robot running on ROS, with vision feed provided by a RealSense Camera d435. During the test, the robot was able to navigate a mapped space while sending an identification of recognized objects falling in its vision field and their classification accuracy based on probability.

**Index Terms:** ROS, Raspberry Pi, Deep Learning, Neural Network

## I. INTRODUCTION

At the beginning, the real challenge was to go beyond straight mathematical calculations towards training computers to build a reference that could stand as the computer's cognitive intelligence[1]. Today, various complex algorithm models in use share the basic principle of a set of data fed into the model as inputs and the trained model produce outputs. In this paper, we study the case of deep learning applied in computer vision. The system we set up is made of a Turtlebot3 Waffle robot controlled by a Raspberry pi4 running on ROS with the Intel RealSense Camera d435. The choice of RealSense Camera is based on the multiform streaming data which will be beneficial for navigation (extraction of sensor data from the stream) and vision (the RGB stream). For enhanced robot vision, we use CNN for object recognition, a Deep Learning algorithm, notable for its perception-oriented advantages. This paper present first the CNN architecture used in this study case and the ROS navigation system on which the vision was implemented. Finally, the results of the implementation will be presented.

* Corresponding author

## II. SYSTEM MODEL AND METHODS

### A. Convolutional Neural Network

Machine learning is today one of the most highlighted and ground-breaking technology in use today. A notable improvement in machine learning was the representational learning which is the ability to read raw inputs data and transform them into internal representation on top of which a learning model is built[2]. Deep Learning is a representational learning breakthrough with multiple levels of representation build around simple but non-linear modules which transform the data from one level to a more abstract level. In the process of composing the representations, new functions are learned which detect and express more accurately the data. Among various learning architectures, Convolutional Neural Network is the best suited for image classification. Convolutional Neural Network (CNN) is designed with a combination of convolution layers realizing the extraction of visual signs on raw data with a multi-layer perceptron in charge of recognition of patterns (Fig. 1).

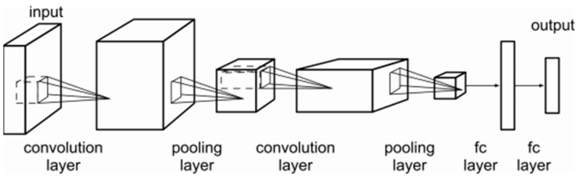


**Fig. 1.** Convolutional Neural Network example with two convolutions layers and a two-layered perceptron

In an image ($I$) consisting of R rows, C columns and D colors components as the input of CNN can be described as a three-dimensional function I (x, y, z). The procedure for obtaining feature maps is represented in the form of the function (1) [3]:

$$I_f(x,y) = b + \sum_{i=-t}^{t} \sum_{j=-t}^{t} \sum_{k=0}^{D-1} W_{i,j,k}\, I(x+i, y+j, k) \quad (1)$$

$$Y = W^T + b \quad (2).$$

CNN usually use many filters. A pooling layer is added for size reduction of the feature map. The output of the pooling layer is then fed as input to a traditional multilayer perceptron (or fully connected layer) which consists of fully connected neural network represented by the function (2). A perceptron algorithm consists of numerous iterations of the function above with parameters tuned every time to match the best results. There are various models of the CNN algorithm, in our case we will use the Inception.

#### 1) The Inception model

The Inception model was built to solve two major problems[4]. First the detection of salient regions in image recognition and the computational cost of many filters.

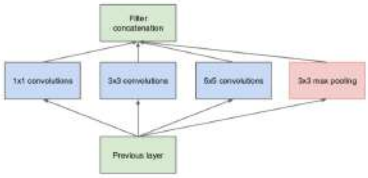


**Fig. 2.** Inception NN model

The inception architecture is built around the concept of multiple layers in which the output of a layer becomes the input of the next layer. Each unit from the earlier layer corresponds to some region of the input image and these units are grouped into filter banks. The layer close to the input image focus on local regions and can be covered by a 1*1-layer filters. However, the image has regions which must be covered with a spatially wide filter. Hence, the actual architecture of the model with 3 filters of size 1*1, 3*3, and 5*5. (Figure 2). Moreover, a pooling filter have been alternatively added on each stage. The main advantage of the model is the possibility of significantly increasing the size of filters at each stage.

### *B. ROS Navigation*

To make the robot move, it first needs a map describing the surface to navigate, secondly it needs the position of the robot at a given time, thirdly, a sensing of the environment to recognize potential obstacles and finally a path calculation model to optimize the best route to destination. In this case we will use gmapping algorithm to create a map. Gmapping provides laser-based SLAM data on a ROS node called slam_gmapping, which helps us to create a 2D grid map. To get the pose estimation, Encoders and IMU (Inertial Measurement Units) are using the dead reckoning process (Figure 3), which calculates the rotations of the wheel to render the pose of the robot. The estimation pose can also rely on the sensors and camera for a correct estimation of the robot's position.

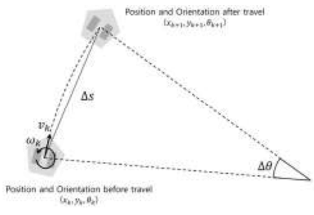


**Fig. 3.** Dead Reckoning Formula

Thirdly, sensors allow to detect obstacles. Here, the sensing data is provided by the RealSense Camera d435. Path planning allows to create a path from point A to point B. The path generated is made of the global path planning for the large view of the map and the local path planning for the close areas of the robot and is based on Dynamic Window Approach (DWA), a collision avoidance[5].

## III. RESULTS AND RESULTS

For implementation, Google’s deep learning library, TensorFlow, is interfaced with ROS. This is done by building a ROS node that subscribes to the image topic from ROS internal communication (sensor_msgs/Image). Once the image is loaded on the image node, it is accessed as a feed of inputs for the CNN model. The results window (Figure 4) shows objects matching the model’s labels, the score gets close if the object features match the labels used to train the model. The result of the implementation shows that the model recognized objects while it is navigating the surface of the test room (Figure 4)

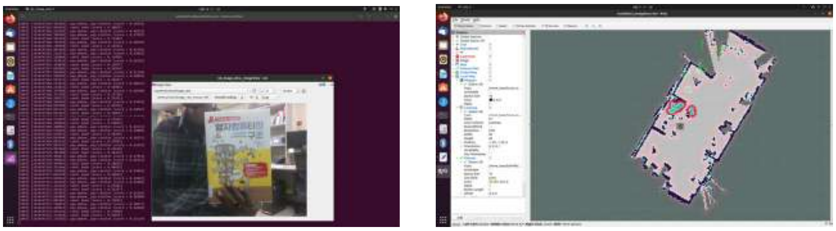

**Fig. 4.** Objects recognition results & Object sensing from the Camera

## ACKNOWLEDGMENTS

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# Trends in Mobile Ransomware and Incident Response from the Perspective of Digital Forensics

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## Abstract

Recently, mobile ransomware has become increasingly diverse, and the number of incidents has increased accordingly. As such, this paper aims to explain the types and characteristics of mobile ransomware and present ways of coping with ransomware incidents from the perspective of digital forensics, based on the results of an analysis of the operational process and vulnerabilities of specific mobile ransomware apps.

**Index Terms**: Mobile Ransomware, Incident, Response, Ransomware Analysis, Digital Forensics

## I. INTRODUCTION

Currently, more than 20,700 mobile ransomware apps are detected every year [1]. In order to minimize the damages resulting from infringement accidents caused by mobile ransomware, research on the application of cryptographic technology analysis and decryption to mobile ransomware is urgently required. This paper analyzes several previously distributed mobile ransomwares, and studies the types and characteristics of each type of ransomware and the results of analyses of cryptographic technology and how to cope with incidents caused by ransomware.

## II. TYPES OF MOBILE RANSOMWARE

This study aimed to investigate trends in several types of mobile ransomware prior to analysis. In addition, ransomwares were categorized and organized into three types according to their characteristics to improve the efficiency of the analysis of mobile ransomwares.

### *A. Locker Type*

The first is a locker type of ransomware that locks the screen of a device it has infected and restricts the use of that device. It mainly displays a message demanding a ransom from the victim via the lock screen. The most representative type include 'LockerPin'.

First detected around August 2015, LockerPin is a mobile ransomware that was

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distributed to users disguised as an adult porn application. When the victim installs and runs this application, a fake FBI message appears and asks for a ransom. In addition, this ransomware randomly changes the PIN of the infected device. If there is no PIN, it sets the PIN anew and keeps the device locked until it receives a ransom [2].

### *B. Crypto Type*

The second type is Crypto ransomware, which encrypts files or data in the devices it has infected, and mainly informs victims of the infection through toast messages or text files, and demands a ransom. CryptoLocker is the most representative of these tpyes of ransomware.

CryptoLocker is a new type of mobile ransomware distributed around June 2020, after a ransomware Trojan horse for computers using Microsoft's Windows operating system was transformed into a mobile version for Android and iOS in September 2013 [3]. In addition, CryptoLocker deceives users and distributes to them a COVID-19 tracking application which, when running, encrypts the files inside the SD card of the infected device, changes the file's extension name, and informs the user that the file has been encrypted. Encrypted and extended files cannot be opened: Therefore, in order to reopen a file, you must pay a ransom to the attacker, receive the password, and enter the password via the application screen [4].

### *C. Hybrid Type*

Finally, there is the hybrid type of ransomware, which combines the functions of the Locker and Crypto types of ransomwares, of which the most representative are SauronLocker and DoubleLocker.

SauronLocker is a mobile ransomware first detected in 2019. It was distributed to users disguised as a crack version of a popular mobile game. When this application is installed and executed, it immediately locks the screen of the victim’s device, which continuously displays a message requesting a ransom from the user. In addition, it transmits the information of the infected device to the attacker server in order to receive the encryption key, and then encrypts the data in the device SD card using the encryption key [5].

As for DoubleLocker, it is a mobile ransomware discovered in the fall of 2017. It is distributed by deceiving users with the Adobe Flash Player through an infected website. When running this application, it changes the device's PIN to lock the screen, encrypts the files inside the SD card of the infected device, and attaches '.cryeye' to the name of the infected device. When the victim pays the ransom, the attacker remotely sets the PIN to unlock the screen and delivers the encryption key to decrypt the file [2].

## III. MOBILE RANSOMWARE ANALYSIS

This section analyzes the cryptographic key generation function of the that of CryptoLocker of the Crypto type, and SauronLocker of the Hybrid type, among the various types described above, and explains how they operate within the device.

### A. Crypto Type: CryptoLocker

When CryptoLocker is executed, the user is notified of the status message of the application and the message that the device's file has been encrypted through a readme.txt generated in the SD card directory. CryptoLocker creates an encryption key by randomly selecting 52 Roman case letters, 10 numbers, and 23 special symbols (!@#$%^&*()_+-=[]|,./?><). After generating the encryption key, this encryption key is used as an encryption key for the AES/CBC/PKCS5Padding algorithm to encrypt a total of 14 formats (txt, jpg, bmp, png, pdf, doc, docx, ppt, pptx, avi, xls, xlsxlsx, VCF, db) in the SD card. When encryption is complete, it creates three files, [original file name.Extension].enc, [original file name.Extension].enc.salt, [original file name.Extensions].enc.iv, based on the original file and it deletes the original file. In addition, information on a randomly generated 16-digit encryption key is stored in the form of an xml file under '/data/data/com.crydroid/shared_ prefs/prefs.xml'.

### B. Hybrid Type: SauronLocker

When SauronLocker is executed, it transmits information on the infected device to the attacker's C&C server. This information includes the UID, firmware version, model name, and country code of the infected device. Thereafter, the attacker C&C server generates an encryption key based on the received device information and transmits the encryption key to the infected device. The device then encrypts the files in the SD card using the received encryption key as the key of the AES encryption algorithm. This creates the encrypted file name [original file name.Extension].encrypted and deletes the original file. The code below shows that the information sent to the attacker's C&C server is hard-coded on the internal source code.

## IV. INCIDENT RESPONSE TO MOBILE RANSOMWARE

The section describes the process of decrypting the encrypted files of devices infected with CryptoLocker to cope with infringement accidents caused by ransomware from a digital forensics perspective. SauronLocker does not analyze this because the attacker's C&C server is down and the encryption key cannot be secured.

### A. Crypto Type: CryptoLocker

CryptoLocker, as explained earlier, stores the encryption key values used to encrypt and decrypt files on SD cards in specific files inside infected devices. As shown in Figure 7, there is a vulnerability in storing and managing the encryption key in the 'com.crydroid. password' key value of the xml file under '/data/data/com.cryroid/shared_ prefs/prefs.xml'.

In addition, it is easy to find out the encryption algorithm for encryption or decryption through static analysis, and there is a vulnerability in storing the Salt and IV values required for decryption in the form of files such as [original file name.Extension].enc.salt and [original file name.Extension].enc.iv in the same path as the encrypted file [original file name.Extension].enc Therefore, the encrypted file may be easily decrypted using various items of information including the encryption key stored therein.

```xml
<?xml version='1.0' encoding='utf-8' standalone='yes' ?>
<map>
    <string name="com.crydroid.PASSWORD">MnGiuXUnz7mUX7Ay</string>
    <boolean name="FINISHED" value="true" />
    <string name="uuid">cdf0317b-2918-4f69-9204-e621116f3644</string>
</map>
```

**Fig. 1.** Inside of prefs.xml

```java
SecretKeySpec secretKeySpec = new SecretKeySpec(SecretKeyFactory.getInstance("PBKDF2WithHmacSHA1")
.generateSecret(new PBEKeySpec(string.toCharArray(), bArr, 65536, 256)).getEncoded(), "AES");
Cipher instance = Cipher.getInstance("AES/CBC/PKCS5Padding");
instance.init(1, secretKeySpec);
AlgorithmParameters parameters = instance.getParameters();
```

**Fig. 2.** CryptoLocker's decryption algorithm

Therefore, in order to recover a device infected with CryptoLocker, first, an encryption key is obtained from the file of Figure 1. Second, the corresponding encryption key, 'Salt', and 'IV' are decrypted through AES/CBC/PKSC5Padding.

## V. DISCUSSION AND CONCLUSION

Mobile ransomware can be created either by modifying PC-based ransomware or by distributing it under a new name after modifying a previously distributed mobile ransomware. Since there are many types of mobile ransomware, it is expected that if they can be classified by their characteristics and studied in order to come up with measures for dealing with infringement accidents, it will be very helpful in responding to and analyzing infringement accidents caused by ransomware.

## ACKNOWLEDGMENTS

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# Sleep Analysis from Polysomnography Signals Using Consumer Device and Machine Learning Approach

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## Abstract

In this Paper we are going to discuss about the accuracy and problems of consumer device in the assessment of sleep using machine learning methods, Sleep Cycle application, Polysomnography signal and wearable hand watch or hand device. Polysomnographic (PSG) signals can be used to diagnose the disorders of sleep and to measure electrical brain activities. Polysomnography signals are taken during the brain, eye, and muscle activity. Here, we assessed commercially available sleep tracker activity tracker, a scientific Actigraph and a mobile phone application (Sleep Cycle) Collected data from 15 nights using PSG and those devices. Then we applied machine learning algorithm on this data.

**Index Terms:** Polysomnography, Sleep Tracker, Activity Tracker, Sleep Classification, Machine Learning

## I. INTRODUCTION

Sleep is correlated with hormone secretion; thus, it plays a vital role in human homeostasis. Lack or changes in the regular pattern of sleeping is termed as a sleeping disorder, and it causes various consequences in human's wellbeing. Biomedical-related exploration fields got new aspirations, along with the development of machine learning algorithms [1]. Electroencephalogram (EEG), Electromyogram (EMG), heart-related auditory signal, Phonocardiogram (PCG), eye-related visual signals, i.e., Electrooculography (EOG) are entitled as the center focus signals in biomedical signal processing applications. Moreover, in consideration of sleep-related applications, Polysomnography (PSG) can be referred to as sleep stage classification, sleep quality measurement and sleep disorder identification [2]. Moreover, these signals are commonly used in sleep behavior analysis, sleep pattern recognition and sleep disorder evaluation. The PSG is a multivariate signal that comprises EEG, ECG, EOG, and EMG signals, which permit monitoring the functionality of brain activities, eye movements, muscles activities, and heart rhythms. Consequently, the PSG signals can provide various information to many sleep-related studies. The nature of these signals and their feature extraction techniques are further discussed in

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Roebuck et al. In that context, we have recently witnessed a vast increase in the available consumer devices, i.e., sleep trackers and mobile-phone applications, which aim to assess and ultimately improve sleep [3].

In that regard, Accelerometer-based sleep trackers, for instance, had high accuracy in detecting sleep but low accuracy in detecting awakenings from sleep which makes them quite efficient in estimating parameters such as TST and/or TiB but not that accurate in estimating wake after sleep onset (WASO) [4]. Similarly, mobile-phone applications had very poor agreement with the PSG gold standard in estimating sleep parameters such as SE and sleep onset latency (SOL) as well as in staging sleep into light and deep sleep [5]. Therefore, the aim of this study was to assess the performance of some of these readily used consumer devices which claim to monitor sleep and to provide reliable information about sleep quality and sleep architecture on a nightly basis. Specifically, we assessed sleep data from two devices: (1) a commercial activity tracker, the Mi band (MB; Xiaomi, China), and (2) a scientific actigraphy, Motion watch 8, as well as one readily used mobile-phone application: the Sleep Cycle (SC; Sweden). We compared sleep parameters as measured by these trackers against our PSG gold standard that relied on semi-automatic sleep staging using the SOMNOlyzer 24X7 solution [6,7,8].

## II. SYSTEM MODEL AND METHODS

### *Data Collection:*

Process of collecting data, the 15 participants were participating (Male and female were equal age range: 20-60) in this study. After confirmation that both the MB and the MW were recording, started with PSG preparation. Before turning the lights off and starting the PSG recording, we started the Sleep Cycle application (SC) and placed the device next to the subject. Participants went to bed at around 11 pm and stayed in bed (TIB, time in bed) for approximately 8 h (452.29 ± 81.78 min). SC tracks sleep throughout the night and use a 30-minute window that ends up with the desired alarm time during which the alarm goes off at the lightest possible sleep stage (i.e., light sleep). SC scores sleep through motion detection via one of two motion-detection modes: (i) microphone, which uses the built-in microphone to analyze movements, or (ii) accelerometer, which uses the phone's built-in accelerometer. SC tracks movements through the night and uses them to detect and score sleep as well as to plot a graph (hypnogram). Sleep scoring: The derived sleep features and sleep stages serve as gold standards for the rest of the analyses. Sleep staging for the SC application was realized via a simple image processing of the figures generated by the application; basically, we discretized the SC illustrations into 3 sleep–wake states as suggested by the application in wake, light sleep, and deep sleep. Statistical analysis: The following five sleep parameters were evaluated: (i) SOL, (ii) SE, (iii) WASO, (iv) TST, and (v) TiB.

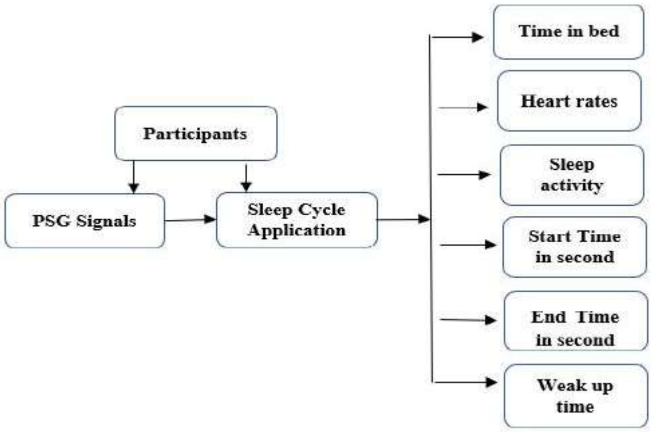


**Fig. 1.** Data Collection from participants using PSG and SC apps

## III. Results

The mean values of the key features of sleep across all participants according to the PSG gold standard were 434.58 ± 95.83 minutes for TiB, 370.12 ± 104.43 minutes for TST, 84.08 ± 13.22% for SE, 25.98 ± 19.35 minutes for SOL, and 39.08 ± 38.43 minutes for WASO. As a first analysis, we simply checked whether the mean sleep values per participant and night correlate between the gold standard and the devices. For TiB, we found good correlation, that is, significant positive associations of the gold standard value with the consumer device. For TST, we only found one moderately positive association for the MB device ($r = 0.49$, $p = 0.02$), while MW was the only device that showed a significant positive correlation for WASO time ($r = 0.78$, $p = 0.02$).

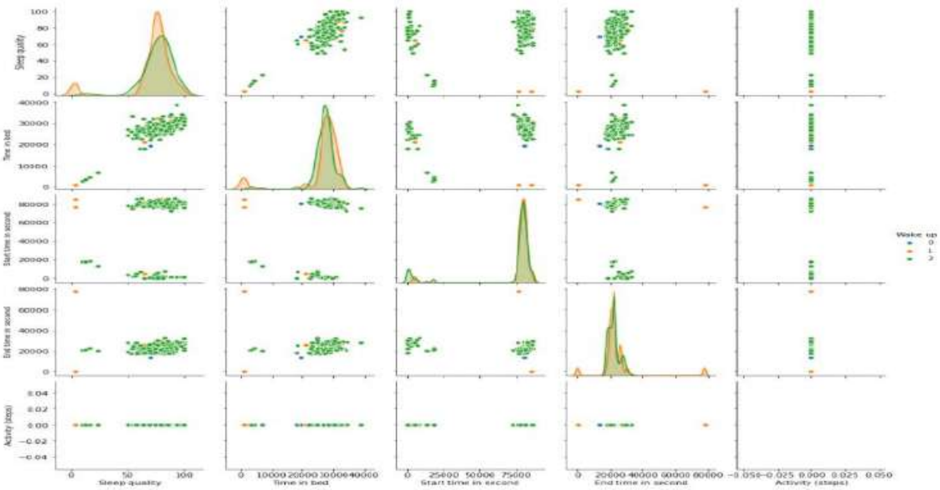

**Fig. 2.** Visualization of sleep stage classification

Epoch-Wise Agreement Per Sleep Stage

Table 1 shows the overall and stage-wise agreement between the 30-s epochs scored by our PSG gold standard and by both the MB device and the SC application. Note that MW is disregarded in this respect as standard MW outputs do not provide (or claim to allow) sleep-staging classifications. The overall agreement over all epochs from all subjects (16,350 epochs for MB; 11,243 epochs for MW; and 9504 epochs for SC) between gold-standard PSG scoring and MB was relatively low (53.31%, k = 0.14, PABAK = 0.06) and even lower for the SC device (46.34%, k = 0.18, PABAK = −0.07). Table 1 also illustrates that the highest level of agreement for MB was in determining light sleep (sensitivity = 70.6% and PPV = 57.8%) and that the lowest sensitivity for MB was for detecting wakefulness (sensitivity = 5.5%; PPV= 62.8%). Conversely, SC had moderate sensitivity in identifying awake epochs (sensitivity = 55.6%) and a low PPV value of 24.3%, meaning that only 24.3% of wake-classified epochs are indeed woken states according to the PSG gold standard. On the other hand, SC had low sensitivity in detecting light sleep (40.9%), yet when it classified light sleep, this was the true state in 61.2% of the cases (i.e., PPV = 61.2%). Moreover, for "deep sleep" classification, we found very poor performance for MB (sensitivity = 47.2%, PPV = 43.6%) and poor performance for the SC app (sensitivity = 52.0%, PPV= 53.0%).

| | PSG Standard | | |
|---|---|---|---|
| | WAKE | LIGHT SLEEP | DEEP SLEEP |
| Mi Band (MB) staging | | | |
| Wake | | | |
| % Sensitivity | 5.5 | 0.1 | 1.5 |
| % PPV | 62.8 | 4.7 | 32.6 |
| Light sleep | | | |
| % Sensitivity | 79.2 | 70.6 | 51.3 |
| % PPV | 18.9 | 57.8 | 23.2 |
| Deep sleep | | | |
| % Sensitivity | 15.3 | 29.3 | 47.2 |
| % PPV | 7.5 | 48.9 | 43.6 |
| Sleep Cycle (SC) staging | | | |
| Wake | | | |
| % Sensitivity | 55.6 | 37.0 | 16.9 |
| % PPV | 24.3 | 61.1 | 14.7 |
| Light sleep | | | |
| % Sensitivity | 36.4 | 40.9 | 31.1 |
| % PPV | 14.4 | 61.2 | 24.4 |
| Deep sleep | | | |
| % Sensitivity | 8.0 | 22.1 | 52.0 |
| % PPV | 4.1 | 42.8 | 53.0 |
| Devices/applications | OA (%) | K/PABAK | |
| Mi Band | | | |
| MB | 53.31 | 0.14/0.06 | |
| Sleep Cycle | | | |
| SC | 46.34 | 0.18/−0.07 | |

**Table 01: PSG – MB and SC cycle percentage of sleep scoring (Awake/ light / deep sleep).**

We also included the scientific MW device (of which the software anyway only provides wake and sleep categories). We then found good overall agreement (OA) for MB and MW (>80%, cf. Table 2) and rather poor OA for the SC app (65.9%). Kappa pairwise agreement indicates a "fair" agreement for MW but poor agreements for the MB and the SC. Specifically, the output shows that the MB and MW devices on the arm and wrist are very good when only "sleep" detection is needed (MB: sensitivity = 99.5%, PPV = 86.8%; MW: sensitivity = 92.9%, PPV = 88.2%). The SC application is as good as the wristband devices in assigning “sleep” to an epoch, as the application is correct in 91.3% of these cases, however, it still misses a third of all sleep epochs (sensitivity = 67.4%). Severe difficulties remain in assigning “awake” epochs by this devices/application and therefore, a proper estimation of overall sleep efficiency or sleep quality remains a challenge. Importantly, when we pooled all sleep stages in one stage, i.e. “sleep”, the OA and the PABAK of the MB and the SC increased while their Cohen’s K scores dropped which m indicate a serious bias in the scoring algorithms of the MB device and the SC app. Moreover, when we excluded REM epochs from this analysis, no significant difference in the agreement scores was observed (see Supplementary Table S2).

| | PSG Standard | |
|---|---|---|
| | WAKE | SLEEP |
| Mi Band (MB) staging | | |
| Wake | | |
| % Sensitivity | 5.5 | 0.5 |
| % PPV | 62.8 | 37.2 |
| Sleep | | |
| % Sensitivity | 94.5 | 99.5 |
| % PPV | 13.2 | 86.8 |
| Sleep Cycle (SC) staging | | |
| Wake | | |
| % Sensitivity | 55.6 | 32.6 |
| % PPV | 19.9 | 80.1 |
| Sleep | | |
| % Sensitivity | 44.4 | 67.4 |
| % PPV | 8.7 | 91.3 |
| MotionWatch (MW) staging | | |
| Wake | | |
| % Sensitivity | 37.5 | 7.8 |
| % PPV | 47.8 | 52.2 |
| Sleep | | |
| % Sensitivity | 62.5 | 92.9 |
| % PPV | 11.5 | 88.5 |
| Devices/applications | OA (%) | K/PABAK |
| Mi Band | | |
| MB | 86.54 | 0.08/0.72 |
| Sleep Cycle | | |
| SC | 65.90 | 0.13/0.30 |
| MotionWatch | | |
| MW | 83.42 | 0.33/0.66 |

**Table 02: PSG – MB and SC cycle percentage of sleep scoring (Awake/ sleep).**

## IV. DISCUTTION

In the present study, we evaluated 2 readily used consumer devices (Mi Band and Motion Watch 8) and one application (Sleep Cycle) for their ability to track sleep. The reason for our selection of such sleep trackers is mainly driven by their dissemination among the public as well as their low cost. We compared these consumer devices to our PSG gold standard which was simultaneously recorded. Overall, we revealed that these devices have an alarmingly low accuracy in scoring sleep in three categories (wake, light sleep, and deep sleep) with the overall agreement ranging between 46.34% for the SC application and 53.02% for the wrist-worn MB. When we tested for the correct classification in only two categories, that is, wake and sleep, the devices of course performed better with an overall agreement of 65.90% for SC, 84.69% for MB, and 81.33% for MW. We also showed that all devices and applications had high accuracy in estimating the most global sleep parameter, TiB. Although these correlations (see Supplementary Table S1) are not sufficient for commenting on the agreement between the sleep trackers and the PSG, they are important to show that even this simple relation does not hold statistically and with alarming disagreements. This raises the question of whether the faulty estimation of values such as TST, SE, WASO, or SOL are due to a priori knowledge of these sleep trackers on the amount of time the average person sleeps or needs to fall asleep. If such information is included in the algorithms and outputs of consumer devices, this would explain why the largest errors occur primarily for “non-average” sleep profiles and nights [9]. In line with this observation, previous studies have highlighted the poor performance of sleep trackers when sleep deviates from the average person’s sleep. However, to date, this argument remains speculative as the MB and the SC do not allow access to their raw data and are black boxes when it comes to their staging algorithms [10]. That is, by assigning “sleep” to basically every epoch, the device also cannot miss sleep epochs, yet it of course strongly overestimates sleep and has a vast number of false alarms for the stage “sleep”. Although MB was the least sensitive between all 3 sleep trackers, it had the highest precision in scoring wakefulness (PPV: 62.8% for MB, 47.8% for MW, and 24.3% for SC). Our results suggest that wrist-worn devices (MB and MW) tend to have better a performance than mobile-phone applications (SC) in measuring the key features of sleep.

## V. CONCLUSION

The currently available consumer devices for sleep tracking do not provide reliable information about one’s sleep. However, devices of that kind could be very promising tools for tracking sleep outside the laboratory in the future given that they adhere more to the scientific standards of sleep staging and analysis. Moreover, by refining their algorithms or even by adding more sensors, these devices might be able to reliably monitor and classify sleep across its full range from wakefulness to light sleep, deep sleep, and “REM” dreaming sleep.

## VI. FUTURE WORK

We will develop our won applications and will used Korean local sleep analysis device for this study. Our future study we also will apply deep learning techniques.

## ACKNOWLEDGMENTS

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## Conflicts of Interest

The authors declare no conflicts of interest. The data is collected from an open-source online database (we modified it ourselves).

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# Diffusion Factors of Business Intelligence Systems in Corporates

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## Abstract

Recently, there could be diverse considerations in General Trading Companies to adopt intelligent information systems such as business analytics systems based on deep learning algorithms. This study focuses on finding out the essential factors affecting the adoption of business analytics systems in general trading companies. In detail, this study focuses on the effects of social influences, trend pressures, perceived/expected performance, needed efforts, self-efficacy, and hedonic motives onto the perceived quality, satisfaction, and intention to use the systems directly and indirectly. Also, this study focuses on the moderating effects of user experiences of business information systems. In the results, it could be found that the user experience could moderate the effects of several independent factors such as self-efficacy and social influences on the perceived quality.

This study can contribute as one of the considerable studies on the adoption of business intelligence systems in companies that can be affected by user experiences, trend pressures, and social influences.

**Index Terms:** Global Trading Companies, General Trading Companies, Business Analytics, Information Systems Diffusion

## I. INTRODUCTION

Recently, there could be diverse considerations in General Trading Companies to adopt intelligent information systems such as business analytics systems based on deep learning algorithms. This study focuses on finding out the essential factors affecting the adoption of business analytics systems in general trading companies. In detail, this study focuses on the effects of social influences, trend pressures, perceived/expected performance, needed efforts, self-efficacy, and hedonic motives onto the perceived quality, satisfaction, and intention to use the systems directly and indirectly. Also, this study focuses on the moderating effects of user experiences of business information systems.

## II. LITERATURE REVIEW AND HYPOTHESES

Verification of user technology adoption is an ongoing challenge in the industrial field (Schwarz and Chin, 2007), requiring mature research reflecting specific industry contexts (Williams et al., 2015). Business intelligence (BI) systems comprise one of the wastelands

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where none of the previous studies have thoroughly confirmed related consumers' technology perception (reference). Thus, the current study explored consumers’ BI system adoption in the frame of Venkatesh et. al. (2003)’s unified theory of acceptance and use of technology (UTAUT) model and modified this model appropriately to the specific BI system adoption context. The UTAUT proposes that four primary constructs (performance expectancy-PE, effort expectancy-EE, social influence-SI, and facilitating conditions-FC) are antecedent variables of behavioral intention and finally turned into use behavior. Additionally, moderating effects of gender, age, experience, and voluntariness of use were explored (Venkatesh et. al. 2003). We adopted the two upfront core constructs of PE and EE but modified the SI on the BI system by including trend pressure (TP). Further, FC was subcategorized as self-efficacy (SE), hedonic motivation (HM) to fully reflect the characteristics of BI systems in the industry context.

In addition, TP in the current study follows the concept of ‘external pressure’ (Jeyaraj et al., 2006) under the frame of environmental context. Kuan and Chow (2000) studied the external pressure with two main sources as competitive pressure and imposition of trading partners. By applying this concept to the current study, the former is closely related to the TP of expected capability increased from utilizing BI system compared to other competitors in the industry.

H1: The performance expectancy (PE) of BI system affects positively on the perceived quality of the systems.

H2: The effort expectancy (EE) of BI system affects negatively on the perceived quality of the systems.

H3: The social influence (SI) of BI system affects positively on the perceived quality of the systems.

H4: The trend pressure (TP) of BI system affects positively on the perceived quality of the systems.

Further, FC was subcategorized as SE and HM, which facilitates consumers to adopt the BI system. First, SE refers to people’s assessment of their ability to perform a specific task well (Bandura, 2006). By applying developed technology, SE has evolved to relevant contexts such as computer self-efficacy (Compeau and Higgins 1995; Nov and Ye, 2009) and mobile self-efficacy (Chao, 2019; Nikou and Economides, 2017). Those researches commonly indicated that consumers who perceive themselves as having high SE showed an increased tendency to new technology acceptance. Accordingly, the concept of SE can be applied to the BI system in which context consumers of high perceived SE would show an escalated adoption tendency toward the BI system. Lastly, hedonic motivation follows the concept of perceived enjoyment from the extended UTAUT model.

H5: The self-efficacy (SE) of BI system affects positively on the perceived quality of the systems.

H6: The hedonic motivation (HM) of BI system affects positively on the perceived quality of the systems.

Relationships among Perceived Quality of the Systems, Satisfaction, and Behavioral Intention

H7: The Perceived Quality of the Systems affects positively on the users' Satisfaction.

H8: The user satisfaction with the Systems affect positively on the users' Intention to adopt and to use the systems

## III. RESULTS

### A. Not-Experience Group

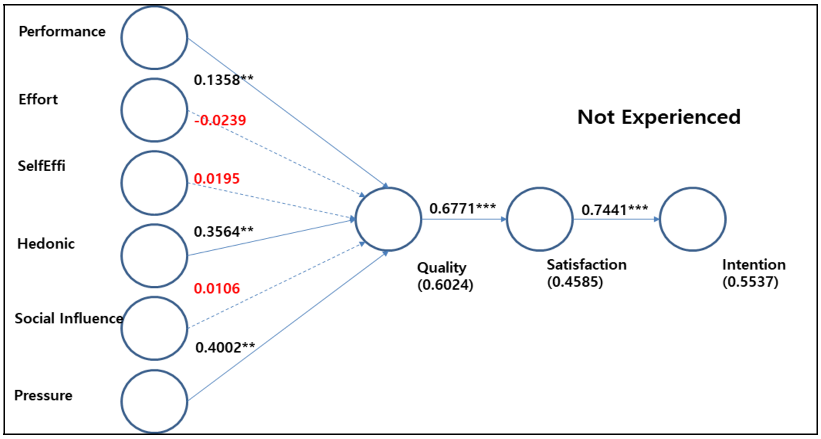


**Fig. 1.** Not-Experienced Group's Analysis Results

Effort, Social Influence, and Self Efficacy were turn out not to be significant while Perceived Performance, Hedonic Motivation, and Pressure of the Times were significant.

### B. Experience Group

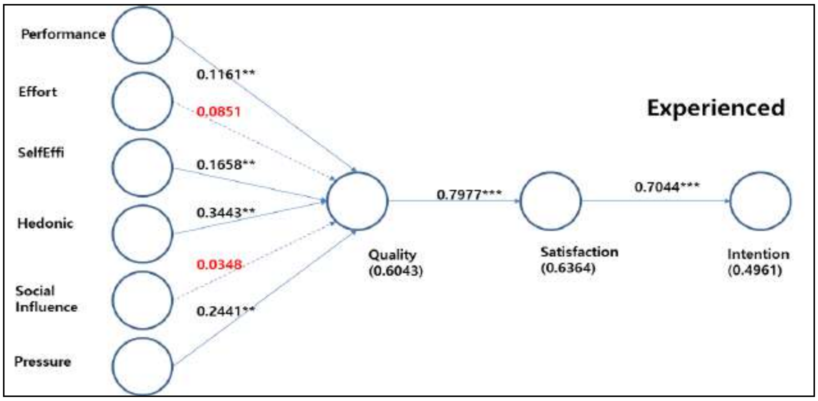


**Fig. 2.** Experienced Group's Analysis Results

Interestingly, Self-Efficacy, Performance, Hedonic MOtivation, and Pressure of the Times were significant at 5% significance level while Perceived Effort and Social Influence were still not significant. So, it can be described that the experience on current information systems would affect the self efficacy to adopt the new intelligence system.

## IV. DISCUSSION AND CONCLUSIONS

We propose the following academic and practical implications

Academic question #1 - Social Influence and Effort to be familiar with the system were not significant far from the previous studies. Then, how about the other industries and other systems? Also we should focus if these two variables would be meaningful in this machine learning era and after?

Academic question #2 – The main independent variables would be effective on other two variables of Satisfaction and Intention? So we would test the hidden mediating effects to find out the effects would be possible?

Academic question #3 – The not-found variables and effects §Social Influence was negative but was positive in both two groups, Why?

Practical Implication #1 - Experience Group – Performance, Self Efficacy, Hedonic Motivation, and Pressure of the Times were significantly effective variables on Quality and Hedonic Motivation and Pressure of the Times were most effective ones

Practical Implication #2 - Non-Experience Group – Performance, Hedonic Motivation, and Pressure of the Times were significantly effective ones, but self efficacy was not. We expect that it is because they didn't experience and are not sure of their capacity, so this may mean that the non-experience group pretends to be interested in adopting the new system. So we can describe this as the pressure of the Times was the most effective one and hedonic motivation was the second one

Practical Implication #3 - Social Influence was not significant both experience group and non-experience group.

# Session IB-A

## IoT and Big Data

# Session NS-A

## Networking and Services

# Session BI-A

## Biomedical Imaging and Engineering

# Session SC

## Semiconductor and Communication Service

# Investigating Handgrip Strength for the Detect of Cognitive Impairment

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## Abstract

In this study, we investigated the use of handgrip strength to detect cognitive impairment. In order to explore handgrip strength, we designed and developed a group of tiny sensors, which was linked to the Internet of Things. The sensors collect and analyzes the user's handgrip strength every millisecond. Users provide data of their handgrip strength to caregivers or medical doctors by the usage of their everyday items such as toothbrushes. Abnormal symptoms could therefore be recognized, and the users will receive constructive feedback and appropriate treatments. This would contribute to the design of a preventative tool for cognitive impairment, with a large database for known strength such as handgrip strength.

**Index Terms**: handgrip strength, early detection, cognitive impairment, IoT
.

## I. INTRODUCTION

With an increasing aging population, dementia could be one of the most popular diseases especially among old people in the society [1, 2]. Unfortunately, there is no available treatment yet, but a better way to combat dementia would be in the early detection of cognitive impairment [1, 2, 3]. In order to ensure early detection of diseases such as dementia, there is need for a special tool to track or manage daily cognitive conditions. In this paper, we investigated the use of handgrip strength to detect cognitive impairment. First, we reviewed the background of cognitive impairment, the handgrip strength, and how those two can be used to detect dementia. Secondly, we described the sensors, and tried to use it to detect handgrip strength. Thirdly, we sampled a few number of older people to test the sensor which was embedded in toothbrush. Lastly, concluded with general comments on pilot testing and with our future direction.

## II. BACKGROUND AND RELATED WORK

### *A. Mild Cognitive Impairment (MCI)*

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* Corresponding author

Mild Cognitive Impairment (MCI) considers the most eminent early symptoms of dementia [4]. Aging people show a variety of cognitive impairment. However, while some show normal aging process, others can possess the risk factors of serious critical symptoms. Therefore, people with MCI are considered at the stage between the normal aging and the more serious decline of dementia. The most apparent symptoms of MCI can be problems with memory, language, and thinking or judgment [5, 6, 7]. Recently, other suggested risk factors for MCI detection are physical activity, grip strength, BMI, sleepiness and sleep duration [8]. Several researchers across many disciplines attempt to discover novel ways to detect the early symptoms of MCI.

### *B. Handgrip Strength*

The grip strength or the handgrip strength is frequently used to examine a person's physical health condition [9]. A Korean study showed that a weaker handgrip strength can be the significant cause of mortality in both women and men [10]. However, cognitive impairment can be strongly related to handgrip strength [9, 10]. Therefore, assessing and monitoring handgrip strength can be a good way to detect people with MCI. The current standard for the measurement of handgrip strength is the use of dynamometer in quantifying the static force [11]. However, different brands of dynamometers may possess different values. The most popular one is the Jamar dynamometer recommended by the American Society for Surgery of the Hand and the American Society of Hand Therapist.

## III. DESIGN AND DEVELOPMENT

### *A. Sensors*

The sensors used in this study is the Force Sensing Resistor (FSR). The working principle of FSR is such that it detects resistance changes by utilizing a user's force or pressure. The major purpose of our study is to create a system with sensors embedded with collection and analysis of an individual user's handgrip strength every millisecond. First, users will provide their handgrip strength data to their caregivers or medical doctors by using their everyday things such as toothbrushes. Then, subsequently, abnormal symptoms will be recognized, and the users will receive constructive feedback and appropriate treatments.

### *B. Experiment*

Figure 1 below shows the data visualization of load cell and gyroscope sensor values.

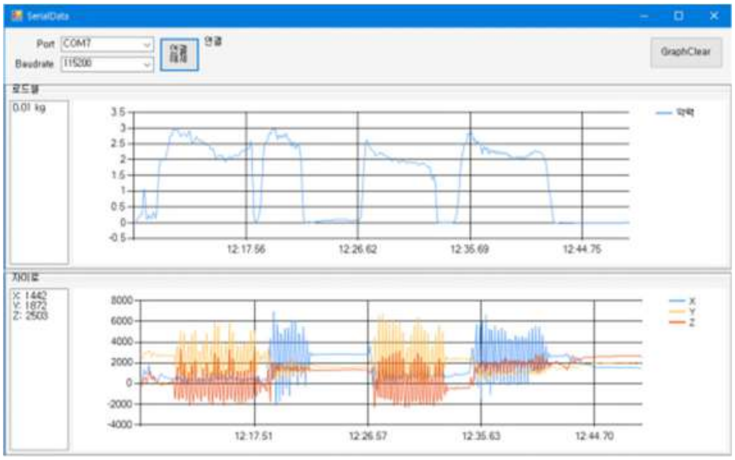


**Fig. 1.** The top graph shows the values of loadcell data and bottom graph shows the values of gyroscope censor data

## IV. DISCUSSION AND CONCLUSIONS

Our approach for the detection of MCI is in the use of sensors that detect handgrip strength. Our first prototype is completed and is about to be released Next is to try embedding these sensors into everyday user's object such as toothbrush or cup. Then we will conduct experiments with a variety of population. This would contribute in the design of a preventative tool for cognitive impairment with a strong known data such as handgrip strength.

## ACKNOWLEDGMENTS

This work has supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (No. NRF-2021R1H1A2092398).

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# Real-Time Recovery and Object Detection of Compressed Sensed Data

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## Abstract

As technologies that combine artificial intelligence (AI) and Internet of Things (IoT) develop, they use large data such as images and videos. However, the compression technique of data becomes very important because it inevitably causes a serious overload on the network. We use compressed sensing and it can reduce data traffic because it transmits compressed sensed data. In this paper, the compressed sensed data is transmitted to the IoT server. Then it implements Infrastructure Node-Application Entity (IN-AE) that can perform real-time recovery and object detection.

**Index Terms**: Compressed Sensing, Object Detection, Real-Time, Recovery

## I. INTRODUCTION

Recently, various technologies such as AI and compressed sensing are being applied to IoT [1-2]. However, data traffic increases because large and real-time data are generated by IoT [3]. There are various compression techniques to solve it [4]. We used compressed sensing to reduce the amount of data by randomly extracting indexes from the original data. Therefore, in this paper, we implemented Infrastructure Node-Application Entity (IN-AE), which transmits compressed sensed data to an IoT server and performs recovery and object detection in real-time using oneM2M subscription and notification [5].

## II. REAL-TIME RECOVERY AND OBJECT DETECTION WITH IN-AE

The proposed real-time recovery and object detection with IN-AE is illustrated in Fig. 1.

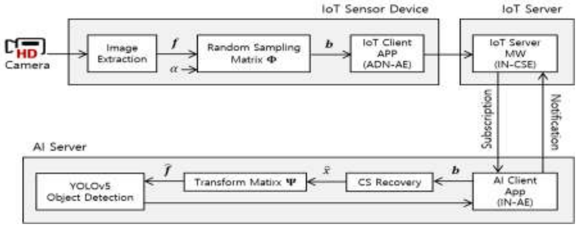


**Fig. 1.** Proposed IN-AE with real-time recovery and object detection in AI server

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[*] Corresponding author

An IoT sensor device with a random sampling matrix for compressed sensing extracts the image $\boldsymbol{f}$ from the camera sensor. The compressed image $\boldsymbol{b}$ according to the compressed sensing rate $\alpha$ a is transmitted to the IoT server. Then, the AI server performs real-time recovery and object detection through the AI client app modeled as an infrastructure node-application entity (IN-AE). Also, it recovers the compressed image $\boldsymbol{b}$ and the transform matrix $\boldsymbol{\Psi}$ inverse transforms $\hat{\boldsymbol{x}}$ to produce the recovered image $\hat{\boldsymbol{f}}$. Finally, after YOLOv5 performs object detection at $\hat{\boldsymbol{f}}$, it forwards information to the AI client app.

## III. RESULTS

We describe the experimental results of IN-AE that perform recovery and object detection in real-time using compressed sensed data. Fig. 2 shows the original image and the reshaped image of compressed sensed data. The size of the original image was 480x640, but as a result of experimenting with the compressed sensing rate set to 50%, the size of the compressed sensed data 153600x1, which was reduced by half from a total of 307200 pixels. We reshaped the compressed sensed data to visualize it. Then, it shows the resource tree whose data is sent to the IoT server and the result image from the compressed image to object detection.

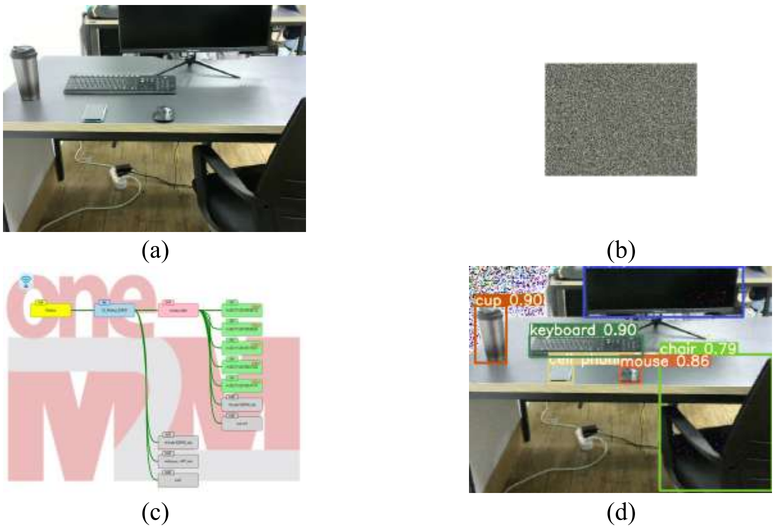


**Fig. 2.** Experimental result image of the proposed IN-AE: (a) original image, (b) reshaped image of compressed sensed data, (c) resource tree where compressed sensed data is sent to the IoT server, (d) object detection image of compressed image

## IV. DISCUSSION AND CONCLUSIONS

In this paper, we proposed an IoT sensor device that performs compressed sensing of images extracted through a camera sensor, an IoT server that transmits compressed sensed data, and an AI server that performs real-time recovery and object detection through IN-AE. In the future, we will be able to research using various large data and AI services.

## ACKNOWLEDGMENTS

This work was supported by Institute for Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government(MSIT) (No.2020-0-00959, Fast Intelligence Analysis HW/SW Engine Exploiting IoT Platform for Boosting On-device AI in 5G Environment)

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# Analysis of 5G AKA vulnerabilities through 5G Simulator

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## Abstract

As the ICT industry develops, 5G mobile communication services characterized by high-speed, ultra-low latency, and ultra-connectivity are gradually expanding their applications such as drones, IoT, AI, and the cloud. As 5G mobile communication implements a hyper-connected society, not only data communication between people and people, but also connection with objects has led to more diverse and vast data flows through the network, thereby increasing the importance of data security. As issues and research on 5G security is actively underway, vulnerability analysis and data analysis for 5G AKA, Authentication and Key Agreement process to provide 5G mobile communication security in the wireless section, are also actively underway. Therefore, in this paper, we analyze 5G AKA vulnerabilities known through a 5G open source simulator and propose a countermeasure against location sniffing attack.

**Index Terms**: 5G security, 5G-AKA, Analysis vulnerabilities, Network Security

## I. INTRODUCTION

5G mobile communication service, which features ultra-fast, super-connected, and ultra-low delay, provides services by being converged with various fields such as Internet of Things, drones, autonomous driving, and AI robots[1] along with smartphones. 5G mobile telecommunication service can be expanded to various industrial fields by connecting all objects to enable convergence services. As fields of applications expand and various devices and objects are connected, the amount of traffic flowing through the network increases significantly, and security threats also increase, raising the importance of data security. In response, the 3GPP(3rd Generation Partnership Project) has established standards to provide data security in wireless sections based on authentication and key agreement processes, 5G AKA(Authentication and Key Agreement), and currently, several organizations are developing 5G simulators that perform 5G AKA processes such as Open5GS[8]. AKA is a network security protocol used from 3rd generation mobile communication, with security vulnerabilities present in each generation, and 5G AKA currently in use in 5G also has multiple security vulnerabilities. Therefore, in this paper, we analyze the vulnerabilities of the 5G AKA process, conduct a simulated attack through a 5G simulator, and present a solution accordingly.

## II. PRELIMINARY WORK

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5G AKA is a standardized authentication and key agreement process established by 3GPP to provide 5G data security in wireless section. Keys that provide integrity and confidentiality can be derived from the generated through the 5G AKA process, and security in the wireless section is provided using the keys derived. The initial process of the authentication procedure and authentication procedure for 5G AKA are specified in TS 33.501[6].

The known 5G AKA vulnerabilities to date include USIM replication and deodorization attacks, Race-Condition[2-3], Man In The Middle attacks, DDoS[4], Location sniffing attack[5], and some of these have been modified and supplemented in the current standards.

## III. ANALYSIS

### A. Experiments environment

Figure 1 shows the scenario of the location sniffing attack experiment. SEAF is not implemented in Open5GS, so AMF replaces the SEAF's role. In addition, experiments were conducted with some modifications to the UERANSIM [9] code, as specified in the standard documents TS 33.501[6] and TS 33.102[7], established by 3GPP.

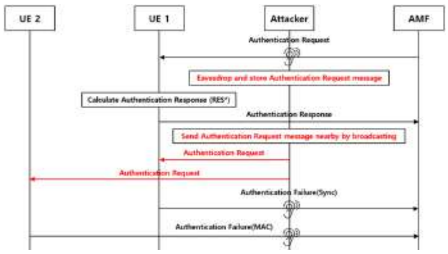


**Fig. 1.** Location sniffing attack scenario

### B. Results

Figure 2 shows the resulting screens of UE 1 and target UE 2. This confirms that UE 1 sent Authentication Failure (MAC Failure) and UE 2 sent Authentication Failure (Sync Failure). Figure 3 shows an Authentication Response packet during the normal authentication process, Figure 4 shows an Authentication Response (Failure) packet from UE 1, and target UE 2.

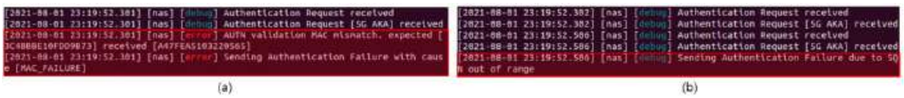


**Fig. 2.** UE 1 (a) and UE 2 (b) results screens

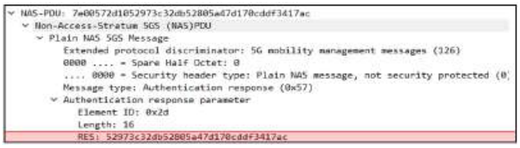


**Fig. 3.** An Authentication Response packet during the normal authentication process

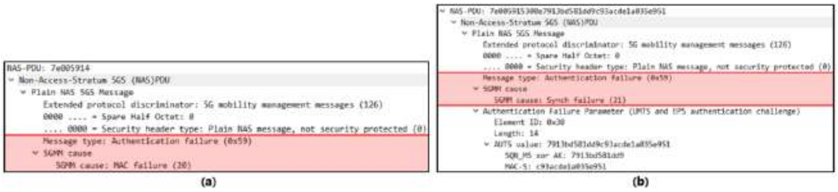


**Fig. 4.** An Authentication Response packet from UE 1 (a) and UE 2 (b)

Unlike the Authentication Response packet during the normal authentication process, it can be seen that both UE 1 and UE 2 have sent Authentication Failure messages. In addition, it can be seen that UE 1 included MAC Failure in the CAUSE field and UE 2 included Sync Failure. By eavesdropping on these Authentication Failure messages, an attacker can determine the location of the target UE through the CAUSE field and can affect the AKA process by causing an incorrect SQN update between the target UE and 5G core.

## *C. Proposed scheme*

Standard provided by 3GPP states that after successful MAC verification, SQN verification should proceed. MAC verification is done through RAND, AUTN values where the non-target UE fails because the RAND value contained in the Authentication Request message does not match the UE's RAND value stored by the SEAF. However, the target UE matches the RAND value contained in the Authentication Request message with the UE's RAND value stored by the SEAF, resulting in successful MAC verification and the start of the next process, SQN verification. Thus, if the SQN verification is carried out first by changing the order of verification, and then MAC verification is performed when the SQN verification is successful, both the target UE and the non-target UE will fail at the SQN verification stage and send Sync Failure messages. If both the target UE and the non-target UE send a Sync Failure message, the target UE cannot be distinguished even if the attacker eavesdrops on the authentication response message.

**Table 1.** A comparison table of proposed scheme to cope with the location sniffing attack

| | Proposed scheme | Scheme 1 [5] | Scheme 2 [6] |
|---|---|---|---|
| Solution | Change the order of MAC/SQN verification. | Utilize the PKI scheme used in 5G network. | Use PUF technology to encrypt with ECIES public key algorithm. |
| Overhead | None | MAC Failure: 1.1463s<br>Sync Failure: 1.0899s | - |

Table 1 shows a comparison table with other solutions presented for the location sniffing attack. Both schemes are methods of encrypting response messages using public key encryption algorithms. As a result of applying the public key encryption algorithm to response messages using the encryption algorithm existing inside Open5GS[8] in the same environment, it was confirmed that an overhead of 1.1463s for MAC Failure and 1.0899s for Sync Failure occurred.

According to the management of sequence number profile provided by 3GPP, the probability of SQN verification success is $\frac{1+L}{2^{48}}$. $L$ is the extent to which the mechanism to verify the freshness of sequence number in USIM allows some misuse of sequence number. The value selection of this parameter $L$ affects USIM only, and is entirely determined by the operator in accordance with the security policy[7]. Thus, if an attacker changes the sequence number value of the stored authentication request message after eavesdropping and sends it back to the target

UE, the probability of SQN verification being successful is $\frac{1+L}{2^{48}}$. This is the probability that when the verification order for Authentication Request messages is changed from SQN verification to MAC verification, the location sniffing attack will succeed through the sequence number significantly found by the attacker within an acceptable time. Therefore, if the SQN verification is carried out first by changing the order of verification, and then MAC verification is performed when the SQN verification is successful, the probability of success of the location sniffing attack conducted in this paper can be reduced to $\frac{1+L}{2^{48}}$ without overhead.

## IV. CONCLUSION

In this paper, we demonstrated the location sniffing attack, one of the 5G AKA vulnerabilities, through Open5GS, a 5G open source simulator. If an attacker eavesdropped on Authentication Request messages received by the target UE during the 5G AKA process, stored the data, and sent it to all nearby UEs on broadcast, it confirmed that the target UE sent the Authentication Failure (Sync Failure) to the 5G core, and UEs other than the target sent the Authentication Failure (MAC Failure) to the 5G core. It also confirmed that the target UE's position could be exposed through the CAUSE field by the attacker eavesdrops these Authentication Failure messages, and that it would affect the authentication process, such as performing SQN resynchronization by causing incorrect SQN updates with 5G core and target UE. Thus, in this paper, we propose a change in the order of the MAC/SQN verification process to improve its vulnerabilities. If the MAC/SQN verification order is changed, both the target UE and the non-target UE send Sync Failure messages, which is expected to prevent the location sniffing attack with high probability without overhead because the attacker cannot distinguish the target UE.

## ACKNOWLEDGMENTS

This work was supported by Institute for Information & Communications Technology Promotion(IITP) grant funded by the Korea government(MSIP) (No.2020-0-00085, Research on Security Technology for 6G Telecommunication with 5G+)

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[8] Open5GS: https://open5gs.org/.

[9] UERANSIM: https://github.com/aligungr/UERANSIM.

# Design of an Orthogonality Sampling Method in Microwave Imaging for a Fast Identification of a Small Anomaly

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## Abstract

In this study, we consider the orthogonality sampling method (OSM) in order to quickly identify a small anomaly in microwave imaging from the measured scattering parameter data. In contrast to the traditional researches, if the location of the transmitter and receiver is the same, the measurement of scattering parameter data cannot be possible. Hence, we set the unknown measurement data as a constant and introduce a new indicator function of the OSM. Throughout the simulation results with various constants, we confirmed that the best results can be obtained when the value of an applied constant is zero.

**Index Terms**: Microwave imaging, Orthogonality sampling method, Scattering parameter, Simulation results

## I. INTRODUCTION

The recently investigated orthogonality sampling method (OSM) is a qualitative method for fast identification of the outline shapes or localization of unknown targets in inverse scattering problems. From the pioneering study [1], it has been confirmed that the OSM is a simple, stable, and computationally inexpensive technique because it requires only one or a few incident fields for localizing small inhomogeneities, it is robust to random noise, and it does not require additional operations such as singular value decomposition, solving an integral equation, etc. As a result, the OSM has been applied and extended to a variety of microwave imaging problems. Related works can be found in [2-5] and references therein.

It is important to note that in real-world microwave imaging, it is extremely difficult to handle measurement data when an antenna transmits and receives the signal simultaneously (see [6-9] for example), so traditional OSM cannot be used directly. In this regard, we consider the design of the OSM for identifying a small anomaly from the measured scattered-field S-parameter data at microwave frequency. To complete this, we introduce a new indicator function by converting the unknown measurement data to a fixed constant. Throughout simulation results with synthetic data, we confirm that the imaging performance of the OSM is significantly dependent on the constant choice and that choosing the zero constant guarantees a good result.

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## II. INDICATOR FUNCTION OF THE OSM

Let $\Omega$ be a region of interest and $S_{j,l}$ be the scattered field S-parameter between a fixed transmitter $l$ and receiver $j$, $j, l = 1,2,\cdots,N$, in the presence of a small anomaly $\Sigma$ with location $\mathbf{r}_*$, and $\mathbb{M}$ be the arrangement of measurement data such that

$$\mathbb{M} = \left(S_{1,l}, S_{2,l}, \cdots S_{l-1,l}, S_{l,l}, S_{l+1,l}, \cdots, S_{N,l}\right). \qquad (1)$$

Then, for $\mathbf{r} \in \Omega$, define an arrangement

$$\mathbb{H} = \left(E_1(\mathbf{r}), E_2(\mathbf{r}), \cdots E_{l-1}(\mathbf{r}), E_{l,l}(\mathbf{r}), E_{l+1,l}(\mathbf{r}), \cdots, E_{N,l}(\mathbf{r})\right),$$

where $E_j(\mathbf{r})$ denotes the $z-$component of the incident field measured at the receiver $j$. Then, the indicator function of the OSM can be introduced as follows (see [5] for instance)

$$\mathfrak{F}_{\mathrm{OSM}}(\mathbf{r}) = |\mathbb{M} \cdot \overline{\mathbb{H}}|.$$

Then, the map of $\mathfrak{F}_{\mathrm{OSM}}(\mathbf{r})$ will contain a peak of large magnitude at which the location of the anomaly can be identified.

However, it is impossible to use $S_{l,l}$ from (1) because each of the $N$ antennas is used for signal transmission and the remaining $N-1$ antennas are used for signal reception. Therefore, in a real-world problem, the arrangement of measurement data is given by

$$\mathbb{M} = \left(S_{1,l}, S_{2,l}, \cdots S_{l-1,l}, \text{unknown}, S_{l+1,l}, \cdots, S_{N,l}\right) \qquad (2)$$

and correspondingly, the indicator function $\mathfrak{F}_{\mathrm{OSM}}(\mathbf{r})$ cannot be defined. In (2), we replace the unknown data with the constant $C$ and introduce the arrangement of measurement data

$$\mathbb{M}(C) = \left(S_{1,l}, S_{2,l}, \cdots S_{l-1,l}, C, S_{l+1,l}, \cdots, S_{N,l}\right)$$

and the corresponding indicator function

$$\mathfrak{F}_{\mathrm{OSM}}(\mathbf{r}, C) = |\mathbb{M}(C) \cdot \overline{\mathbb{H}}|.$$

## III. SIMULATION RESULTS AND DISCUSSION

We exhibit some simulation results using synthetic data generated by the CST STUDIO SUITE to find an appropriate value $C$ for obtaining good results. For simulation, we applied $f = 1\text{GHz}$ frequency and $\Omega$ was selected as a ball with radius $0.08\text{m}$. We refer to Fig. 1 for an illustration of the simulation configuration and material properties.

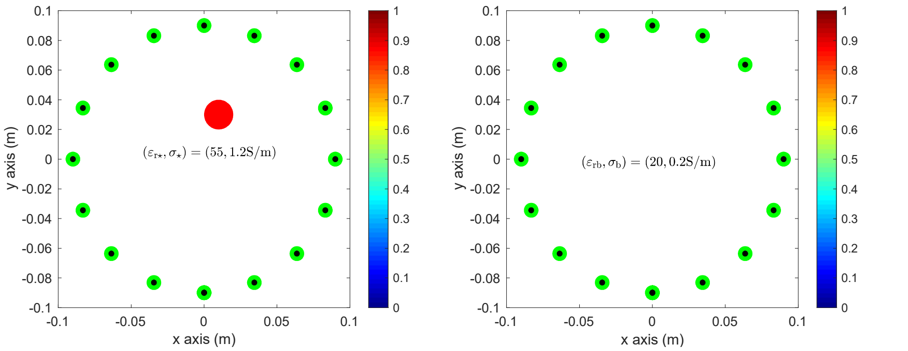


**Fig. 1.** Illustrations of simulation configuration with (left) and without (right) anomaly, and material properties

Fig. 2 shows maps of $\mathfrak{F}_{\text{OSM}}(\mathbf{r}, C)$ with various values of $C$ when the location of the transmitter is $(0.09\text{m}, 0\text{m})$. Based on the result, we can examine that the location of the anomaly $\Sigma$ is clearly identified when the value of $C$ is zero. Notice that if the value of $C$ is small (here, 0.1), a local maximum value $\mathfrak{F}_{\text{OSM}}(\mathbf{r}, C)$ appears in the neighborhood of $\Sigma$ but it is extremely difficult to identify the location of $\Sigma$. Furthermore, if $C > 0.1$, it is impossible to determine the location of $\Sigma$. Hence, we conclude that $C = 0$ is the best choice for achieving good results through the OSM.

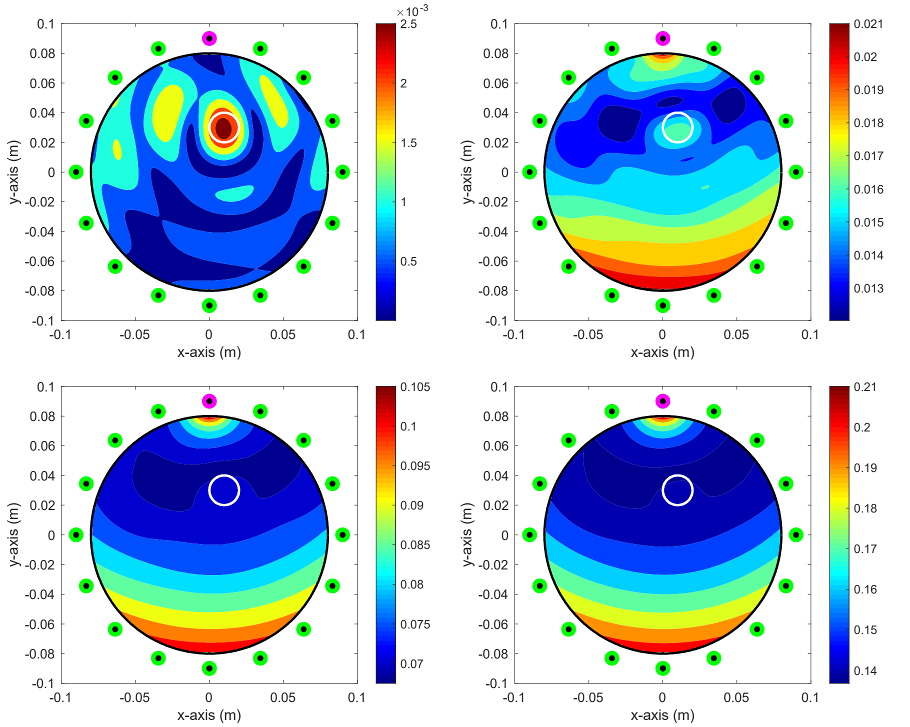


**Fig. 2.** Maps of $\mathfrak{F}_{\text{OSM}}(\mathbf{r}, C)$ with $C = 0$ (top, left), $C = 0.1$ (top, right), $C = 0.5$ (bottom, left), and $C = 1$ (bottom, right). A white-colored solid line describes the boundary of the anomaly

## IV. CONCLUSION

In this investigation, we considered the application of the OSM in microwave imaging for identifying a small anomaly from the measured scattered field S-parameters. By converting the unknown measurement data into a constant, we introduced a new indicator function of the OSM. Throughout the simulation result with various constants, it was confirmed that the best result can be obtained when the value of applied constant is zero.

Unfortunately, the theoretical explanation for such an occurrence remains unknown. Thus, the establishment of mathematical theory for explaining this phenomenon will be the forthcoming work. Furthermore, only the identification of the location of a small anomaly is properly considered. Extension to the identification of multiple anomalies or arbitrary shaped extended anomalies will be an interesting subject.

## ACKNOWLEDGMENTS

This research was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (NRF-2020R1A2C1A01005221).

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# Macro-modeling of P-type Feedback Field-Effect Transistor

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## Abstract

In this paper, we propose a macro-model of a P-type feedback field-effect transistor (PFBFET) based on geometrical analysis. The macro-model of PFBFET is configured with two circuits. One is charge integrator circuit and the other is current generation circuit. To verify the validation of the model, mismatches of simulation results between technology computer aided design (TCAD) and simulation program with integrated circuit emphasis (SPICE) were observed at the subthreshold region and the threshold voltage, due to limitations of models for the MOSFET and diode used in macro-model

**Index Terms**: Macro-model, P-type feedback field-effect transistor, charge integrated circuit, current generation circuit.

## I. INTRODUCTION

A feedback field-effect transistor (FBFET) is in the spotlight for the next generation devices in various fields. The FBFET has approximately zero subthreshold swing and hysteresis characteristics, which are occurred by the positive feedback between carriers [1].

In terms of investigating electrical characteristics of the FBFET, the technology computer aided design (TCAD) simulator is powerful for a single device. However, in order to analyze and predict the whole system, the simulation program with integrated circuit emphasis (SPICE) simulator is more powerful than the TCAD simulation. For simulating the circuits consisting of the FBFETs using the SPICE simulation, the compact-model of the FBFET is needed. In the previous work, macro-modeling of N-type FBFET(NFBFET) has been proposed [2], but macro-model of P-type FBFET(PFBFET) has not reported yet. For simulating circuits consisting of the NFBFET and PFBFET, the macro-model of the PFBFET is required. Therefore, in this study, we propose the macro-model of the PFBFET for the SPICE simulation.

## II. MACRO-MODELING

Figure 1 shows the circuit diagram of the macro-model of PFBFET. The macro-model of PFBFET consists of two circuits. One is the charge integration circuit and the other is current

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* Corresponding author

generation circuit. The charge integration circuit consists of one PMOSFET, capacitor, and resistor, and the current generation circuit consists of one ideal switch, resistor, and diode.

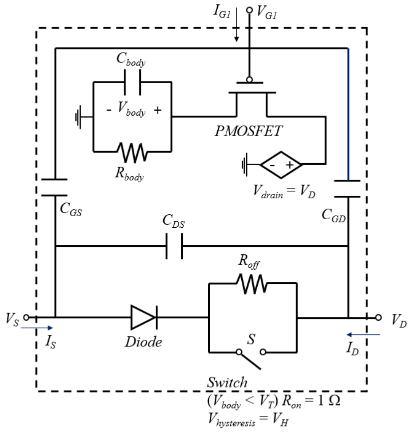


**Fig. 1.** Circuit diagram of macro-model of PFBFET

Figure 2 shows SPICE results of drain-source current ($|I_{DS}|$) – gate-source voltage ($V_{GS}$) characteristics for macro-model of the PFBFET. The symbols and lines denote SPICE and TCAD results, respectively. The threshold voltage of forward and reverse sweep is -0.74 and -0.23 V, respectively. The magnitude of memory window, which is difference with threshold voltage of forward and reverse sweep, is 0.51 V at drain-source voltage ($|V_{DS}|$) = 1 V. There were mismatches at subthreshold region and threshold voltage of low $V_{DS}$, due to limitation of MOSFET and diode model used in macro-model.

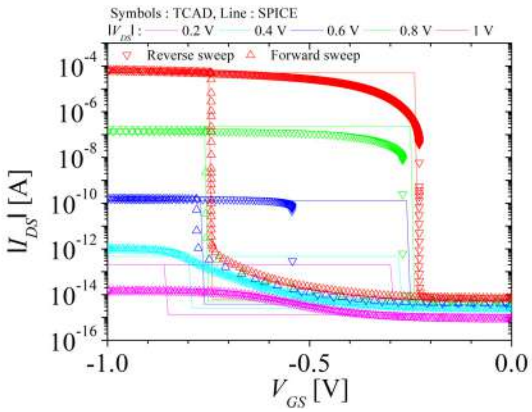


**Fig. 2.** SPICE results of macro-model of PFBFET for $I_{DS}$-$V_{GS}$ characteristics

## III. MODEL VALIDAION

Figure 3 shows SPICE results of voltage transfer characteristics (VTC) for inverter consisting of the NFBFET and PFBFET model. The symbols and lines denote TCAD and SPICE results, respectively. The macro-model of NFBFET that is presented in the previous work was used for simulation. Switching voltage gap, which is occurred by difference between the threshold voltage of forward and reverse sweep, was 20 mV for SPICE and TCAD simulation results. Moreover, those two results show not clear on/off state.

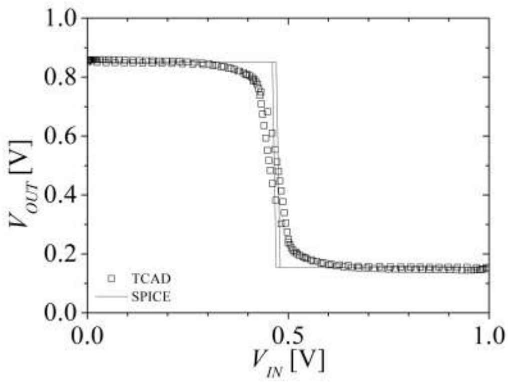


**Fig. 3.** SPICE results of inverter-FBFET for voltage transfer characteristics

## IV. CONCLUSIONS

In this work, the macro-model of the PFBFET was presented for the SPICE simulation. The macro-model of the PFBFET is configured with two circuits. One is charge integration circuit and the other is current generation circuit. The macro-model of PFBFET implements steep switching behavior, but mismatches was observed at threshold voltage and subthreshold region, due to limitation of model of MOSFET and diode used in macro-model. For validating macro-model, the VTC was investigated for inverter consisting of NFBFET and PFBFET model. The VTC shows the switching voltage gap and do not reach clear on/off state.

## ACKNOWLEDGMENTS

This research was supported by the Basic Science Research Program through NRF of Korea funded by the Ministry of Education (NRF-2019R1A2C1085295). This work was supported by IDEC (EDA tool).

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# Session BI-B

## Biomedical Imaging and Engineering

# Session IT-B

## IT Convergence Technology

# Session IB-B

## IoT and Big Data

# Predicting Localization of Pneumothorax - Collapsed Lungs Using Deep Learning

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## Abstract

Development of modern computer vision techniques powered by deep learning has leaded to make many medical applications in the context of healthcare. Pneumothorax is the disease when the lung has collapsed as the result of air entering the pleural space of the lung. This air tends to create a growth in pressure around the lung and causes it to collapse partly or fully. It can be diagnosed with chest radiography. A pneumothorax can be serious and life-threatening emergency depending on how much air is trapped in the pleural space. Larger amounts of trapped air can be fatal if medical treatment is not detected early. So, we propose a deep learning method to predict the affected area which will help the doctor to make better decisions. We have implemented U-net convolutional network with DenseNet121 as a backbone for the localization and achieved promising results.

**Index Terms**: Deep Learning, Pneumothorax, Localization, Image Segmentation.

## I. INTRODUCTION

A pneumothorax is a lung disease that can cause air trapping in your lungs especially, in the pleural space. The air in the pleural space might cause the lung to collapse due to an increase in pressure around it. A pneumothorax can be serious and life-threatening emergency depending on how much air is trapped in the pleural space [1]. It is typically detected on chest X-ray, examined by a doctor. But this requires manual effort. Because the present imaging volumes are so large, reviewing each image and preparing a report takes a long time. Our objective is to build a method to predict the affected area by segmentation X-ray images. This will make it easier to prioritize the treatment of pneumothorax patients. We will use the given images and RLE masks to train the proposed model.

## II. SYSTEM MODEL AND METHODS

### A. Dataset Column Analysis

For this semantic segmentation job, we adopted the UNET architecture [2], replacing the encoder part with a pre-trained DenseNet121 [3] backbone with imagenet weights and keeping the decoder part the same. The dataset can be found on the Kaggle website[4]. ImageId and EncodedPixels make up the given data. We have a DICOM-format image

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for each ImageId. The value '-1' for EncodedPixels indicates that the image is free of pneumothorax. Masks in run-length-encoded (RLE) format are used in images with pneumothorax. We'll decrypt the code and make the mask. RLE is a very simple form of data compression in which the input is a stream of data (e.g., "AAABBCCCC") and the output is a sequence of counts of consecutive data values in a row (e.g., "3A2B4C"). [5].

## B. Segmentation Model

### 1) Segmentation Model

By having Kaggle SIIM pneumothorax dataset, we get images along with masks. We will train a model using that data and predict masks for the test data. So, this is a Semantic Image Segmentation problem. In this Semantic Image Segmentation problem, we measure the performance of the model based on the "IOU score". We will use a combination of "binary_crossentropy" and "dice_loss" as loss functions. These terms are explained below.

#### a) Intersection over Union (IoU) Score:

The Intersection over Union (IoU) [6] metric, also referred to as the Jaccard index. This is a method to quantify the percent overlap between the target mask and our prediction output. This metric is closely related to the Dice coefficient. The IoU metric measures the number of pixels common between the target and prediction masks divided by the total number of pixels present across both masks. In the following, figure 2 illustrates the formula of IoU metric.

#### b) Pixel-wise cross-entropy loss:

This loss [7] compares the class predictions (depth-wise pixel vector) to our one-hot encoded target vector for each pixel. The log loss aggregated over all possible classes is used to calculate pixel-wise loss.

#### c) Dice loss:

Dice Loss [8] = 1-Dice Coefficient.

# III. RESULTS

## A. IoU score and Loss

The following Fig. 1 shows the graphs of IOU Score and Loss.

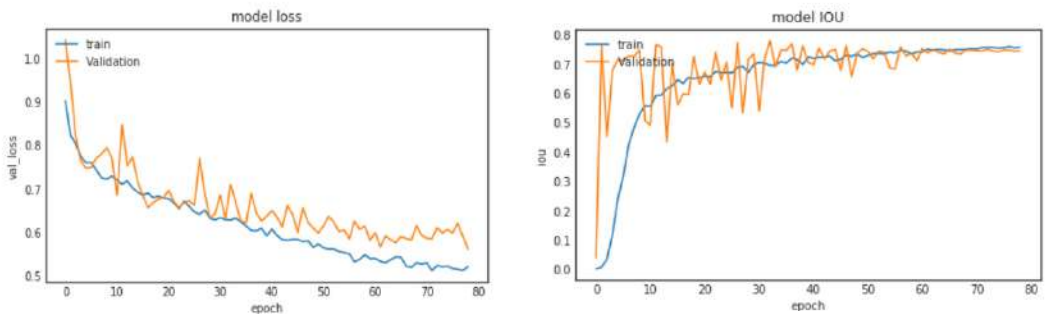


**Fig. 1.** The graphs of IOU Score and Loss

### *B. Original and Predicted Masks*

The following Fig. 2 displays some of the images and their corresponding original and predicted masks using the above model.

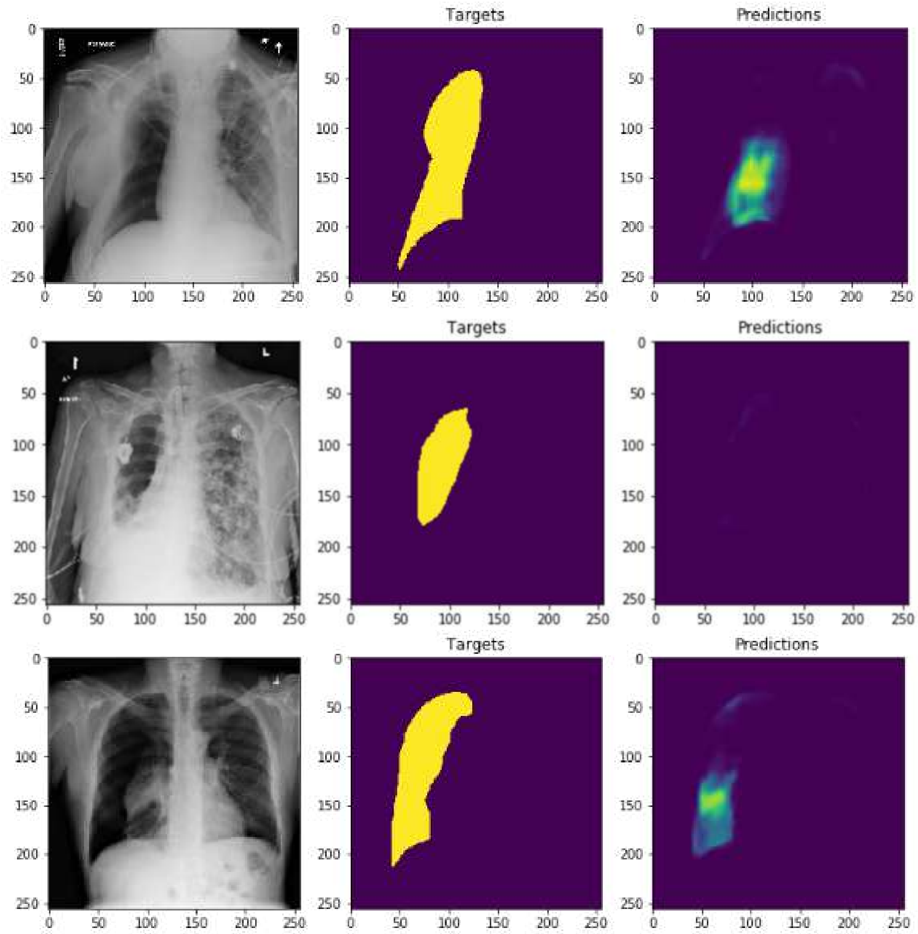


**Fig. 2.** Original and Predicted Masks

## IV. DISCUSSION AND CONCLUSIONS

### *A. Prediction of Pneumothorax*

A chest X-ray is usually used to diagnose pneumothorax, which is then inspected by a clinician or radiologist. However, this necessitates manual labor. Because the present imaging volumes are so large, reviewing each image and preparing a report takes a long time. If a pneumothorax is not diagnosed early, it might result in a life-threatening emergency owing to lung collapse and respiratory or circulatory difficulties. Our model's segmentation can help clinicians treat and diagnose diseases with greater precision, speed up the diagnosis process, and enhance efficiency.

### *B. Future Work*

We were unable to train our model for more epochs due to a lack of suitable computing resources. We will receive a better prediction if it is trained for more epochs. We also filtered out images with a very low IoU score for the segmentation model. We might achieve better results if we oversample these images and retrain the model.

## ACKNOWLEDGMENTS

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# A Preliminary Study of the Proliferation Control System for Cervical Cancer Cells

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## Abstract

Recently, ultrasonic anti-cancer therapy has been proposed as a useful treatment to significantly reduce side effects of anticancer therapy by injecting micro-bubbles or contrast agents into patients and producing ultrasound at specific frequencies. In this paper, a single stimulation and complex stimulation system are applied using LED and Ultrasound to confirm the inhibition of HeLa cell proliferation, and the cell area is calculated based on acquired optical microscopic images.

**Index Terms**: LED (Light Emitting Diode), Ultrasound, HeLa, Cell Proliferation

## I. INTRODUCTION

Cervical cancer is an aggressive and malignant tumor with a high risk of recurrence and death in women. Ultrasonic cancer cell therapy is a useful way to reduce side effects of cell damage caused by external stimulation and does not cause fatal stimulation to the immune system. On the other hand, LEDs used in photodynamic therapy are easy to miniaturize, inhibit fever, and reduce damage to normal cells compared to lasers [1-5].

Therefore, in this paper, a single stimulation and complex stimulation system are made using LED and Ultrasound, and HeLa cell proliferation suppression is confirmed, and the cell area is calculated based on the results.

## II. SYSTEM MODEL AND METHODS

### *A. Cancer cell preparation*

Cervical cancer cells (HeLa cells, Korean Cell Line Bank, Seoul, Republic of Korea) were cultured in a medium solution consisting of DMEM (Dulbecco's modified Eagle's medium), 10% FBS (Fetal Bovine Serum (pH 7.4), and 1% Penicillin Streptomycin. The cells were incubated at 37°C humidified incubator with 5% $CO_2$ for 72 hours. The cells obtained by centrifugation and cell suspension using Trypsin solution were placed in cell culture flask, and the experiment was conducted by setting the date on which external stimulation was

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first applied to Day 1.

### B. Optical and ultrasonic stimulation

The light stimulation by LED (Photron 3W Blue Power LED, Photron) was applied from the bottom of the 6-well culture flask and concentrated in the center of the well where the cells were cultured as in Fig.1 (a). The ultrasonic stimulation system was configured to maintain a frequency of 1 MHz in a waveform generator (Function Generator, Techtronics Inc., Beaverton, OR, USA) and generates a signal of 1,000 cycles with an output voltage of 190mVpp. Ultrasound probe was located on the upper part of the cell culture flask which can stimulate on the surface of the cell culture medium as in Fig. 1 (b). Therefore, both optical and ultrasonic stimulation can be induced simultaneously to the cells as in Fig. 1 (c). Each experiment was performed for 30 minutes per day up to five days. The conceptual diagram of multimodal stimulation represents as in Fig. 2.

(a) (b) (c)

**Fig. 1.** Optical and ultrasound stimulation system. (a) single LED, (b) single US, and (c) combinational stimulation using US with LED.

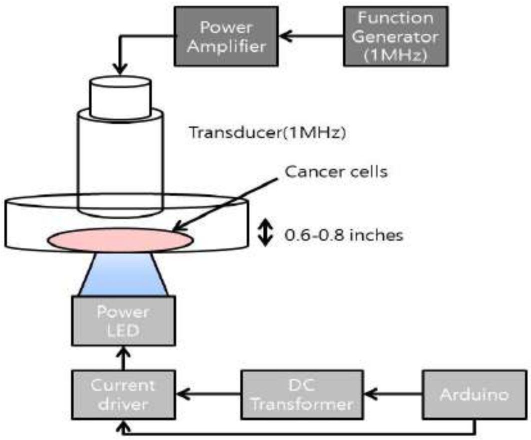


**Fig. 2.** Schematic design for the proposed cancer therapeutic module.

### *C. Cell growth rate quantification*

Cervical cancer cell images were acquired in the same location with an inverted optical microscope (IX73, Olympus, Japan) before and after the stimulation. Various image processing tools were applied for quantitative analysis using MATLAB (MathWorks, Natick, MA, USA) program, and the cell growth rate was compared to the other groups.

## III. RESULTS

In this experiment, HeLa proliferation control was successfully carried out by using LED and ultrasonic stimulation. The representative images of the control group, the experimental group applied only single LED or ultrasound stimulation, and the experimental group applied both stimuli are shown in Fig. 3. The cell growth rate was quantified and compared based on the type and date of stimulation. All experimental groups applied to a single or multimodal stimulation suppress cell proliferation. The average cell growth rates are shown in Figure 4.

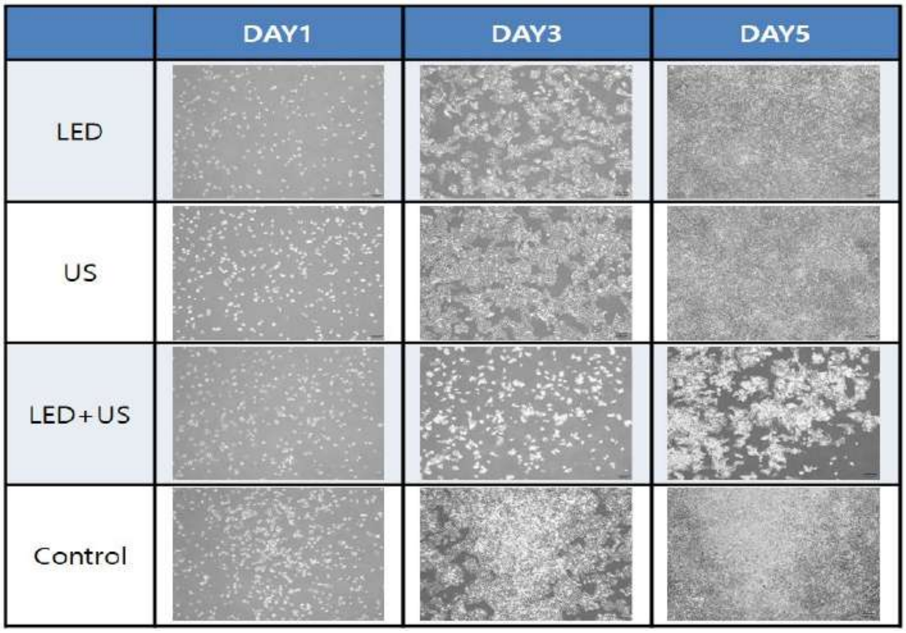


**Fig. 3.** The experimental results of the cell density of HeLa cell

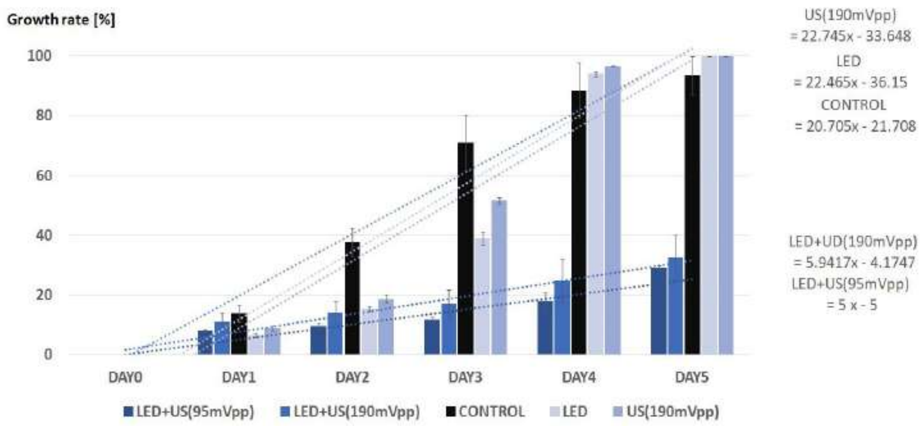


**Fig. 4.** The growth rate of the cell density of HeLa cell

## IV. DISCUSSION AND CONCLUSIONS

In this study, it was confirmed that the use of LED and ultrasonic stimulation has the effect of suppressing proliferation of cancer cells. A single stimulus consisting of LED or ultrasound was difficult to identify the difference from the control group. However, it was confirmed that the proliferation rate of cells was suppressed when both stimuli were applied simultaneously. Additional research will be conducted to verify the proliferation effect using LED with different wavelength and ultrasonic fusion stimuli in different wavelength bands.

## ACKNOWLEDGMENTS

This research was supported by HuStar program (Kumoh National Institute of Technology).

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# Real-Time AI Model Learning Method for the Digital Twin-Based Smart Pipe Integrated Management system

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## Abstract

The digital twin-based smart pipe integrated management system (DTSP-IM) is designed to innovatively operate underground water pipes. First, we buried underground waterway pipes with self-diagnostic and health-monitoring sensing functions. These intelligent pipes transmit data on their status to the DTSP-IM in real time. Based on this data, DTSP-IM performs analysis and monitoring of the conditions of underground waterways. The key issue in implementing the system is how to analyze the data and make clear decisions. To solve this problem, we used a real-time machine learning method. We trained the model by dividing the incoming sensor data into training and verification data in real-time order. Then, we observed the differences in the accuracy of the model according to the method of segmenting the data based on temporal weights. As a result, we propose an appropriate learning model for our system. In addition, the core concept of this learning model is shown to be valid through the verification of the conceptual model.

**Index Terms**: Digital Twin, AI Model, DTSP-IM, Machine Learning

## I. INTRODUCTION

In the light of the 4th industrial revolution, the Korean government and affiliated organizations are establishing a smart city information system using artificial intelligence, IoT, and augmented reality. In addition, they are developing smart solutions in many fields. Accordingly, in the field of water and sewage, digital twin technology is being used to build a future smart water platform. These projects are being led by K-water (the Korea Water Resources Corporation) [1].

Looking at the situation of water supply and sewage pipes in Korea, 31% (58,234 km) of water pipes and 59% (286 locations) of water purification plants were installed 20 years ago, and local waterworks installed in the 1970s and 80s have rapidly aged. In addition, most of these water and sewage management facilities are managed by local governments, but there is a concern that the capacity of water supply facilities may degrade over time [1] However, to cope with this problem, the government and affiliated organizations are trying to smart city information systems using artificial intelligence, IoT, and augmented reality, and developing smart solutions. As part of these efforts, we are conducting research to develop

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a digital twin-based smart pipe integrated management system by developing a "self-diagnosis and health monitoring functional combination smart pipe system" to produce tap water for public consumption with confidence.

The digital twin-based smart pipe integrated management system (DTSP-IM) was studied from the perspective of the advanced real-time machine learning method (ARTMLM) and fast situational awareness method (FSAM). The DTSP-IM is designed to innovatively operate underground water pipe. First, to construct this system, we buried underground waterway pipes with self-diagnosis and health-monitoring sensing functions. These intelligent pipes transmit their status data to the DTSP-IM in real time. Based on this data, DTSP-IM performs analysis and monitoring of the conditions of underground waterways. The key issue in implementing the system is how to analyze the data and make clear decisions. A real-time machine learning method was applied to solve this problem. Section 2 explains expanded application in our DTSP-IM. In Section 3, a special real-time AI machine learning model is proposed. Section 4 describes the results of an evaluation of the performance of this proposal, performed by implementing it at the level of a conceptual model. Finally, Section 5 presents the conclusion.

## II. DIGITAL TWIN-BASED SMART PIPE INTEGRATED MANAGEMENT SYSTEM

DTSP-IM is a system that innovatively operates underground water pipes. As an integrated solution for efficient operation, this system operates through smart decision-making and monitoring by burying water pipes with self-diagnosis and condition-monitoring sensor functions underground. The final goal of this integrated smart pipe system is to provide a smart pipe operation solution.

### *A. Process of developing DTSP-IM*

The process of developing the DTSP-IM is divided into three detailed development items. Subsequently, the technologies of each of the three detailed items are combined into one to form an integrated system. The detailed development item involves the development of an integrated solution for efficient operation and monitoring that receives data from a smart pipe capable of self-diagnosis and condition monitoring, as well as an operational digital twin solution that can make smart decisions through the introduction of core technologies (artificial intelligence, augmented reality, etc.). Through the development of a sensor system for self-diagnosis and state monitoring, the second item directs the development of a pipeline-binding sensor system that can monitor performance and state information, such as physical, chemical, and structural state change, transfer characteristics of internal fluid. The third item directs the development of a smart pipe (tube) such that sensor system devices can be combined with pipes in joints, manholes, and valve rooms, respond to earthquakes and sedimentation, and improve performance compared to existing tubes in terms of measures such as chlorine corrosion resistance and usable lifetime.[2]

Technology-based smart pipe integrated management systems based on digital twins, the development of smart pipe health monitoring sensor systems, and sensor-coupled smart pipe development methods are the main foundational technologies required to develop this system. Figure 1 is a conceptual diagram of the completed DTSP-IM.

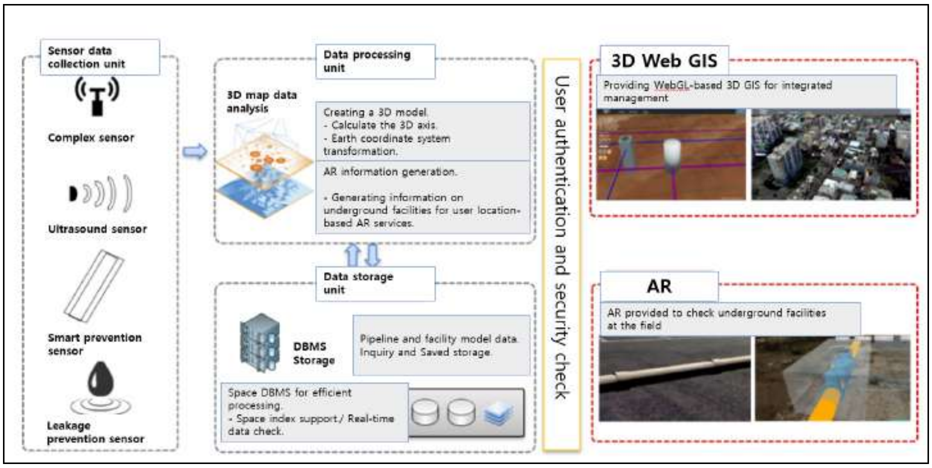


**Fig. 1.** Conceptual diagram of DTSP-IM

## *B. Components of DTSP-IM*

Because remote control and monitoring are among the primary functions of the DTSP-IM, approaches to real-time monitoring configuration are an important issue. To this end, we designed a special real-time-based agent function, which indicated a layered architecture based on the transmission point where sensor data is exchanged as described below. The entire system consists of three layers.[3][4][5][6]

A Sensing Layer consists of sensors and transmission agents built into smart pipes scheduled to be buried on a nationwide scale. They transmit status data in real time, from the current pipe to the upper layer. The main data include flow rate, hydraulic pressure, external pressure, etc., for the quantity supplied to the pipe. The upper part of the sensing layer is a data filtering layer, in which pipes buried in numerous regions are grouped into regional units to some extent to centrally receive and analyze detected data. This layer can be judged according to regional importance and management cost and placed appropriately. In this layer, signals from the sensing layer are analyzed based on the model trained with the data accumulated so far. Based on this analysis, it is possible to determine the severity level of the current waterway supply situation as well as the condensation of the waterway and its degree of aging. Of course, it is operated via the use of groups of artificial intelligence models designed to judge and complement each other based on rules. The corresponding determination value is labeled and transmitted to the shortest layer, the decision layer, which expresses the data received from the data filtering layer in an appropriate UI/UX. The overall situation is monitored, and the system is designed to trigger an alert if necessary. In fact, if the main decision-making functions are handled by the data filtering layer, which is a sublayer, the load of the entire system can be distributed. In other words, monitoring the decision layer in real time is a major design consideration.

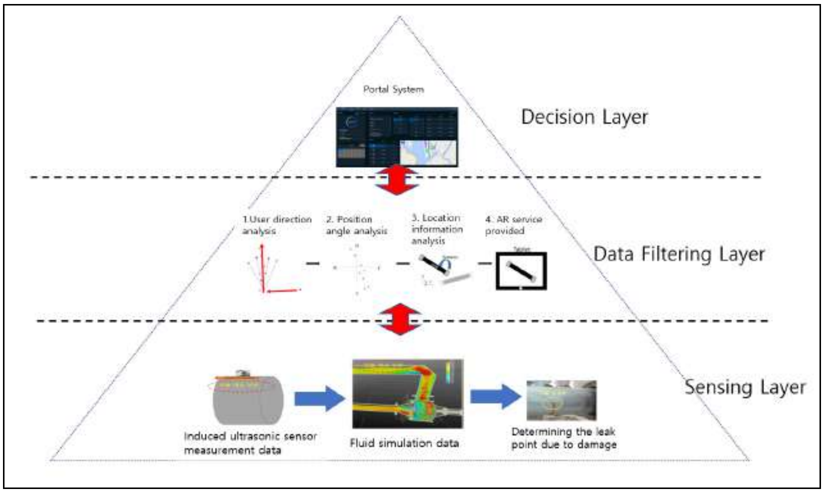


**Fig. 2.** Three layers of DTSP-IM

## III. PROPOSED REAL-TIME AI MODEL LEARNING METHOD

A significant amount of data is aggregated in real time in DTSP-IM, with which the system performs analysis and monitoring of the conditions of underground waterways. Methods designed to analyze data and make clear decisions are a key issue in the implementation of this system. To solve this problem, data input in the model learning process was used as a time-division and distribution processing method. This is a useful way to process data generated in real time, such as for stock markets and defense information. This method divides learning data in real time in order of generation. First, in the AI modeling process, the timing of data input is divided as shown in Figure 3. During the training of the model, training and validation datasets were input. When the model was evaluated, a testing dataset was input to complete the trained model. Thereafter, the trained model can be used to make predictions with state data.[7][8][9][10]

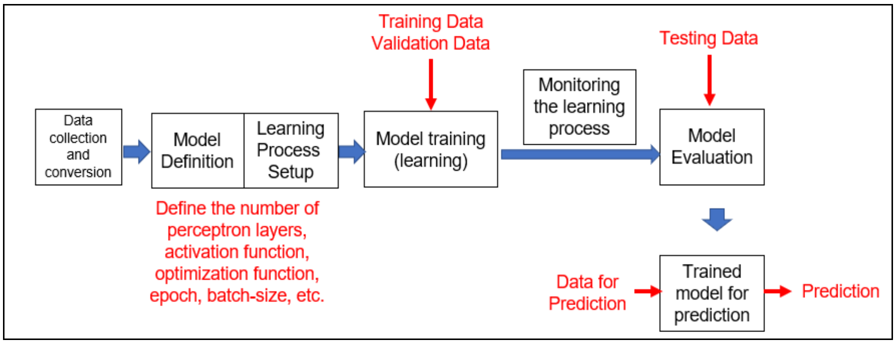


**Fig. 3.** Input time for each dataset during modeling processing

In this system, data was divided and used for model processing as shown in Figure 4 according to the order of data generation. When this time-division processing is performed, the efficiency of the processing time may increase because the model is trained and verified with the most recently generated data.

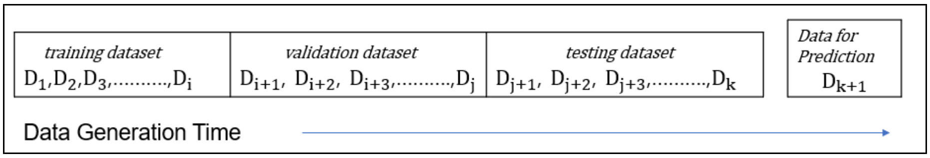


**Fig. 4.** Split data to be used in the order of data generation

If multiple processors distribute the method of separating data to be used according to the data generation time, the processing time will be further reduced. First, data is recorded in the data spool according to the order in which it occurs. This data pool can be shared and used by n processors. While processor 1 performs data processing, process 2 processes a background-method with delayed time. When the n-th processor completes the processing, the processing time can be greatly reduced if the processing is repeated such that the first process is performed again.

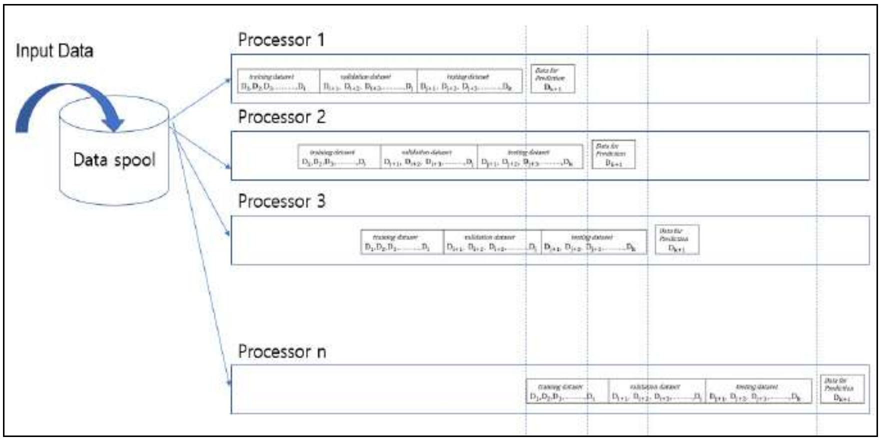


**Fig. 5.** Distributed processing by n processors.

In this way, data is divided into training, validation, and testing datasets according to the order of occurrence. Moreover, there is a slight time difference in data processing so that several processes can be distributed in parallel. Then, because the model is continuously trained on the immediately preceding data, this approach is very useful for processing data with considerable association between the current and previous data. The data processed by this system have a close relationship with current data instead of old data. but the relationship weakens over time. In this case, it would be very appropriate to use the method proposed above.

## IV. IMPLEMENTATION AND EVALUATION

In order to validate this proposal, an AI model cannot be trained with data from all regions of Korea, owing to many limitations in terms of budget and technical methods. Therefore, in this study, data were selected and collected from a limited area. In order to determine the aging of the underground structure, related data were collected. The applied data included information on the type of pipes (electricity, constant, sewage, communication), as well as their unit length, diameter, thickness, material, depth of installation, and installation date. Target data was classified into 10 steps from 0 to 9 by measuring the aging level of pipes. As a special case, in order to train the model in real time, the measured time item for all collected data was added. These data were referred to as data provided as a standard through the public big data portal in Korea. In this reference data, there was no measurement time and type of pipe. Therefore, in order to determine the condition of the underground structure buried in some selected places, it was measured using equipment designed to perform a non-destructive procedure, without digging out the underground structure. Tables 1 and 2 describe the data used.

**Table 1.** Related data for prediction

| Type | Factor | Content |
|---|---|---|
| Input 1 | Type of pipe | It is predicted that the durability will vary depending on the usage. (Electricity, constant, sewage, communication) |
| Input 2 | Unit length | If the length is large, the strength is expected to be low. |
| Input 3 | Diameter | The larger the diameter, the lower the strength expected. |
| Input 4 | Thickness | The smaller the thickness, the weaker the strength expected. |
| Input 5 | Material | Materials like metal are expected to have high strength. |
| Input 6 | Depth of installation | It is predicted that the larger the depth, the lower the intensity due to the pressure. |
| Input 7 | Installation date | If the installation date is long, the strength is expected to be low. |
| Input 8 | Measured time item | When the measurement date is very old, the data cannot be trusted. However, if the date is at an available level, it can be used to establish the reliability of the data. In addition, the measurement date is used as an item for use as real-time rounding learning data in this proposal. |

**Table 2.** Result Data

| Type | Factor | Content |
|---|---|---|
| Target | Aging level of pipes | Target data was classified into 10 steps from 0 to 9 by measuring the aging level of pipes. |

The existing method for learning the entire data as a single model and the case of dividing the data into chronological order and dividing it into models several times were compared. In the case of determining the aging of underground structures, the result is less related to the model to be predicted after a long time period of data measurement, and vice versa, and is largely related to the model to be predicted. Hence, the experimental results demonstrate the excellent performance of the proposed real-time AI model.

## V. CONCLUSION

In the use of machine learning to measure the aging level of underground structures, considerable time is required to collect sufficient data to measure the state of the structures. If AI models are trained with data generated by this time difference, the results of existing AI learning methods may be distorted because data is treated as consistent weights. Therefore, if the data is divided and distributed in the manner proposed in this work, efficiency is expected to increase in terms of the processing time required for model analysis and the accuracy of the model. However, this proposal requires more precise data collection and distributed system implementation to enable the utilization of the system at the conceptual design level, which remains a challenge for future work.

## ACKNOWLEDGMENTS

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# Method Of Design Drawing Conversion Automation for 3D BIM

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## Abstract

BIM (Building Information Modeling) is being actively introduced in all fields of the construction industry. In Korea, BIM[1] has been mandatory for all construction projects since 2016. BIM is a key element of smart construction technology, and recently, it is changing from the method of generating design drawings created in 2D CAD to the method of generating 3D design drawings using BIM and 3D models. However, the reality is that the current trend is not rapidly changing in the field for various reasons. It is an important part of smart construction technology because it is possible to build various services using digital twin and metaverse technology using 3D spatial data designed for conversion based on BIM.

In this paper, we examine the problems of 3D BIM introduction and propose a method to solve them. The proposed method introduces an automatic conversion process that analyzes the 2D design drawing data generated by 2D CAD, extracts the elements composing the design drawing, and converts it into 3D spatial data.

**Index Terms**: 3D Spatial Data, BIM, 2D Design Drawing Data Extraction, Digital Twin, 3D Modeling

## I. INTRODUCTION

The global construction industry is experiencing difficulties in project delays and construction schedule management due to the impact of COVID-19, and construction cannot be completed on schedule due to irregular weather due to global warming. In addition, construction delays and construction projects are canceled, resulting in job losses in the construction industry. In order to solve this situation, the Korean government and the Ministry of Land, Infrastructure and Transport are working to solve the problems and development of the construction industry by using 'smart construction technology'.

The main technologies of smart construction technology, such as artificial intelligence, big data, Internet of Things, BIM(Building Information Modeling), and drone technology, can be utilized. The construction industry is divided into design, construction, and maintenance stages. In the design stage, BIM technology can be used to avoid design interference and prevent re-construction. In the construction stage, it is possible to establish a construction schedule and manage materials through big data analysis after collecting

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construction site data through IoT technology. In the maintenance stage, it is possible to predict safety accidents and perform on-site maintenance using artificial intelligence models. By introducing smart construction technology to the entire construction industry, it is possible to solve problems and reduce the accident rate by improving productivity (reducing the construction period) and improving the working environment at the construction site. Therefore, digital transformation in the construction industry is now becoming a necessity rather than an option.

In this paper, we propose a design drawing conversion automation method for 3D BIM as a method to shorten the construction period in the design stage.

## II. SYSTEM MODEL AND METHODS

Currently, Autodesk Revit is widely used as a representative BIM software in the construction industry, and the built BIM data can be managed with BIM software. Table 1 shows representative BIM software.

**Table 1.** BIM Software

| Company | Authoring Tool | Analysis Tool |
|---|---|---|
| Autodesk[2] | Revit<br>Civil 3D<br>Infraworks | Navisworks<br>BIM 360 |
| Trimble | Tekla Structures[3]<br>SketchUp[4] | TeklaBIMSight[3]<br>Vico Office |
| Graphisoft | Archicad[5] | BIMx[6] |

Most of the design drawing conversion methods in the construction industry use BIM Software. The method proposed in this paper does not use the commercial software mentioned above.

The applicable 2D drawings were developed based on the data of 7 major underground facilities (waterworks, sewerage, gas, electricity, communication, oil transmission, and heating). In addition, general architectural drawings will be applied.

The design drawing conversion process is as follows. First, after the 2D design drawing data pre-processing process, data composing the drawing, such as point, line, block, text, etc.

Since the extracted data has only information on the elements constituting the drawing, it is not possible to construct BIM with this data. So, we work to convert the extracted data into facility data. So, we work to convert the extracted data into facility data. The worked data is classified in order to connect with the actual facility and objectified so that the data can be connected.

When processing data, it is different depending on the type of each drawing, so it is necessary to have a certain degree of understanding about the drawings in order to process data. For example, the position coordinates of the points constituting the pipeline in the plan view are the parts that mark the singular point of the pipeline. Each singularity marks the point where the curved pipe or branch pipe is buried on the floor plan.

Based on the objectified data, it is converted into 3D spatial data for BIM. Through this process, design data can be converted into 3D spatial data and data for 3D BIM can be constructed along with 3D modeling automatically generated.


**Fig. 1.** Automation process of design drawing conversion

Figure 1. shows the whole process. The preprocessing stage is a stage in which a CAD engineer directly modifies using CAD software. The reason for doing this by hand is that a person who has an understanding of the drawings must directly view and judge the drawings and modify the CAD entity.

In the Extracting Data stage, the drawing data that has completed the preprocessing operation is received, the drawing information is analyzed, and the CAD entity elements are sorted and grouped based on the analyzed information to extract the data.

In the postprocessing stage, data mapping with facilities is performed through spatial analysis between point, line, text, and block. Through data mapping, each entity is created in the form of data for BIM and outputs data in JSON and CSV file format.

The finally completed 3D spatial information data can automatically generate a facility 3D modeling file through the parametric 3D modeling [7] process. Data database for 3D BIM by combining the 3D modeling file and 3D spatial information data to build

## III. RESULTS

For the test, 2D design data of the actual construction site was used. For comparative test data, a 1.6km2 area under actual underground facility construction was selected. The test measured only the conversion design process, excluding the 3D modeling file creation process. For comparison, the automated process proposed in this paper and the manual data extraction method by CAD engineers were compared.

**Table 2.** Working time comparison Result

| Method | Preprocessing | Extracting Data | Postprocessing |
|---|---|---|---|
| Suggested method | 2 days | 10 minutes | |
| Traditional method | 4~5 weeks (by 1 person) | | |

Based on the test environment, the method proposed in this paper took a little over 2 days, and the traditional method took about 4 to 5 weeks for one CAD engineer with 5 or more years of experience to extract data. Although the results of this comparison showed a big difference, it is necessary to conduct a test using 2D design drawing data under various conditions.-

## IV. DISCUSSION AND CONCLUSIONS

The proposed design drawing conversion automation method dramatically shortened the work time compared to the existing traditional method. However, the reason for not using the data extraction technique using artificial intelligence and image processing is that underground facilities must be installed at the correct location during construction so that the correct location of the underground facility can be quickly found during maintenance. In addition, if an underground facility cannot be found at an accurate location, there is a problem in that construction time and maintenance cost increase during maintenance (repair work). So, in order to get accurate GIS information (latitude, longitude), I had to convert the drawing to ASCII data and extract the correct value. In the future, the conversion design automation method needs to be improved in consideration of various data extraction methods depending on the data utilization method for design drawing conversion.

## ACKNOWLEDGMENTS

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# A Research on Automatic Generation of Video Metadata for Media Super-Personalization Recommendation

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## Abstract

The media content market is revitalized as various contents are mass-produced due to the recent development of the Internet and digital. In addition, platforms that provide personalized services for content consumption are emerging, and each platform is competing to recommend personalization of content. Existing platforms take a method of directly viewing and manually inputting metadata of videos. This will waste time and money processing large amounts of data. In this paper, keyframes and audio spectra based on the YCbCr color model of the movie trailer are extracted for automatic generation of metadata. The extracted audio spectrum and image keyframes are used as learning data for genre recognition of deep learning, and deep learning that determine genres among video metadata is implemented and suggestions for utilization are proposed.

**Index Terms**: Deep Learning, Metadata, OTT, Audio Spectrum, Keyframe, YCbCr.

## I. INTRODUCTION

With the development of the Internet and digital, more and more platforms which storing large amounts of media data and providing customized services online. In order to recommend content that suits an individual's taste, metadata of the content must be generated. it compares the metadata of the generated content and the user's information to proceed personalized service. At this time, high-quality metadata is required for an efficient recommendation system. Existing platforms take the method of directly watching videos and manually entering metadata. This will waste time and money when processing large amounts of data.

Music is closely related to movies. People can imagine the scene just by listening to the music played in the movie. As such, music has an excellent function to express the characteristics of the movie and the emotions of the scene. [1].

Therefore, this study aims to study how to generate metadata by analyzing the audio of the video and extracting the keyframe based on the YCbCr color model for super-personalization recommendation.

* Corresponding author

## II. SYSTEM MODEL AND METHODS

This chapter deals with the flow chart and model design of the system for extracting metadata. Among various types of metadata, first of all, I would like to propose a method of extracting the genre of a movie as metadata. The audio data and the image data are separated from the video content to extract metadata.

The following Figure 1 shows the proposed system flowchart. Media content such as movie trailers is prepared for the learning of deep learning models, and voice data and image data separated from the video are prepared. The separated image data is used to extract a keyframe through a YCbCr color model. Thereafter, generate a histogram of the keyframe. Finally, metadata about the movie star is extracted by recognizing the movie star's face through the face recognition model. Separated voice data removes voice and leaves only background music. The processed voice data is generated through STFT to generate an audio spectrum of each movie trailer. Audio spectrum and keyframe histograms, which obtained through a series of processes were stored as images and were divided into training data and evaluation data to process them as deep learning data. Thereafter, metadata such as genre is extracted through training of deep learning and image classification, and stored in a database.

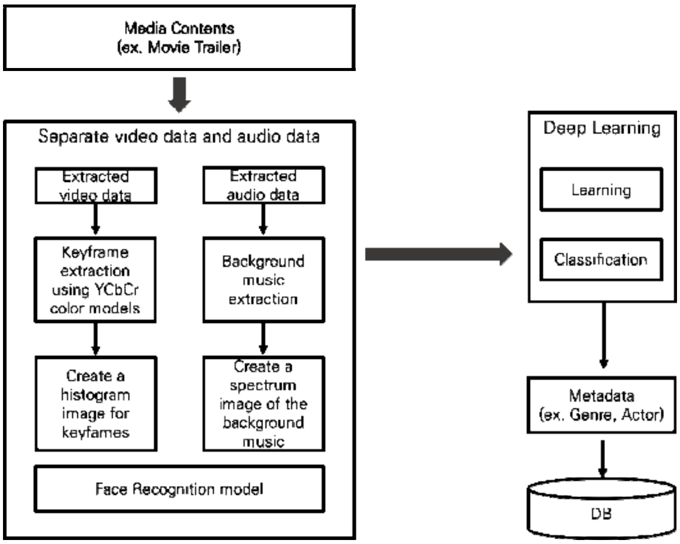


**Fig. 1.** Video Metadata Extraction System Flow Chart

In this study, four films were selected by dividing the genres into Comic, Action, Horror and Romance, and each video and audio data were separated. The following Table 1. Shows the movie trailers used by genre.

**Table 1.** Classification of genres of movie trailers used

| Genre | Trailer 1 | Trailer 2 | Trailer 3 | Trailer 4 |
|---|---|---|---|---|
| Comic | The Extreme Job | Honest Candidate | Ms.Wife | The Secret Zoo |
| Action | Godzilla King of the Monsters | The Ashfall | Transformer | Iron Mask |
| Horror | The Nun | Us | The Gongiam | 0.0MHz |
| Romance | Carol | The Notting Hill | Once | The Beauty Inside |

Audio data extracted from each movie trailer image were analyzed for frequency components over time using STFT(Short Time Fourier Transform), which was acquired as a spectral image. Spectral images obtained as a result of audio analysis were classified as training data for each genre, and transfer learning was conducted using the ResNet34 [2] deep learning model. Spectral images were classified, transfer learning was conducted through ResNet34, learning and evaluation were conducted.

Keyframes were extracted through the YCbCr color model. [3, 4]. A histogram image of the extracted keyframe was generated, and 50 images were randomly selected for each trailer. Using a total of 800 data, the classification results by genre were confirmed by applying them to logistic regression models and VGG-16 [5] which one of CNN (Convolutional Neural Networks). The language used in the system was Python, and Numpy, OpenCV, PyTorch, etc. In audio data, transfer learning was used, which means that some abilities of neural networks learned in certain fields are used to learn neural networks used in similar or completely new fields. For deep learning, training data was conducted at 75% of all data and test data at 25% of all data.

## III. RESULTS

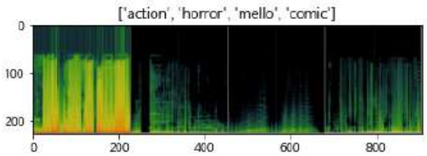


**Fig. 2.** Visualization of Training data Batch

Fig. 2 shows a visualization of the training data placement result for the audio spectrum. This means action, horror, romance, and comedy genres from left to right. As a result, we were able to confirm that each audio spectrum images according to the action, horror, romance, and comic classes were well arranged.

Fig. 3 visualizes the evaluation results of testing the audio spectrum of the Horror genre. Accuracy was 100%, and the Loss value was 0.2713. The high degree of Accuracy means that the training data intended to classify genres based on the audio spectrum is properly recognized and classified. Through these results, we were able to confirm that AI can classify genres using background music audio in movies. We inferred that if the genre of a movie is classified using audio spectrum, it is possible to automatically generate metadata for the genre as well.

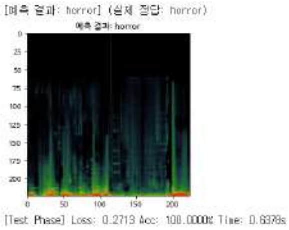


**Fig. 3.** Testing Results

However, in the case of the method using keyframes, the accuracy was 88.9%. This result seems to have appeared because the type and amount of training data are relatively small. In the future, we plan to supplement the results by studying other feature factors.

## IV. DISCUSSION AND CONCLUSIONS

In this study, we proposed a method of automatically generating metadata elements with artificial intelligence, rather than the existing method in which people directly input metadata. Among them, the classification accuracy was high when ResNet was used for the spectrum image by extracting the audio spectrum by genre.

We plan to improve the performance of the system by increasing the diversity of pre-trained data for accurate classification in the video as well as audio, and by increasing the amount of data for additional learning. It is expected that personalized services' consumption will be promoted if the feature elements that can classify images are found and additionally applied to increase the accuracy of artificial intelligence and build an automatic metadata generation system.

## ACKNOWLEDGMENTS

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# Gaussian Filter Design for Occupant Heat Detection and Movement Management

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## Abstract

Recently, due to COVID-19, the use of non-face-to-face authentication and fever detection systems is increasing. As the number of confirmed cases increases, the government is making it mandatory to authenticate and install a fever detector. It is used for entering and leaving not only general restaurants but also all stores. In order to increase the effectiveness of non-contact long-distance body heat measurement, it is most important to measure and predict the movement of people entering and leaving. Therefore, in this paper, the movement of the entrance and exit is assumed to be a normal distribution, and a Gaussian filter is applied to it to trace the movement path. It is expected to further develop K-Quarantine by distributing it to public facilities and nursing facilities in the future.

**Index Terms:** Occupant heat detection, gaussian filter, predict movement, Gaussian distribution.

## I. INTRODUCTION

Recently, due to COVID-19, non-contact social distancing is being implemented all around us[1]. In addition, when entering and leaving all facilities, heat detection and authentication procedures are performed to control access. During the implementation of access control measures, personal information is disclosed to others, leading to problems such as human rights violations and leakage of personal information[2]. In addition, the system currently in use consists of a heat detector and a smart authentication system separately.

Therefore, there are cases of congestion in places where there is a lot of floating population because temperature and authentication tests must be conducted separately when entering and exiting. In the case of congestion, the rules of distance are not observed well, and as the distance increases, the possibility of virus transmission increases. Therefore, there is a need for a system that can perform both a thermal test and an authentication test at the same time. Most of the recently developed products are devices that are individually installed as a temperature check system to check body temperature.

In this paper, the movement of the entrance and exit is assumed to be a normal distribution, and a Gaussian filter is applied to it to trace the movement path. It is expected to further develop K-Quarantine by distributing it to public facilities and nursing facilities in the future.

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## II. SYSTEM MODEL AND METHODS

Equation (1) shows the state model according to the time of the entrants.

$$A, B, H, Q, R, x, P \qquad (1)$$

Equation (1) is the part that specifies the system model and initial value.

$x$ is the pedestrian state. $P$ is the covariance value indicating how confident the filter is the solution. Using Equation (2), we pass through the system matrix A, which is the value obtained from Equation (1), and $x_{t-1}$ representing the previous value of $x$.predict the current state.

$$\bar{x}_t = Ax_{t-1} \qquad (2)$$

Using Equation (2), calculate the covariance (expected error) as Equation (3) Calculate. where $P_{t-1}$ is the previous $P$ value, $A$ and $Q$ are the system model and $Q$ is the covariance matrix of the system noise.

$$\bar{P}_t = AP_{t-1}A^T + Q \qquad (3)$$

Then, using Equations (2) and (3), the Kalman gain is calculate as in (4). Here, $H$ and $R$ are the system models of Equation (1), and $R$ is the covariance matrix of the measurement noise.

$$K_t = \bar{P}_t H^T (H\bar{P}_t H^T + R)^{-1} \qquad (4)$$

Then, using Equation (4), Equation (5) where the value of $x_t$ is an estimated value save Here, $z_t$ is a measurement value in the real environment, and noise is included in this value.

$$x_t = \bar{x}_t + K_t(z_t - H\bar{x}_t) \qquad (5)$$

$$P_t = \bar{P}_t - K_t H \bar{P}_t \qquad (6)$$

Then, using equations (3) and (4) of the proposed algorithm, Equation (6), which is the error covariance value, is calculated. At this time, the $P_t$ value does not disappear and is updated at every measurement, and after Equation (6) is processed, it is processed by returning to Equation (2). This cycle is repeated until no more $z_t$ values are entered.

As shown in Figure 1, when the proposed algorithm was not applied, it was difficult to clearly track the position of the pedestrian, but on the contrary, when the proposed algorithm was applied, it was confirmed that the shape was more similar to the original.

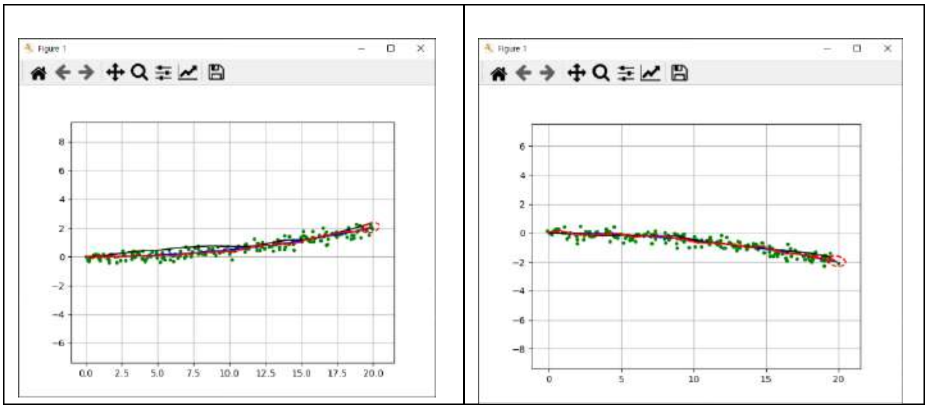


**Fig. 1.** Result of tracking the location of the visitor

## III. RESULTS

In this paper, the movement of the entrance and exit is assumed to be a normal distribution, and a Gaussian filter is applied to it to trace the movement path. It is expected to further develop K-Quarantine by distributing it to public facilities and nursing facilities in the future

## ACKNOWLEDGMENTS

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# Block-chain-based Medical Information Security for Collaboration in A Telemedicine Environment

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## Abstract

As medical data become valuable materials for healthcare industry, secure sharing and patient's self-sovereign ownership of data also become important. Medical services are changing in the era of the 4th industrial revolution. Since the private block-chain is in a state of knowing the information about the participants in advance, a person with a high social reputation or verified among them is selected and authorized for block generation. The algorithm started from the belief that the authority will manage the block-chain network, take charge of the transmission and creation of blocks, and thoroughly verify the blocks to protect the social reputation. If verification fails, the authority will lose social reputation. We will faithfully carry out the task of verifying. In the proposed system, the system consists of a node, a block-chain including smart contracts, and external storage, and stores and shares information using the node. It encrypts the information components and creates a meta-block to decrypt the corresponding elements. By ensuring the integrity of medical information using meta-blocks and encrypted data, it is possible to safely utilize shared data based on a mutually heterogeneous network

**Index Terms**: Block-Chain, Medical Information Security, Telemedicine, Medical Data Sharing.

## I. INTRODUCTION

Telemedicine can be said to have started with the purpose of improving medical access in the outskirts of cities where medical access is weak. With the development of ICT (Information and Communication Technology) technology, it was promoted to achieve the purpose of more expanded and stable medical services, but the need for telemedicine increased rapidly in the context of the COVID-19 pandemic. The generated medical information is being used for research in the field of digital healthcare, such as telemedicine and AI-based medical analysis technology. However, high integrity and reliability of data are required for the accuracy of treatment and analysis technology that is directly related to the patient's life. In order to meet these requirements, research is being actively conducted to provide integrity and reliability by applying blockchain, a distributed storage technology.

It is an algorithm based on the belief that the authority manages the block chain network, is responsible for the transmission and creation of blocks, and will thoroughly verify the block to protect the social reputation. If verification fails, the authority will lose social reputation. Therefore, it will faithfully perform the task of verifying the block. Since medical information is centrally managed by the hospital, there is also a problem that the weakness of the hospital itself leads to the weakness of patient data. The patient has no choice but to trust the security of the hospital, and it becomes difficult to solve the problem of forgery or falsification of medical information or the leakage of medical information caused by the limitation. We can no longer trust the security of the hospital through this. Therefore, in this paper, we propose a medical information security smart contract for safe cooperation of specialists based on telemedicine.

## II. RELATED WORKS

### *A. Medical Information System*

Medical information refers to a variety of information related to medical care, ranging from patient treatment to medical education, medical research, and medical management. Data handled in medicine are generated through well-defined medical work processes. In other words, data generated through medical work processes such as subjective symptoms or objective symptoms of patients handled by doctors or nurses, blood findings from clinical pathology labs, X-ray photographs taken by radiology, and histological findings reported by the Department of Anatomy and Pathology means. The medical information system serves to support various decision-making in the medical field by collecting, systematizing, and generating necessary information. A major type of medical information system currently in use is a hospital information system (HIS). This system includes clinical information system (CIS), financial information system (FIS), laboratory information system (LIS), nurse information system (NIS), and pharmacy information. System (PIS, Pharmacy Information System), Medical Image Storage and Transmission System (PACS, Picture Archiving and Communication System), Radiology Information System (RIS, Radiology Information Systems), Prescription Delivery System (OCS, Order Communication System), Electronic Medical Records ( It is composed of a combination of EMR, Electronic medical record), and Wide Area Medical Information System (WAMIS).

### *B. Block-chain*

Block-chain technology does not store transaction information in a specific institution or central server. In addition, it can be said that it is a technology that is distributed and stored on the network, and recorded and managed jointly by all participants. One block includes the transaction history for the past 10 minutes, the hash value of the immediately preceding block, and the none value. It can be said that the block chain is formed by continuously connecting these blocks. Each block has a timestamp, and the block-chain can only be updated when system participants agree and when new data is entered. It is a decentralized electronic cryptographic ledger or database platform that, once entered into a block, can never be deleted. Therefore, in storing digital data immutably so that the network and users can safely share it, the block-chain applies the public key encryption method to verify the owner in the ledger. In a block-chain, only the person who records half of the public key pair and holds the other half of the private key can become the owner and decide the next transaction instead of a name or social security number.

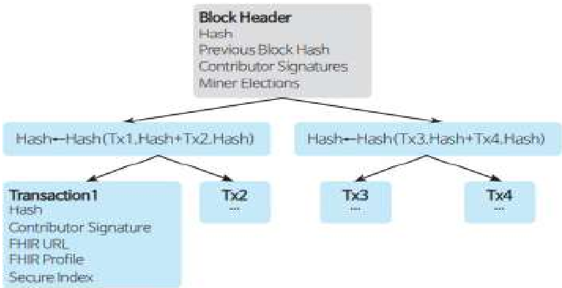


**Fig. 1.** Healthcare block-chain block header structure reflecting FHIR

Block-chain technology is expected as an alternative to fulfill the requirements of ONC-HIT while supplementing rather than replacing the FHIR system. In the case of storing and distributing all medical or health-related information, it is difficult to directly store large-capacity image information such as X-rays and MRIs, and there is a risk if Personally Identifiable Information (PII) is publicly exposed. Therefore, to solve this problem of medical information, 'On-Chain' data that directly stores information in the block-chain and 'Off-Chain' data that uses a link stored in the block-chain as a pointer for information stored in a separate traditional database There are two types of information storage methods available.

## III. Block-chain-based medical information security for collaboration in a telemedicine environment

In this paper, we propose a medical image reading and sharing system using block-chain technology. It is a model that aims to prevent security accidents that may occur in the process of safely storing and communicating various imaging databases such as CT, MRI, X-Ray, Mammo, and ultrasound among medical data. The proposed model can prevent exposure of important personal information and prepare for security incidents when delivering medical images for lesion reading between medical staff in telemedicine. The configuration of the proposed system provides a lightweight encryption communication technology based on a consensus algorithm and smart contract. The proposed system is a private type of block-chain technology that restricts assessors participating in telemedicine, and the system configuration is as follows.

[Fig 2] The system configuration diagram of the proposed method is shown.

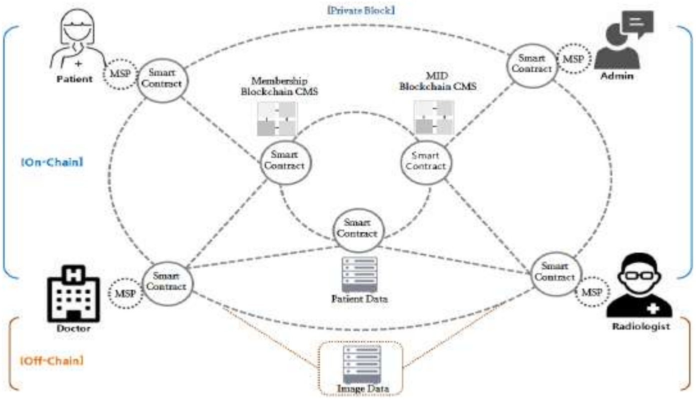


**Fig. 2.** System diagram

In the proposed paper, we tried to solve the privacy problem of sensitive data in order to link the telemedicine system with the block-chain. To solve the problem, as shown in [Fig 2], the block-chain network and the MID blockchain network for verifying the identity of each agent owner were linked with the telemedicine system. In the MID block-chain network of the proposed model, it consists of patients, hospital personnel, readers, and administrators, and constitutes a private block-chain through smart contracts. The entire process of reading telemedicine images is communicated using a block-chain network. The proposed model guarantees the originality of medical image data and reading findings, provides forgery prevention and data integrity assurance, and protects sensitive medical data from malicious hacking by storing medical image data as a block chain.

The block-chain Hyperledger Fabric modular architecture of the proposed model supports components such as consensus and membership services within the block-chain in a plug-and-play manner. Fabric does not have a form for cryptocurrency payment and uses certificates and channels to limit data access to only authorized users, even if they exist on the same network. First, the Membership service authenticates the client. Hyperledger Fabric, the proposed model, does not have a form for cryptocurrency payment and uses certificates and channels to limit data access to only authorized users, even if they exist in the same network.

The authentication process of the proposed block-chain network is as follows.

1. First, the Membership service authenticates the client.

2. When authentication is complete, a transaction proposal is sent to *Per* to execute the transaction.

3. The Endorser of *Per* receives the transaction proposal, signs it through internal processing, and sends the verification result again.

4. The signed transaction is sent to the ordered, arranged in the order of the transaction by the consensus algorithm, and delivered to the *Commiter* of *Per*.

5. The *Commiter* stores the ledger after verifying the transaction, and the Fabric additionally deploys the actual chain code through the channel and executes the transaction.

In the proposed block-chain network, since the capacity of medical images is very large, it is configured to acquire and transmit images in compliance with DICOM (Digital Imaging and Communications in Medicine). In addition, the on-chain data method that transmits the reader's request information, observation information, and interlocking information, and the off-chain data where actual data exists through index information of medical image data (images such as CT, MRI, MG, CR, etc.) It is composed of off-chain data to protect and provide privacy of sensitive information.

## IV. DISCUSSION AND CONCLUSIONS

In this paper, medical image data can be obtained through the medical image data client program, the acquired image data can be viewed, and the medical image data block-chain network is accessed using the medical image data SDK (Medical Image Data Reading Application Library). Through the connected block-chain network, it is possible to share image data for remote treatment and to transmit treatment results or cooperation items to a remote location. In the proposed block-chain network, medical image data that has been de-identified of personal information can be viewed and transmitted by accessing the medical image data Block-chain Network using the medical image data SDK (medical image data reading application library). Security was considered in the video data transmission process. It was implemented so that medical image data transmitted to a remote location can be inquired through the medical image data reading program, and the medical image data can be opened and checked at the remote location, and can be read and written and saved. At this time, medical image data is supported so that it can be viewed and transmitted, i.e., downloaded or uploaded, by accessing the medical image data block-chain network using the reading application library.

## ACKNOWLEDGMENTS

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# A Study on the Importance of Post-Processing for Each Use Situation of Deep Learning

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## Abstract

Artificial intelligence is being used not only in general data processing in the present era, but also in all various fields. A lot of data is used to utilize such artificial intelligence technology, and processes such as filtering or converting it are required to use effective data. In this paper, a process to solve this problem is proposed assuming a situation in which excessive resource use or improvement may be made among situations using artificial intelligence. A CCTV server that performs multiple inputs was held as a test case, and a method of compressing and converting multiple data into one image and outputting multiple results again was performed to improve the inability to multi-process during deep learning processing.

**Index Terms**: Deep learning, Post-processing, Image Processing, Data processing, Artificial Intelligence

## I. INTRODUCTION

Many methods have been studied to utilize artificial intelligence. The more complex the operation in software, the more advanced the hardware to solve it, and the currently announced backbone neural networks with strong performance are slow but capable of performing[1]. The accuracy has reached a certain level, reaching the degree to which objects are more accurately identified than humans, and in some parts, they are performing tasks on behalf of humans. High-performance hardware is required to confirm the results showing the latest high accuracy, resulting in excessive resources and costs.

However, in the case of object recognition, which has already reached a high level, there is a question of whether it is necessary to use hardware consumptively while using a high-performance model. It is an area that needs to be continuously developed over time, but it is necessary to reduce costs by developing a system with appropriate performance where necessary. However, due to the interest caused by the current Fourth Industrial Revolution, excessive investment is being made to install high-performance technologies in areas that do not require the use of artificial intelligence, and this needs to be effectively improved[2].

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In this paper, we propose a method to improve results or effectively utilize resources by introducing additional post-processing processes in performing deep learning appropriate for hardware and usage environments. It explains how to introduce a process that can be added to learning as well as results.

## II. RELATED RESEARCH

There are various types of deep learning models capable of object recognition. Representatively, there are CNN, R-CNN, Mask R-CNN, YOLO, YOLACT, etc., and the Backbone network uses frequently used things, but different methods for finding objects are performed in different models[3-6].

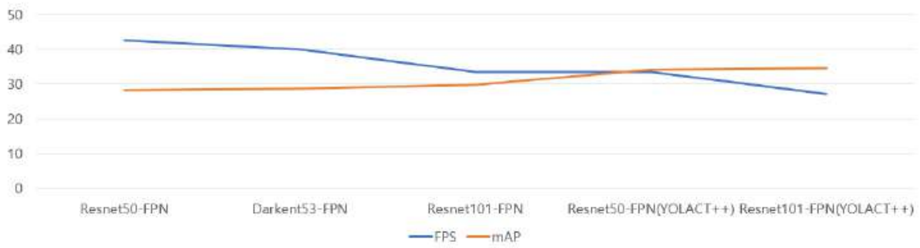


**Fig. 1.** Backbone that can be used when processing YOLACT

Figure 1 shows a typical comparison of performance by backbone network through YOLACT. The image size is fixed at 550, and it can be seen that the speed and mAP are different for each network. On average, it can be seen that if the processing speed is fast, the accuracy decreases accordingly. However, since the difference in perceived performance is not very large, using an appropriate model can benefit from the processing speed even if the accuracy is a little low.

## III. METHODS

### A. Hardware efficiency

Hardware used for performing actual deep learning may operate only one model. In addition, deep learning performs operations in parallel, but cannot be additionally performed if the process of deep learning occupies the GPU. Even when performing parallel operations on learning, multiple images are loaded and processed in graphic memory at once, and models produced by learning also use many graphic memories to output results. Assuming that one image is usually used at a time, the following method can be used.

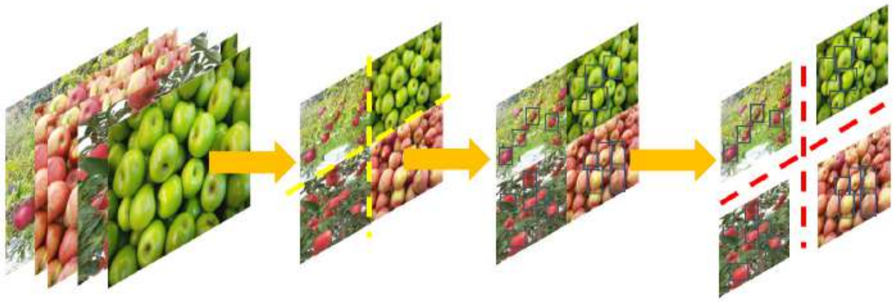

**Fig. 2.** The first Proposal process

Figure 2 shows the process of compressing and segmenting images for multiple image inputs and outputs for learning and performing results. The image size is compressed in consideration of the resolution for existing input in the image input. When attaching images to each other, the entire size image maintains the resolution of one existing image and returns the position value of the object according to the compressed image ratio when outputting the learning result or object detection result. Although not yet used for learning, when detecting objects, four images could be performed at the same processing speed, and the use of resources remained the same as when one image was processed.

## B. The performance of object recognition

In general, classification and object detection are the main methods of artificial intelligence processing using images. Among them, it is important to accurately locate the object for object detection. If a low-weight model is used here, the accuracy may be reduced, but the use of hardware resources may be reduced.

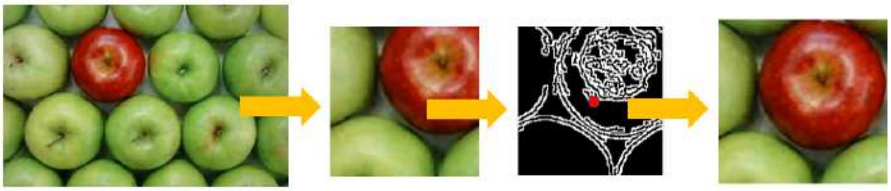

**Fig. 3.** The second Proposal process

Figure 3 shows a position correction method that can be used in object detection. In general, information on an object that appears when an object is detected through deep learning is represented in the form of a bounding box. The execution of the process first finds the center point in the bounding box processed as a result of deep learning. Thereafter, color data of an object belonging to a central point is checked in the data in the bounding box to compare data around the central point. If the data were cut off vertically to the left and right of the bounding box and vertically to the top and bottom, it would not have been able to properly detect the object. Usually, object detection forms a bounding box larger than the corresponding object, but if it is cut off at the boundary, object detection is wrong. If object color data similar to the center point is detected by further expanding the bounding box, the bounding box is expanded to the end point of the data.

## IV. CONCLUSIONS

This paper proposes a method that can improve detection performance through image processing when compressing multiple images input to process multiple inputs at a time and reflecting the object detection location in consideration of the compression ratio or using a low-cost deep learning model for object detection. In addition to performing deep learning used in the proposed method, there are many other models such as general text data use and image classification. There are many ways to process data, and processes for processing it can be devised outside the general form. Artificial intelligence can continue to develop and appropriate applications must also develop together.

## ACKNOWLEDGMENTS

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# A Decentralized Approach of Healthcare Data Collection for Research

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## Abstract

Accurate data is an important part of research work. Data should be as accurate and reliable as possible. When it comes to healthcare research then it is more important for researchers to have the most accurate and reliable data. Data analysis is compromised if there are doubts in data collection which leads to wrong results. Since the healthcare data is sensitive and its leakage may lead to serious issues. So, the security and privacy of healthcare data are also important along with accuracy and integrity. In this study, we have proposed a blockchain-based healthcare data collection framework. In the first phase, the participants for data collection will be registered on the blockchain. In the second phase, they will be collected using a software application. Then the data will be encrypted and stored on IPFS after the identity verification of the data sender. After successful storage of data, the data index of IPFS will be stored on the blockchain network. In this way, only authorized participants can participate in data collection and accurate data will be collected. The data stored on the IPFS is secured and can only be identified by the indexes that are stored on the blockchain.

**Index Terms**: Healthcare, Data Collection, Privacy, Security, Blockchain, IPFS, Decentralized.

## I. INTRODUCTION

Data is an essential part in terms of getting insights about a specific topic, research, or study. In digital transformation, the data is considered an important part, especially in getting insights, managing operations, and making forecasts in a way that will be significant in value. In terms of scientific research data is an essential factor. In modern research, data accuracy and availability are major problems. Data must be accurate and freely available for scientific research to do new experiments and solve real-world problems[1]. Regardless of the field or inclination of research, accurate and appropriate data is necessary to maintain research integrity. There are many consequences of inaccurate data such as research questions are not properly being addressed, misleading research findings, and wastage of resources and time [2]. To get authentic results data must be accurate and reliable.

* Corresponding author

In healthcare research, the integrity of the data is important, while irrelevant and inaccurate data harm healthcare research outcomes that may lead to serious issues [3]. In the healthcare industry, we can see how research is transforming the way of diagnosis and treatment. The use of AI in the medical field solves big problems, such as reducing the workload, diagnosing diseases, and forecasting the epidemic more effectively [4].

Data collection refers to the method of measuring, observing, and obtaining accurate information. Data collection techniques and methods vary per field, in healthcare data collection there are a variety of data collection methods such as questionaries, observations, and examining the documents. Maintaining data quality and integrity is the main concern in healthcare data collection. There are several tools for healthcare data collection, Customer Relationship Management Systems (CRM's), Electronic Health Record Systems (HER's), and Mobile Applications are the most popular[5]. Healthcare data is complex unlike the data of any other field[6]. Since several reasons make healthcare data collection a difficult and time taking process:

**Data is Distributed:** Data is collected from multiple places, maybe from multiple departments or multiple hospitals. It can be in different formats e.g. text, numeric, image or video, etc.

**Variable Definitions:** New research is coming out every day, so the definitions for diagnosis are inconsistent. Also in different clinics have different criteria to identify a disease.

**Incomplete Data:** The data is collected for years. Also, it is scrubbed and standardized that resulting in the data becoming incomplete.

In our proposed framework we are addressing these issues.

## II. PRELIMINARIES

In this section, we have made known some preliminaries that are used in the proposed framework.

### *A. Blockchain*

Blockchain is a peer-to-peer distributed ledger technology. Blockchain records information in a way that makes it impossible or difficult to hack, alter or delete[7]. The transfer of information in blockchain is called a transaction. The collection of transactions build up the blocks. Every block has the information of its previous block, In this way, all the blocks are chained together. After verification, these blocks are added to the chain and distributed among the peers of the blockchain network. Every node in the network maintains the record of all the blocks in the network.

### *B. Smart Contract*

A smart contract is an electronic form of a contract that is deployed on the blockchain network. Smart contracts are programmed and can self-execution[8]. In simple words, all the terms of the agreement are written in code, and when these conditions are met the contract will be executed. Smart contracts are immutable. After the execution of the smart contract, the resulting transactions are recorded on the blockchain.

### *C. InterPlanetary File System (IPFS)*

IPFS is a peer-to-peer decentralized file storage and sharing system[9]. Data uploaded to the IPFS, split into smaller chunks, distributed among the network nodes, and assigned a unique hash to locate that data. IPFS works similar to the blockchain concept but it is not based on blockchain. If there is any change in the uploaded data then the hash would automatically be changed. IPFS provides the facility of maintaining the entire history of data by providing the versioning system, it facilitates the addition of a new version of a file and connects it to the previous one[10]. It provides transport encryption to securely transfer the data from one node to another[11].

### *D. Decentralized Application (DApp)*

DApp is an application that is developed based on a peer-to-peer network. DApp is used to provide an interface between the blockchain network and the user[12]. Different blockchain frameworks provide the API (Application Programming Interface) to communicate with the smart contracts deployed on the network. DApp's interact with these APIs to communicate with blockchain networks.

## III. SYSTEM MODEL

In our proposed system every user has to register on the network and a private and public key pair will be issued to the users. These key pairs will be used as credentials to interact with the system.

As mentioned in Fig.1 our proposed system is divided into three main components dApp, blockchain network, and IPFS. The dApp provides the interface between the user and the system, the blockchain network consists of participating nodes and hosts the smart contract, and the IPFS is used to store the data. These components are further elaborated one by one in the following sections:

### *A. Decentralized Application (DApp)*

For this system, the dApp will be developed with predefined data input fields to prevent wrong data inputs. These input fields will be dynamic, can be enabled or disabled according to the requirements of data collection or data provider. It prevents data to be incomplete and inaccurate. Every uploaded record is treated as a file. That data file is encrypted and sent to the blockchain along with the encryption key and the private key of the user. The private key will be used for user verification. No one can interact with the system without valid credentials.

DApp will also be used to download the data. The user requests the data along with the private key. After validating the IPFS address of the requested data, the encryption key will be provided. Data will be downloaded from the IPFS and decrypted in dApp.

### *B. Blockchain*

There are two parts of this system component. The first one is a smart contract and the second is a blockchain ledger.

### 1) Smart Contract

Smart contract verifies all incoming data uploading and downloading requests by validating the user credentials. For data uploading requests the smart contract allows to upload the data to the IPFS after the credentials verification. For the downloading request, the smart contract first validates the credentials and then the availability of the data whether the requested data is available or not. After this process, it provides the encryption key of that data and the IPFS address of the data from the blockchain ledger.

### 2) Blockchain Ledger

Blockchain ledger records all the transactions such as smart contract executions, IPFS addresses of the data, and data encryption keys along with the data identifiers and the information of the data uploader. Also, keeps the records of the data download transactions.

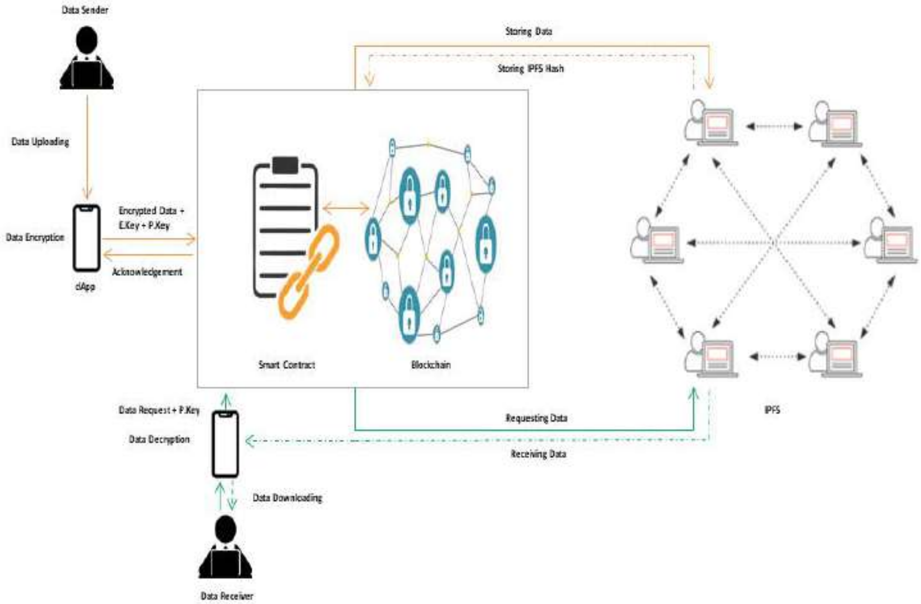


**Fig. 1.** System Model and Workflow

## C. *IPFS (InterPlanetry File System)*

IPFS is used as a file system to store the data files. In the data uploading process, after all the processing, data send to the IPFS. The IPFS stores the data on the IPFS nodes and generates an address of that data in the form of a hash. This hash is then stored back into the blockchain.

In the data uploading request, after credential verification, the data address hash and the decryption key are given by the smart contract from the blockchain, and the data associated with that address is downloaded by the requester from the IPFS.

## IV. CONCLUSIONS

The process of collecting data for research is always a difficult and time taking process. When it comes to healthcare data then there are several issues including security, privacy, and integrity of the data. There are many other problems with healthcare data, the data is distributed, unstructured, inconsistent, and complex. In our proposed framework we have addressed these issues. We have used the dApp concept to make data consistent and structured. We have used blockchain technology to make data transparent and secure. IPFS plays an important role in this framework. IPFS provides secure sharing and easier accessibility of data. Since the healthcare data is sensitive, we have used encryption techniques to encrypt the data, and blockchain will keep the records of every data uploading and sharing transaction that can be used in a future audit. The smart contract will ensure authorized access to the data. All these techniques enable this framework to keep data accurate, consistent, reliable, and easily accessible to the researchers. However, the real-world application of this framework is not developed yet. In the future, we will implement and test the proposed framework in the real-world environment.

## ACKNOWLEDGMENTS

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# Correlation Analysis of Production Changes of Feed Crop Data according to Climate Change

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## Abstract

Recently, climate change issues such as abnormal climate and global warming have become important issues in various industrial fields around the world. Especially in the agricultural field, a variety of researches on changes in suitable cultivation areas and prediction of crop production has been carried out as the cultivation environment of various crops has been changed according to climate change. In this paper, in order to analyze the correlation between the change in productivity of forage crops according to climate change and climatic factors, we constructed a database of basic data that were consisted of the forage crops productivity and climate data gathered from the Synoptic Meteorological Observation. And then we apply machine learning-based big data analysis to the established database. As a result, it is figured out that the production of forage crops is sensitive to the effects of climate change, so it is expected that there will be changes in the field of cultivation of forage crops in the future.

**Index Terms**: Feed Crop, Climate Change, Big Data Analysis, Suitable Cultivation Area

## I. INTRODUCTION

The government is promoting the ecological livestock production that produces eco-friendly livestock products, and is providing a lot of support to diversify the production base and improve the productivity of forage. Due to abnormal weather such as high temperature, drought, and dry weather, damage from meteorological disasters of forage crops is expected to increase. Therefore, various studies have been conducted on the amount of feed crops and changes in productivity due to climate change to provide agricultural information to livestock farmers. In particular, like other crops, it is necessary to study the effects and vulnerabilities of feed crops, as well as to investigate changes in production and cultivation environment.

In this paper, in order to develop a productivity prediction model to evaluate the vulnerability to the influence of changes in cultivation sites according to climatic conditions and cultivation environments, a dataset was constructed using climate data and forage crop production, and the number of buildings as dependent variables and the Big data analysis

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such as correlation analysis, multicollinearity test, and linear regression analysis was performed on climate data elements that are independent variables, and climate factors affecting production were extracted to develop an impact vulnerability prediction model.

## II. DATA GTHERING AND PREPROCESSING

A basic data set was constructed with the annual and regional production and climate factor data by collecting past crop productivity surveys and climate data. Italian ryegrass (IRG), and the dry matter productivity is in kg/ha. Annual climate element data were obtained through the meteorological data open portal and data provided by the National Academy of Animal Sciences, and collected data were like the average temperature, minimum temperature, maximum temperature, heat wave days, and longest heat wave. The attributes of database were constructed by collecting the number of days, precipitation, average relative humidity, total daylight hours, sunshine rate, average wind speed, August maximum temperature, August average temperature, January minimum temperature, and January average temperature.

The climate data was acquired by web crawling from the Korea Meteorological Administration based on the experimental year and region, and the average annual temperature, the highest temperature, the lowest temperature, the number of heatwave days, the maximum heatwave duration, and precipitation were used. Figure 1 showed the constructed database of basic climate data and dry matter productivity.

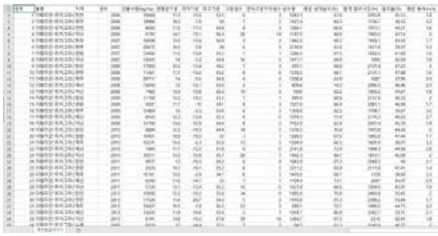

**Fig. 1.** Constructed database of basic data gathered

## III. CORRELATION ANALYSIS

Correlation analysis coefficient value between IRG building quantity and climate factor data. Correlation analysis was performed using R for the selected climate factor data and forage crop production data. As for the correlation coefficient, which numerically represents the degree of linearity between two variables x and y, if the absolute value is 0.4 or more, the correlation between the two variables is judged to be significant. Table 1(a) below shows the results of correlation analysis between forage crop production data and climate factor data.

In regression analysis, when some explanatory variables are highly correlated with other explanatory variables and have a negative effect, multicollinearity is defined as present. As a method of testing the correlation between independent variables, if the absolute value of the correlation coefficient between the independent variables is 0.9 or more, multicollinearity is judged to exist. As a result of confirming the absolute value of the correlation coefficient between independent variables, as shown in table 1(b), strong correlation was observed between several independent variables. When the VIF value was 10 or more or the VIF square root value was less than 2, multicollinearity was judged to exist. Similarly, the results of Table 1(b) and the values were derived by excluding the VIF square root values of all independent variables until they became less than 2.

**Table 1.** Result of Correlation analysis

(a) coefficient value between IRG and climate data

| explanatory variable | coefficient value |
|---|---|
| precipitation | **0.10** |
| average relative humidity | **0.10** |
| insolation | **-0.45** |
| average wind speed | **0.53** |
| pasture | **0.58** |
| December precipitation | 0.56 |
| Growing days | -0.33 |
| October precipitation | 0.40 |
| sum of precipitation | 0.46 |

(b) multicollinearity analysis

| VIF | Square of VIF |
|---|---|
| 1.700360 | 1.303979 |
| 1.296787 | 1.138766 |
| 2.661126 | 1.631296 |
| 3.270574 | 1.808473 |
| 1.400973 | 1.183627 |
| 2.442544 | 1.562864 |
| 2.228152 | 1.492700 |
| 1.588800 | 1.260476 |
| 2.532393 | 1.591349 |

As a result of performing simple linear regression analysis for each independent variable on the production data, which is the dependent variable, the p-value except for the amount of precipitation, average relative humidity, and grass species. The value was less than 0.05, which could be considered statistically significant, but the adjusted R-squared values of most variables were low, so multiple linear regression analysis was performed next. In the multiple regression model, the coefficient of determination increases as the number of independent variables increases, so the optimal model was derived using as few independent variables as possible, excluding independent variables with low influence. Multiple regression analysis was performed using stepwise selection method using the data of forage crop production as the dependent variable and 11 previously selected climatic factor data as independent variables. Starting with a null model in which no variables are included, variables determined to be significant are added to the regression model one by one, and whenever a new variable is added, it is tested whether the added variable is significant with the variables included in the existing regression model.

The final model is "dry matter amount = -0.191 × solar irradiance + 0.12 × average wind speed + 0.377 × grass length + 0.106 × October precipitation + 0.229 × December precipitation". The modified coefficient of determination value, which is the coefficient of determination considering the number of independent variables and the number of data, is 0.531, and the model has about 53% of explanatory power, and the p-value (significance probability) of the F-statistic is at the significance level (0.05). ) lower than the 95%

confidence interval, so the null hypothesis was rejected and the alternative hypothesis was tested, so the estimated regression equation was judged to be statistically significant.

## IV. DISCUSSION AND CONCLUSIONS

In this paper, in order to prepare a proactive and preemptive climate change adaptation policy to minimize the adverse effects of grassland and forage crop production due to climate change, a survey on the productivity of forage crops in the past and public data from the Korea Meteorological Administration were collected to provide building production data. In addition, correlation analysis and regression analysis were performed using the basic data DB, and the production and climate change vulnerability evaluation of Italian ryegrass, a winter fodder crop, were performed.

IRG was found to be most affected by the average annual temperature and the maximum temperature. In particular, it was analyzed that it was affected by the average and minimum temperatures in January and February as winter feed crops. Therefore, it is predicted that the limit line for the cultivation area of winter feed crops will be shifted to the north.

## ACKNOWLEDGMENTS

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# Implementation of an AI-based Vision Inspection System for Semiconductor Process Quality Control

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## Abstract

This paper presents an implementation of an AI-based vision inspection system for semiconductor process quality control. The hardware of the optimal vision inspection system consists of a conveyor belt structure transport system and a real-time high-speed line scan camera device module. And the software system consists of a trigger- based image acquisition module, an image processing module, and an AI module. The AI module for semiconductor process quality control, which is the core function of the proposed system, uses an image recognition technology based on supervised learning, so it is carried out to recognize and classify images by extracting features from labeled data and learning to classify images. The implemented system is useful to the improve semiconductor quality control.

**Index Terms**: Machine vision, line scan camera, real-time quality control, image recognition technology

## I. RESEARCH BACKGROUND

Real-time quality verification technology for rapidly moving products in the product manufacturing process is very important. However, there are difficulties in quality control for manufacturing process of rapidly moving products. For better quality control many detection methods have been researched and introduced. In particular, machine vision defect detectors using image analysis and sensors occupy a large proportion [1-4].

In addition, many companies are attempting to combine machine vision and deep learning for more precise defect detection [5,6]. While products are supplied irregularly, it is needed to figure out the time of triggering the lines scan camera when the supply time of the product using a webcam.

In this paper, we propose a deep learning technology that determines whether a product is defective by acquiring a high-resolution image using a line scan camera and implement machine vision technology as a method of determining the point of view.

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## II. SYSTEM FRAMEWORK

Figure 1 shows the system configuration diagram of the proposed defect detection system. It is a system that detects defects using line scan cameras and machine vision software for real-time precise defect detection of manufactured products moving on high-speed continuous rolls. A surface inspection system has been established to identify and solve problems in real time even in the manufacturing of materials. Figure 2 shows the actual system developed.

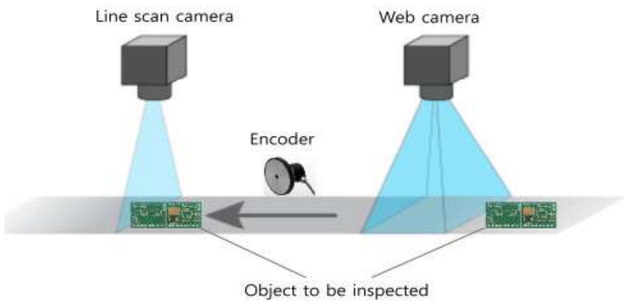



**Fig. 1.** Configuration diagram of the proposed system

**Fig. 2.** Implemented of the proposed quality control support system for rapidly moving products

The system consisted of four detailed components as shown in figure 3. Detailed devices are as follows: a line scan camera to scan real-time high-speed moving objects, a lighting device with adjustable brightness, a front-mounted webcam to trigger a line scan camera to obtain images of products supplied irregularly, and an encoder which is used to figure out the speed detection of the conveyor belt.

Line scan camera

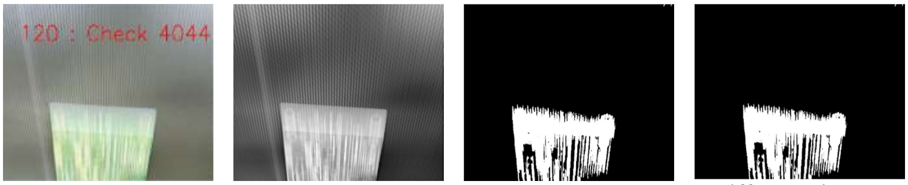
Lighting device

Webcam for trigger Encoders for speed detection

**Fig. 3.** Linescan camera for high-speed real-time scanning, Lighting device, Webcam for trigger and Encoders for speed detection.

## III. DEEP LEARNING BASED VISION INSPECTION

In order to generate the trigger, a method was used to continuously analyze the image input through the webcam prior to the line scan camera, and then generate a trigger to the line scan camera as soon as the front part of the product is visible. First, a normal color image was sequentially converted into a contrast image and a binary image, and then a difference image was created based on the binary image with parallax to recognize the time of product arrival. The image processing process was shown in Figure 4.




Normal color image Contrast image Binary image Difference image

**Fig. 4.** Image processing techniques for generating triggers

Previous section presented a method of acquiring high-resolution images of real-time high-speed moving products. Then the images collected in this way were processed through the machine learning model constructed. The AI module used an image recognition technology based on supervised learning, and performs the function of recognizing/ classifying images by performing learning to classify images by extracting features from labeled data.

## IV. CONCLUSIONS

In this paper, as a method to perform quality inspection in real time on the manufacturing process of products moving continuously at high speed, images of the products were classified into defective or good products through image acquisition of deep learning. We are going to evaluate the proposed system and improve the accuracy of the system as a future work. It is expected to contribute to the improvement of semiconductor quality control efficiency by applying our system to manufacturing process.

## ACKNOWLEDGMENTS

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# Design of Intelligent Monitoring System for Smart Farm Applying Machine Learning

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## Abstract

In this paper, we propose an IoT-based intelligent monitoring system for monitoring livestock in livestock farms applying deep learning. We design not only a framework of livestock farms but also software architecture of the proposed system. The framework of the intelligent monitoring system to analyze the images from CCTV which was installed in the smart farm and learn the abnormal or normal conditions of animals using deep learning, then it is possible to respond quickly to abnormal livestock. We construct a CNN learning model for image learning and context awareness of farms. Our study contributes to apply ICT technology for smart farms of livestock. We are going to implement the proposed system and perform the experiments for accuracy of learning model.

**Index Terms**: IoT, deep learning, intelligent smart farm monitoring, context awareness, CNN

## I. INTRODUCTION

IoT and various sensors are useful for a more efficient precision agriculture industry. Livestock farms are also operating smart farms by applying IoT technology. In livestock farms, studies using machine learning technology are being carried out for the health and welfare of animals. Livestock farmers are already starting to use some advanced ICT technologies to improve the efficiency of their work. To monitor the conditions of animals and environment, they are installing CCTVs and IoT sensors on their farms. In this paper, we proposed to apply machine learning to the monitoring system of smart farms. We employed convolutional neural network which was optimized for image recognition.

## II. RELATED WORKS

Recently, the need for a context-aware service as the intelligent service in ubiquitous environments according to the development of sensor technologies has increased. The

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intelligent IoT service system is defined as a system that acquires data from the environment, recognizes the situation using the acquired data, and interacts with the user environment according to the service rules and the domain knowledge. IoT technologies is able to provide enormous potential for more convenient intelligent service. For intelligent monitoring service in specific domain like smart livestock farms, it is needed applying deep learning to support context awareness through images recognition. A convolutional neural network (CNN) is a machine learning model based on deep supervised learning, and it has excellent applicability and is strong in local feature extraction and classification. We present the framework of intelligent monitoring system for livestock farms applying CNN.

## III. INTELLIGENT MONITORING SYSTEM for LIVESTOCK FARMS

The proposed intelligent monitoring system has two parts: one is IoT based hardware including various sensors and the other is software part which operates hardware devices and data processing. Figure 1 shows the software architecture of the system, and monitoring server carries out the learning and data analysis of sensor data.

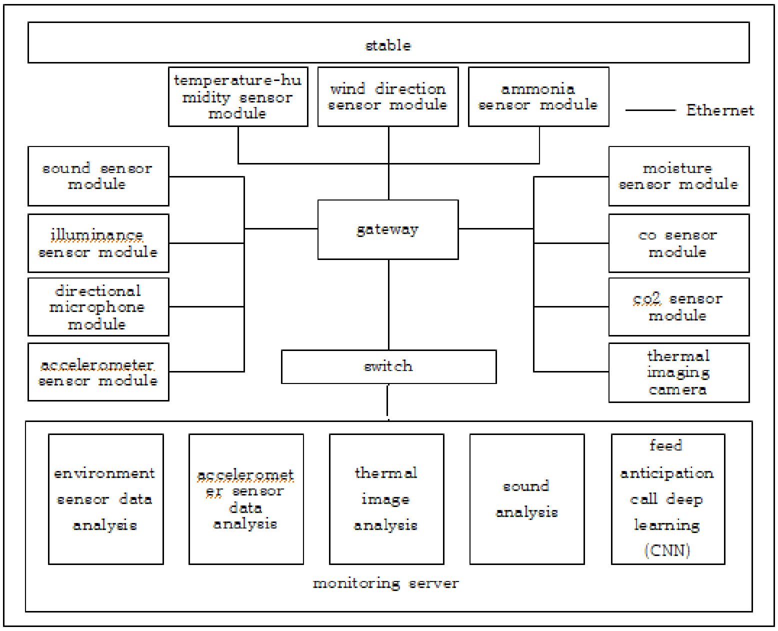


**Fig. 1.** Framework of intelligent monitoring system for smart farms based on machine learning

Various sensors such as temperature and humidity sensor, wind direction/wind speed sensor, CO sensor, CO2 sensor, ammonia sensor, moisture sensor and illuminance sensor are installed on livestock farm. A sensor module composed of a sensor, ADC, processor, and communication module transmits sensor data to a gateway using Ethernet or Wi-Fi. The gateway transmits data to the monitoring server using Ethernet, and the monitoring server analyzes the collected data. Monitoring server also receives images from CCTV and send them to deep learning module that can detect the abnormal status of the livestock farms. The server needs to be capable of image storage, event storage, search, and receive images. The data transmitted from the attached sensor should be stored in the monitoring server.

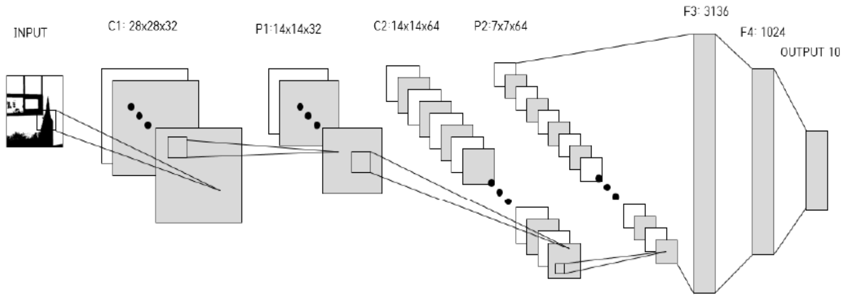


**Fig. 2.** Design of CNN learning model for intelligent monitoring

Learning module must be constructed using training images in advance. We designed CNN model for learning as shown in fig.2. We will implement the monitoring server and learning model using Python and evaluate an accuracy of the implemented learning model.

## IV. CONCLUSIONS

In this paper, we proposed an intelligent monitoring system, which can perform functions such as to check livestock conditions and environment. The proposed system can be used for situational awareness of livestock, real-time video transmission, and context-awareness of abnormal situations. We designed the CNN model for an intelligent monitoring system to figure out abnormal status of the livestock. We are going not only to implement the proposed system but also to carry out the experiments applied to livestock farms as a future works.

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# Real-time File Access Monitoring Technology in Zero-Trust Architecture

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## Abstract

Many organizations that have adopted a perimeter-based security model operate security solutions such as firewalls, NAC, and anti-virus to deny security threats from outside. However, security threats do not only arise from the outside. In recent security threats, there are more security threats from the inside than from the outside. To solve this problem, a zero-trust model was proposed. The zero-trust model does not trust all users and only allows users who have been verified enough to access information services. This zero-trust model requires a function to monitor the verified user's behavior in real time and an access control function to reject it when an unauthorized behavior is detected. In this study, we propose a real-time monitoring of user's file access in a zero-trust environment. The real-time file access monitoring technique of this study monitors the user's file access system-call in the kernel. This technique can check the type of user's file access system-call and object include absolute file path and subject. Also, if the monitoring method proposed in this study is enforced, there is an advantage that the user cannot bypass the file access monitoring function. However, since this study was proposed based on the linux environment, follow-up studies are needed to apply it to various operating environments such as windows.

**Index Terms**: Real-time Monitoring, File Access, Authorization, Zero-Trust, Access Control

## I. INTRODUCTION

As information technology improves, so do security threats. Many organizations operate various security solutions to deny security threats and protect information services. Such security management had the advantage of increasing the operational efficiency of the security solution. However, in an enterprise environment, security threats arise from the outside, but also from the inside. The perimeter-based security model is good for denying security threats from the outside, but it is impossible to deny security threats from the inside [1].

To solve this problem, a zero-trust model was proposed. In the zero-trust model. However, since the zero-trust model is proposed as a basic environment for the network layer, there is a limitation in that it cannot monitor the access to the file/directory in real time. In this study, in order to overcome this limitation, we propose a method for monitoring unauthorized

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file/directory access at the system level that extends the real-time monitoring function among the functions required by the zero-trust model.

## II. Zero-trust model

The zero-trust model is a model proposed by John Kindervag and was proposed to improve the vulnerabilities of the existing perimeter-based security model. Since the perimeter-based model trusts internal members, it has the disadvantage of not being able to detect or deny the unauthorized actions of malicious internal members [2].

However, the zero-trust model rejects the security scope of the enterprise environment. The zero-trust model distrusts all subjects who have access to information resources and treats them all as malicious attackers. Users accessing information resources decide whether to allow access through MFA (Multi Factor Authentication) and security stability verification of the user's device. Verified users are granted access to information resources, in which case the least privilege is assigned [3, 4].

## III. Research background and solution

### *A. Zero-trust mode's requirements and limit*

The zero-trust model regards all subjects of information resources as malicious attackers. Therefore, when granting access to information resources, the access subject as well as the subject's environment are sufficiently verified, and the verified subject is assigned the minimum authority. Even the zero-trust model cannot be perfect. A malicious attacker can use various methods to perform unauthorized actions even in a zero-trust environment. To solve these problems, the zero-trust model requires real-time monitoring and control functions [5].

Unauthorized access doesn't just happen on the network. After gaining access to the system, a malicious attacker can access unauthorized files or directories. Also, a malicious attacker can access an unauthorized application process. However, since the zero-trust model is basically proposed based on the network, there is a limit in that it cannot detect or deny unauthorized access to these files/directories.

### *B. Real-time file access monitoring architecture*

In this study, we propose an architecture that can monitor all access to file/directory in real time, which can overcome the limitations of the zero-trust model.

The proposed real-time monitoring structure consists of two components. File Access Event Checker checks the user's file access in the kernel. All kernel events of the user are checked through LSM [6], and if the generated event corresponds to file access, detailed information about it is delivered to the file access monitor at the application level.

File Access Monitor receives the file access event information generated by the kernel and delivers it to the user. It can record a log or generate an alarm when a specific file is accessed.

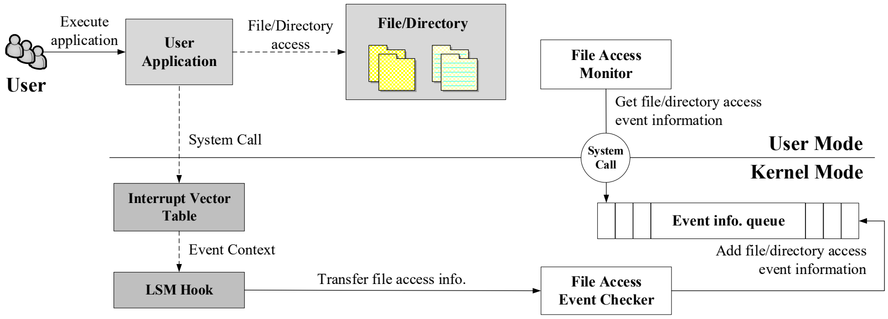


**Fig. 1.** Real-time file access monitor architecture for zero-trust architecture

## IV. CONCLUSIONS

Security threats are evolving as well as information services. In particular, the frequency of security threats occurring from within is higher than that from outside. In such an environment, the zero-trust model will be able to solve the limitations of the perimeter-based security model.

In this study, we proposed a method for real-time monitoring by checking user access to a specific file or directory in the system. The architecture proposed in this study operates at the kernel level and has the advantage that an attacker cannot bypass file access. However, since this study was conducted based on the Linux operating system, follow-up studies that should be verified on Windows or Unix-type operating systems are needed.

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# A Study on the Impact of the Covid19 Pandemic on Individuals' ICT Utilization

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## Abstract

The COVID19 pandemic is affecting the lives and businesses of individuals with great changes that have not been experienced. The general public is struggling to effectively respond to these changes by using ICT. Nevertheless, there are few prior studies on the impact of ICT utilization during the period of the coronavirus outbreak. Therefore, in this study, a survey was conducted on Korean adults to systematically analyze how the lives and businesses of ordinary people changed during this pandemic and what ICT contributed for overcomes these difficulties. As a result of the analysis, it was found that through the use of ICT, individuals increased safety in life, strengthens productivity in telecommuting, and improved health through exercise such as home training. However, it also found that there are large gaps between generations, men and women, and regions in the level and scope of ICT utilization. In this study, the policy and usage directions for resolving this digital divide were presented as a conclusion.

**Index Terms**: ICT Utilization, Covid19, Safety, Home Training, Digital Divide

## I. INTRODUCTION

The COVID19 pandemic is affecting the lives and businesses of individuals with great changes that have not been experienced. The general public is struggling to effectively respond to these changes by using ICT. Nevertheless, there are few prior studies on the impact of ICT utilization during the period of the coronavirus outbreak. Therefore, in this study, a survey was conducted on Korean adults to systematically analyze how the lives and businesses of ordinary people changed during this pandemic and what ICT contributed for overcomes these difficulties.

## II. DIFFICULTIES EXPERIENCED AFTERE COVID-19 OUTBREAK

Following the COVID-19 outbreak, the public has been suffering from physical, relationship and psychological difficulties such as lack of exercise, reduced human relationships, and increased depression and helplessness. The ETRI's Technology Policy Research Division conducted a survey of adults nationwide in the second half of 2020 to understand the change in IT usage by the public following the COVID-19 outbreak [1]. As

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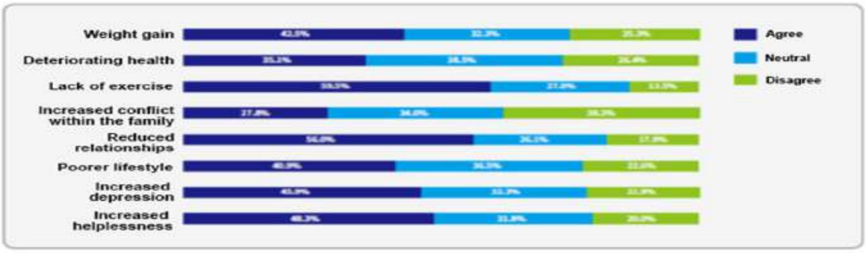
shown in Figure 1, lack of exercise was the biggest physical difficulty among people (59.5% of the public), and about four out of 10 adults gained weight (42.5%) during the COVID-19 pandemic.

Figure 2 shows that women suffered slightly more physical, relationship, and psychological difficulties than men in the COVID-19 era.




Source: ETRI(2020)

**Fig. 1.** Difficulties experienced by the public after the COVID-19 outbreak

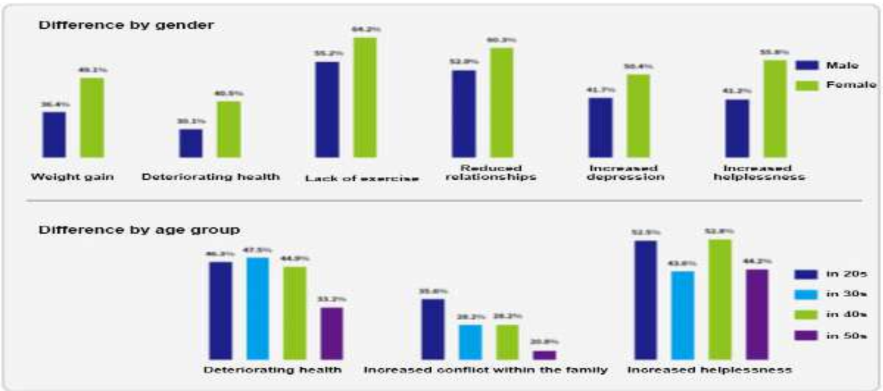



**Fig. 2.** Demographic differences in physical, relationship, and psychological difficulties after the COVID-19 outbreak

## III. IT USAGE STATUS DURING THE COVID19 PANDEMIC

Since the outbreak of COVID-19, the use of IT by the public has significantly increased, and services related to leisure activities, disinfection, safety measures, and home activities based on wired and wireless Internet use have been greatly expanded. In 2020, people used an average of 1.8 IT devices and 12.6 IT services [2,3]. As shown in Figure 3, two out of three people used IT-enabled services, such as portal sites, YouTube, social media (SNS), disinfection information, financial transactions, IPTV/OTT, and games, more than two days a week (or eight days a month) on average. In summary, after the COVID-19 outbreak, most people spent significantly more hours watching YouTube and IPTV/OTT for leisure in the context of a limited indoor space, and routinely used contact-free services such as working from home, learning from home, remote meeting, food ordering/delivery, online religious activities and eCommerce.

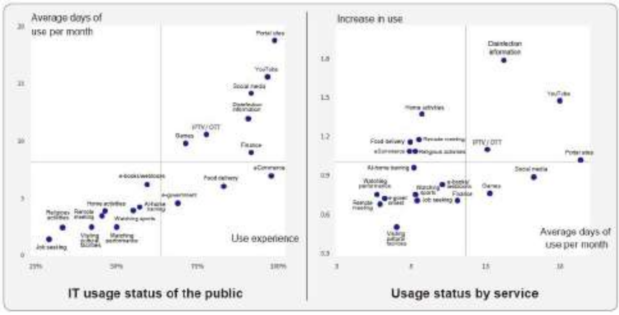



**Fig. 3.** IT usage status after the COVID-19 outbreak

On the other hand, in terms of IT usage, there were some differences according to demographic characteristics such as gender, age, residence, income level, and occupation. The number of IT devices in use was slightly higher among men (1.9) than women (1.6). On a monthly average, men spent more days in games and sports while women in social media, eCommerce, and e-books/webtoons. In short, people used relatively more or increased the use of services suitable for gender, age, and occupational characteristics in response to the COVID-19 situation.

## IV. UTILITY AND CONCERNS OF IT TO RESPOND THE COVID-19 PANDEMIC

### *A. Response to COVID-19 and utility of IT*

The use of IT was effective in most areas of daily life and activities such as safety management, leisure activities, home activities, communication, and daily life management of the public in the pandemic era. Many people received help from IT in many areas such as leisure activities (65.0% of the public), safety management (61.9%), daily life management (60.1%), communication (58.6%), mental health (54.3%), and home activities (53.5%) in order to overcome the COVID-19 situation. However, a relatively lower percentage of people (44.5%) answered that IT was helpful to physical health. a relatively higher percentage of professionals and the self-employed experienced utility in safety management; professionals, office workers, homemakers and students in leisure activities; office workers, professionals, and students in home activities; and professionals, office workers and homemakers in daily life management. In summary, IT services have contributed to the overall quality of life and activities of people in response to COVID-19, and areas of utility experienced by the public vary according to their occupation.

### *B. Concerns about the adverse effects of IT among the public*

The public was more concerned about leakage of personal information through hacking (55.0% of the public) and abuse by bad intentions such as fake news or deep fakes (54.1%). On the other hand, fewer people (43.0%) showed concerns about the reduction in actual human relationships due to excessive immersion in IT. women were more concerned about deterioration of health due to excessive use of IT, leakage of personal information, and abuse by bad intentions, compared to men. In particular, the percentage of women who were concerned about deteriorating health stood at 52.7%, 10.5% higher than that of men, 42.2%. In short, as the use of IT sharply increased after the COVID-19 outbreak, people, especially women, were most concerned about the misuse of personal information, including the leakage of personal information.

## V. DISCUSSION AND CONCLUSIONS

This paper analyzes how the public has utilized IT and what kinds of help they have received from IT based on a survey conducted by the ETRI's Policy Research Division at the end of 2020. The results of this analysis are summarized, and implications for Korea to lead the contact-free society that has emerged as a new global trend driven by the COVID-19 pandemic are presented as follows.

Frist, during the COVID-19 pandemic, the public in Korea is experiencing a lack of exercise, reduced communication with others, and increased depression or helplessness due to social distancing and indoor activities, but they are overcoming these problems through active use of contact-free IT services.

Second, The increase in IT utilization and the expansion to the contact-free virtual world have greatly contributed to the public's response to the COVID-19 crisis, such as safety management, leisure, home activities, increased communication, and physical and mental health. However, concerns are also growing about deteriorating health due to excessive use of IT, leakage of personal information, abuse by bad intentions, and a digital divide.

Third, it has to urgently strengthen the digital new deal centering on the D.N.A (Data-Network-Artificial Intelligence) fields, expand core technologies of the next-generation contact-free services, and increase investment in digital-based contact-free platforms, which are vulnerable. In addition, it needs to innovate the regulations that restrict the contact-free society and overhaul current laws and systems.

Finally, it is necessary to enhance digital inclusion for the socially marginalized and inter-generational digital communication skills while expanding opportunities for professional education on next-generation contact-free core technologies, including AI, to increase digital innovation capabilities.

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# Novel Engineering and Phenomenological Qualitative Research

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## Abstract

Ministry of Education stated process-centric evaluation in 2015 revised curriculum. The evaluation requires teacher's long-lasting observation to students. The process must be subjective, but very important. We need a way to evaluate student's learning process for teacher. There are quantitative and qualitative method in evaluation. The quantitative way is more dominant than qualitative in engineering education over the last 50 years. The process-centric evaluation itself means qualitative. So this paper is going to explore a possibility to apply phenomenological qualitative research to Novel Engineering learning model using philosophical background. Some researchers have proved that Novel engineering is a learner-centric and good way to integrate many subjects in school. I expect the phenomenological qualitative research based on Novel Engineering can extract the various essences from teachers and students' teaching and learning experiences.

**Index Terms**: Novel Engineering, Phenomenological Qualitative Research, Integrated Curriculum, Essence Intuition, 2015 Revised Curriculum

## I. INTRODUCTION

Some of the keywords in 4$^{th}$ industrial revolution are variety, complexity, uncertainty, and individuality etc. The keywords make us harder to predict future. Most marketing strategies are to predict tendencies of a population through sampling. The method can predict average but has a limit to manage individual characteristic. It's why AI emerges. In these day, we need a way to provide suitable solutions with individual customer. It's the same as educational field.

The revised 2015 curriculum has made school change into new one. Process-centric evaluation, consistent teaching and learning and appropriate amount of learning are remarkable. Especially process-centric evaluation focus process than product while learning. So many educational local governments have tried to educate teachers. But the attempt didn't successfully be settled because of ambiguities of the evaluation.

Korean Institute of Curriculum and Evaluation (KICE) in South Korea define process-centric assessment as "assessment providing suitable feedback to support student's growth and development". But the definition is also ambiguous. We don't know what to evaluate and how to evaluate. Most of teachers know that two main components of evaluation are measurement and decision-making. More important is decision-making. This make them be confused. I think that the evaluation policy would be fail.

Anyway it's obvious that the process-centric evaluation could be more and more important in next curriculum revision. We need a way to evaluate a student's learning process. In this paper I'm going to introduce a phenomenological qualitative evaluation method to evaluate learning process of them based on Novel Engineering interdisciplinary learning model.

## II. Phenomenological Qualitative Research

Humanities and social studies researchers have criticized the limitations on mathematical quantitative analysis because quantitative research has so many advantages but a limit to express whole of human thought and behavior. Alternative way is qualitative research. There are many qualitative method like ethnography, auto-ethnography, phenomenology, grounded theory, narrative inquiry, life history [1]. For a long time, it's controversial that qualitative research is scientific or not. In spite of the controversy, more and more researchers adopt qualitative research because of its attempt to see essence of human being. It's encouraging. In this chapter, we will describe phenomenological qualitative research. The method is based on phenomenology of Husserl.

The method has been developed by Giorgi, Colaizzi, Benner, van Manen, van Kaam etc. The method consist of 3 step; collecting experiential data by interview, analyzing the data and writing report. They are distinguished from traditional phenomenological researches in phenomenological epoche and reduction and essential intuition. Epoche is to stop seeing with prejudice to subject. This means that we have to see subject as is. Reduction is to see the essence of subject. Essential intuition by Husserl means that we have to see essential not realistic structure of someone's experience [2].

We can find many phenomenological qualitative researches in South Korea.

Park said that qualitative research isn't mathematical, but we can't ignore its meaningfulness. The research explained the meaning and possibility of academic convergence by phenomenology well. The paper emphasized the essence intuition of phenomenology. The research implied that phenomenological qualitative research can deal with convergence education [3].

Lee performed qualitative research to figure out multicultural students' difficulties in school based on Giorgi phenomenological qualitative method. They draw 9 essentials able to be an essence of discrimination in school [14].

Jeon performed qualitative research to figure out university students' Youtube experiences based on Colaizzi phenomenological qualitative method. They draw 10 essentials able to be an essence of Youtube experiences. The research show that students' use Youtube as a way to escape stresses of learning and human relationship and good tool to learn something meaningful [4].

Ko performed qualitative research based on van Manen phenomenological qualitative method to figure out what the essences of the bullied students' experiences is [5].

We can find out so many phenomenological qualitative researches in various research area. In this paper, we will adopt phenomenological qualitative researches for following research area, Novel Engineering (NE). NE is a learning model integrating literacy and engineering. Lee criticized the current collaborative researches and suggested the right direction of them. [6].

From above references, it's quite certain that we can understand student's experiences happened in Novel Engineering class phenomenologically.

## III. Novel Engineering

2015 revised curriculum reinforces reading (a whole book a semester), software education. Novel Engineering (NE) is a comprehensive approach to integrate literacy (reading and writing), STEAM and software education. These are performed individually until now [7, 8, 9]. CEEO (Center for Engineering Education and Outreach) has researched NE for several years [10]. NE is one way for multidisciplinary education. NE consists of steps; reading, identify problems, design solutions, building, feedback, reconstruct story [11]. It starts with reading and end in writing. Engineering design process is performed on its way. Most teachers have had difficulties in identifying problems in engineering design process. But NE can help teachers solve these age-old difficulties as NE can come up with problems in a book.

## IV. Discussion

Our society get much more complex and various. The phenomenon will make school set up policies for convergence education for teachers and students. So 2022 revised curriculum is in progress followed by previous revision. We can expect that the policies would continue.

Evaluation has been an important elements in education. We need to change evaluation trend into qualitative than quantitative way. All of us know that quantitative evaluation is efficient but has a limit to express student's thought and behavior. A process-centric evaluation requires a way for teacher to observe students subjectively. What is important is that teacher's subjective observation have to guarantee objectivity. Local office of education have to try to offer a teacher training program for teachers.

Novel Engineering is a kind of PBL (problem based learning) integrating literacy and engineering. We already proved that Novel Engineering is highly effective in improving creative problem-solving ability under usual and blended learning environments [12, 13].

Based on the above philosophical discourses, we knew that experiences of students participating in Novel Engineering class can be expressed phenomenologically. This means phenomenological qualitative evaluation is possible and suitable for the NE class.

For successful phenomenological qualitative research, we need to train how to interview, analyze data and extract essences of experiences, even though it's not easy to learn.

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# Deep Learning-based PM10 Prediction Model Using EEMD

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## Abstract

Although various studies have focused on improving the accuracy of particulate matter (PM) prediction, the training of deep learning models has not been adequately conducted because of various characteristics based on the PM concentration. In this study, a prediction model of PM concentration is proposed based on ensemble empirical mode decomposition (EEMD). After decomposing the PM concentration through EEMD, the final PM concentration value is derived by analyzing the prediction results according to each derived characteristic. Performance evaluation of the model verified that the PM concentration prediction reached an accuracy of 91.7%.

**Index Terms**: DNN, EEMD, Neural network, Particulate matter

## I. INTRODUCTION

The social problems caused by particulate matter with a diameter of 10 microns or less (PM 10) have led to the implementation of various policies and forecasting services [1]. Accordingly, studies have been conducted to provide a more accurate forecasting service to the public, particularly focusing on the use of deep learning algorithms to improve the accuracy of PM concentration prediction. However, there are some difficulties in improving the accuracy due to the various characteristics of PM10 [2][3].

In this study, a prediction model of PM concentration based on ensemble empirical mode decomposition (EEMD) was designed to reflect and predict various characteristics of PM concentration. EEMD is used to decompose the PM concentration into n intrinsic mode functions (IMFs). Subsequently, n models predicting the decomposed IMF are combined to predict and evaluate the final PM concentration value.

## II. Data collection and composition

Meteorological and air pollutant data collected for 10 years from 2009 to 2019 in Cheonan city were used as the training data of the model for predicting PM concentration [4][5]. Meteorological data consisted of temperature, humidity, wind speed, and wind direction, and air pollutant data were composed of collected PM10, $O_3$, CO, $NO_2$, and $SO_2$. A preparation process was required to facilitate the prediction model training for collected data, which was conducted through one hot encoding and min max scaling. For training and

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performance evaluation of the model using the preprocessed data, 75% of the total data were used as training data and 25% as test data.

## III. Design of the prediction model

EEMD can effectively capture the nonlinear complexity of data, enabling the identification of the characteristics of varying PM concentrations. Therefore, a model to predict the final concentration value was designed by decomposing PM10, the prediction target, using EEMD and undertaking a model ensemble process.

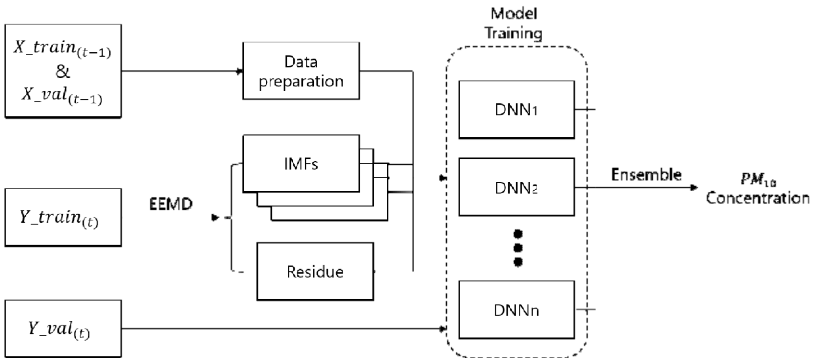


**Fig. 1.** EEMD-based PM10 prediction model structure

As shown in Figure 1, a deep neural network (DNN)-based prediction model was created according to the number of IMFs derived from the EEMD decomposition of PM10 among the training data. After the generated DNN models predict the corresponding IMF through input data, the final PM10 value is predicted through a combination of the predicted values output from each model.

**Table 1.** Hyperparameter search results

| Division | Search scope | Search result |
|---|---|---|
| Layer | 2, 3, 4 | 3 |
| Hidden node | 20–200 | 20 |
| L2 | 0–0.001 | 0.001 |
| Dropout rate | 0–0.5 | 0 |
| Batch size | 20–100 | 60 |
| Epoch | 100 | 100 |

Each DNN model is a regression model; accordingly, ReLu was used as the activation function, Adam as the optimization function, and mean square error as the loss function. For the optimization of the DNN model, detailed attribute values were commonly applied through a hyperparameter search. Table 1 shows the hyperparameter search results of the DNN models.

## IV. Performance evaluation

Table 2 shows the performance evaluation of the prediction model using EEMD. The performance was compared according to the number of EEMDs executed by two models, one that performed 400 times, and the other that performed 500 times.

**Table 2.** Evaluation of prediction performance

| Frequency of EEMD | 400 times | 500 times |
|---|---|---|
| Number of DNN models | 16 | 15 |
| RMSE | 20.2329 | 18.4161 |
| Overall accuracy | 89.41% | 91.7% |
| “Good” accuracy | 88.12% | 81.08% |
| “Normal” accuracy | 89.39% | 94.22% |
| “Bad” accuracy | 92.77% | 87.74% |
| “Very bad” accuracy | 66.67% | 93.71% |

The results of the prediction indicated that the overall accuracy of concentration prediction was 89.41% for the model that performed 400 EEMDs. Analyzing the accuracy by classification using the air quality index (AQI), it was identified that the accuracy of “Bad” was the highest at 92.77%, whereas the accuracy of “Very bad” was the lowest at 66.67%. As for the model that performed 500 EEMDs, the overall accuracy was 91.7%, and the accuracy of “Normal” was the highest at 94.22%, whereas the accuracy of “Good” was the lowest at 81.08%. When comparing the two cases, the largest difference of 27.04% occurred in the accuracy of “Very bad.”

## V. Conclusion

In this study, an EEMD-based PM10 prediction model was constructed and the corresponding prediction performance was evaluated. Meteorological and air pollutant data collected in Cheonan City were used as the data for the prediction model. The final data were divided into 75% for training and 25% for test data for training of the prediction model using the preprocessed data. The decomposition of PM10 among the training data was performed using EEMD, and a DNN model was constructed to predict the n IMFs derived from the decomposition results. The final prediction value of PM concentration was derived by combining the results of the DNN models. The performance was evaluated by comparing the prediction results of 400 and 500 EEMDs. The performance evaluation yielded an overall accuracy of 90%. By classifying the accuracy using AQI, the accuracy of “Good” and “Bad” was higher in the model that performed 400 EEMDs compared to that of the model that performed 500 EEMDs, whereas the accuracies of “Normal” and “Very bad” were higher in the model that performed 500 EEMDs. In particular, the accuracy of “Very bad” showed a difference of 27.04%, with 66.67% and 93.71% accuracy by the model performing 400 EEMDs and 500 EEMDs respectively. Based on these results, it was possible to confirm that the optimum accuracy can be derived according to the range of PM concentration when using EEMD. In the future, research to improve the overall accuracy of PM concentration prediction by constructing an optimum model for each concentration range will be conducted.

## ACKNOWLEDGMENTS

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# Extracting the Optimal Moving Patterns of Edge Devices by Applying Frequency and Weights

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## Abstract

In an FEC (Fog Edge Computing) environment, this paper provides a preliminary investigation to improve the efficiency of computational offloading using mobile agents. It presents an effective moving pattern extraction algorithm that adheres to AoE (Applications on Edge device) time and space constraints while minimizing execution time and memory requirements. Experiments were used to compare and evaluate its performance capabilities. The proposed algorithm, OPE-FW, not only reduces database access and execution time by using frequency rate and applying generalization of time-space attributes to reduce memory consumption, but it also calculates optimal paths more accurately than existing algorithms, including weights (distance, preference, and congestion).

**Index Terms:** Fog/Edge Computing, Moving Object, Optimal Moving Pattern, Frequency, Spatiotemporal Weight.

## I. INTRODUCTION

Recently, a method of securing proximity to user equipment by shifting cloud services to the mobile network's edge cloud has been proposed under the new Fog/Edge Computing (FEC) paradigm [1,2]. Additionally, by predicting dynamic location change patterns of terminal devices (mobile objects) requesting services, a method of efficiently distributing and deploying computing resources in an FEC environment is required [2,4,5]. Previous research [3,8] has proposed an algorithm for extracting the optimal moving pattern by analyzing the moving paths of moving objects requiring application services in an arbitrary spatiotemporal environment based on frequency, but while frequently used moving paths are likely to be optimal, they cannot be guaranteed. As a result, this study provides a method for extracting an optimal moving pattern with the lowest cost by adding an arbitrary weight (distance, time, congestion [6]) to extracted paths and applying a support factor threshold value for frequent patterns.

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## II. TARGET DATA, WEIGHTS AND PROPOSED ALGORITHM

The proposed method is based on analysis of a comparative examination of path extraction performance based on the size of the spatial range of the A* algorithm with empirical weights [7,8].

### A. Target Data

A moving sequence is formed by applying time interval constraints to the movement history data of AoE to extract the moving pattern of AoE, and it is then translated into a generalized sequence and employed. Generalization and summary of history data of moving objects on a road network produce a set of moving sequence data.

### B. Applied Weights

Each path's weight includes a correction time (c_vt) and a correction distance (c_d), as well as a congestion rate (CR) applied to the correction time. The c_d makes use of a normalized comparison value by setting the longest path (4.5 km) within a given spatial range to 1, while the c_vt makes use of a normalized comparison value by setting the greatest value to 1. Furthermore, when the real weight is applied, ef_vt and ef_d, which are effect factors that can be arbitrarily selected by the user depending on the situation, are also applied at the same time, with ef_vt = 0.7 and ef_d = 0.3 in this paper. The applied weights are determined as follows:

$$\begin{aligned} &\text{Applied Weight (AW)} = c\_vt * ef\_vt + c\_d * ef\_d \\ &c\_vt = c\_d * CR \\ &c\_d = d / 4.5(\text{km}) \end{aligned} \tag{1}$$

### C. Optimal Moving Pattern Extraction Algorithm

When calculating a maximum frequency of 2-node sequences, the proposed algorithm is a method of extracting a 2-node sequence with a minimum applied weight among 2-node sequences having a maximum frequency of 2-node or higher, which varies from prior works [8]. The proposed optimal moving pattern extraction procedure with frequency and weight derives a candidate sequence set from a moving sequence set satisfying constraints from AoE's movement history database (AoE-DB), and then extracts a 2-node sequence set from it. By applying the minimum support factor, time, and distance to the extracted 2-node sequences, the optimal moving pattern is determined as a linear list of 2-node sequences to the destination. The proposed algorithm consists of three main components: a moving sequence extraction module, a data generalization module, and the optimal moving pattern extraction module that applies frequency or weight simultaneously.

## III. EXPERIMENTS AND RESULTS

The results of comparison experiments based on the execution time, number of access nodes, and accuracy of the algorithm targeting the OPE-freq, A*, and Dijkstra algorithms are used to evaluate the performance of extracting the optimal moving pattern of the OPE FW algorithm in this chapter. Because the performance of the A* algorithm varies significantly depending on the empirical weight, it is divided into two section ranges (A*-a: 5-10 km, A*-b: 15-20 km).

### A. Comparison of Execution Time

The results of comparing the proposed algorithm, OPE FW, with OPE-freq, A*, and Dijkstra algorithms for the execution time of extracting the optimal moving pattern in the same spatiotemporal region are shown in Table 1. When compared to the OPE-freq algorithm, which only uses frequency, the OPE-FW algorithm takes a little longer, and the comparison with the A* algorithm with straightness based on empirical weight varies depending on the size of the section range. Furthermore, there is a significant difference between the OPE-FW algorithm and the Dijkstra algorithm, which determines the optimal pattern by searching for all nodes inside the interval range.

**Table 1.** Comparison of execution time

| Number of executions | OPE_FW | OPE_freq | A* (10 ~ 20Km) | A* (20 ~ 30Km) | Dijkstra |
|---|---|---|---|---|---|
| 120 | 1.48 | 0.90 | 0.33 | 5.23 | 45.71 |
| 240 | 1.58 | 0.96 | 0.41 | 5.61 | 97.24 |
| 360 | 1.63 | 1.13 | 0.39 | 5.14 | 250.86 |
| 480 | 1.69 | 1.25 | 0.42 | 5.78 | 646.27 |

### B. Comparison of Number of Nodes Accessed

Due to the time it takes to decide whether to select a path, the number of nodes accessed has a significant impact on the algorithm's performance, as shown in Table 2. Like the OPE-freq algorithm, which only applies frequency, the OPE-FW algorithm, which applies frequency and weights simultaneously, excludes nodes with relatively low frequency at every step (extract only patterns with high frequency from history data), and it has a significantly smaller number of nodes accessed than other algorithms. In comparison to the OPE-freq algorithm, the OPE-FW algorithm requires more node access to calculate the applied weight for frequent patterns with low support factors. As the execution time evaluation, the number of access nodes increases inefficiently as the interval range increases due to the A* algorithm's straightness. The time complexity of the Dijkstra algorithm varies depending on the topology of the road network, but in general it is $O(n^2)$, therefore the greatest number of nodes that can be accessible from each node that make up the optimal path is (n-1). As a result, it is inefficient in comparison to other algorithms.

**Table 2.** Comparison of number of nodes accessed

| Number of executions | OPE-FW | OPE-freq | A* (10~20Km) | A* (20~30Km) | Dijkstra |
|---|---|---|---|---|---|
| 120 | 35.34 | 25.51 | 52.60 | 179.27 | 950.25 |
| 240 | 36.06 | 25.97 | 54.89 | 176.30 | 2120.84 |
| 360 | 37.87 | 27.15 | 60.55 | 170.15 | 3327.50 |
| 480 | 39.30 | 28.03 | 57.48 | 178.06 | 4252.77 |

### C. Comparison of Accuracy

Table 3 compares the accuracy of optimal path extraction with that of the Dijkstra algorithm, which extracts the most accurate optimal path. When the accuracy of the A* algorithm is improved by empirical weights, the execution time increases significantly. As a result, the setting of empirical weights is a significant aspect in evaluating performance ability. The OPE-freq algorithm is just as accurate as the A* algorithm, but it extracts the optimal path with relatively fast execution time. The OPE-FW algorithm has accuracy that is near to the Dijkstra algorithm's optimal path and can extract the optimal path that minimizes the cost of movement.

**Table 3.** Comparison of accuracy

| Number of executions | OPE-FW | OPE-freq | A* (10~20Km) | A* (20~30Km) | Dijkstra |
|---|---|---|---|---|---|
| 120 | 93.66 | 87.35 | 78.90 | 89.12 | 100.00 |
| 240 | 95.37 | 88.12 | 79.84 | 87.54 | 100.00 |
| 360 | 96.32 | 87.84 | 77.82 | 88.82 | 100.00 |
| 480 | 95.87 | 89.85 | 82.12 | 91.27 | 100.00 |

## IV. DISCUSSION AND CONCLUSIONS

This paper added to previous work to increase the efficiency of computation offloading using mobile agents in an FEC environment and proposed an efficient moving pattern extraction algorithm that conforms to AoE's spatiotemporal limitations while requiring the least amount of memory. By using frequency, the proposed OPE-FW algorithm, minimizes database access and execution time, generalizes time-space attributes to reduce memory consumption, and extracts more accurate optimal patterns by using spatiotemporal weights of paths. When comparing and evaluating the OPE-FW algorithm against the OPE-freq algorithm, A*, and Dijkstra algorithms in terms of execution time, number of access nodes, and accuracy, it was concluded that while the performance time required for calculating and applying weights increased slightly, other performance measurements were significantly improved. The OPE-FW algorithm, like the previously described OPE-freq algorithm, is appropriate to applications requiring dynamic characteristics of AoE and so has an effective application for offloading of FEC environment.

## ACKNOWLEDGMENTS

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# A Study on Big Data Refining Technique for Analysis and Visualization of Public Services Based on R Programming

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## Abstract

Public services managed by the state vary by age, income quintile, and occupation. There are various platforms that notify these public service resources, but detailed conditions such as the number of household members do not meet, so they often do not receive support. Therefore, it is necessary to provide accurate information corresponding to the support target by analyzing and visualizing public service data. To this end, the process of preprocessing data is important, and it is performed through data cleansing and analysis variables. In this paper, we study techniques for correct cleansing of public service data based on the R language useful for data analysis. The frequency and percentage between categorical data are calculated and the association between variables is visualized as bar graphs. Users will be able to more intuitively and easily understand the types of public services through the analyzed results.

**Index Terms**: Public service, R Data analysis, Structure information.

## I. INTRODUCTION

The data analysis process proceeds from problem recognition to current status analysis, modeling, data collection, data analysis, and utilization of analysis results. Among them, the process of preprocessing and cleansing collected data is an important task to reduce unbalanced data and increase data reliability. In this paper, the analysis is conducted using raw data from the public service API of the Ministry of Public Administration and Security of Korea. Using the R language makes it easier to apply various refining techniques that identify and remove missing data or outlier or replace or convert them into other values.

## II. SYSTEM MODEL AND METHODS

The public service API includes a service list model representing the type of public service and a support conditions model representing the target of support. Fig 1 shows the table expressed as a schema after converting the data of the JSON file into a CSV file.

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| age_bin | class_bin | income_bin |
|---|---|---|
| male | pregnant_women | income050 |
| female | disabled | income5175 |
| infants | national_merit | income76100 |
| children | soldier | income101200 |
| adolescents | farmers | income200exc |
| adolescents | fishermen | |
| youth | forestry_workers | |
| middle_age | EMH_students | |
| prime_of_life | UG_student | |
| old_age | not_applicable | |

| home_bin |
|---|
| sick_person |
| SP_households |
| multicul_families |
| one_parent_family |
| MC_households |

**Fig. 1.** Items by classification of public service API

Data preprocessing was performed by dividing the analysis variables into age, income, class, and households. Public service data consists only of nominal data "Y" and missing value NA, so only the data missing value processing method was applied. Missing values were associated with other variables, but missing values corresponded to Missing At Random (MAR) that did not affect the results [1-3]. First, the missing values were checked with the is.na function and all missing values were replaced with "N" values by giving a condition of ifelse. Filtering was performed to declare each group as data variables such as age_bin, class_bin, incoming_bin, and home_bin. The number of times corresponding to the type of public service is expressed as the frequency of "Y", and the number of times not corresponding is expressed as the frequency of "N". The frequency of data for each variable was limited to 300. Fig 2 shows the number of "Y" and "N" expressed in each data variable.

| | dis_name | Y | N | |
|---|---|---|---|---|
| 1 | male | 279 | 21 | |
| 2 | female | 300 | 0 | |
| 3 | infants0005 | 39 | 261 | |
| 4 | children0612 | 44 | 256 | |
| 5 | adolescents1318 | 50 | 250 | age_bin |
| 6 | youth1929 | 220 | 80 | |
| 7 | middle_age3049 | 212 | 88 | |
| 8 | prime_of_life5064 | 184 | 116 | |
| 9 | old_age65exc | 170 | 130 | |
| 10 | income0050 | 299 | 1 | |
| 11 | income5175 | 238 | 62 | |
| 12 | income76100 | 211 | 89 | income_bin |
| 13 | income101200 | 201 | 99 | |
| 14 | income200exc | 164 | 136 | |
| 15 | pregnant_women | 175 | 125 | |
| 16 | disabled | 151 | 149 | |
| 17 | national_merit | 136 | 164 | |
| 18 | soldier | 127 | 173 | |
| 19 | farmers | 127 | 173 | |
| 20 | fishermen | 120 | 180 | class_bin |
| 21 | forestry_workers | 119 | 181 | |
| 22 | EMH_students | 123 | 177 | |
| 23 | UG_student | 126 | 174 | |
| 24 | not_applicable | 219 | 81 | |
| 25 | sick_person | 228 | 72 | |
| 26 | SP_households | 217 | 83 | |
| 27 | multicul_families | 223 | 77 | home_bin |
| 28 | one_parent_family | 222 | 78 | |
| 29 | MC_households | 217 | 83 | |

**Fig. 2.** Frequency table for each group eligible for public service support

## III. RESULTS

The frequency table was visualized using the ggplot2 package. The frequency and percentage of each variable were indicated and the rate of support was checked. Figures 3, 4, 5, and 6 show the visualization results for each group.

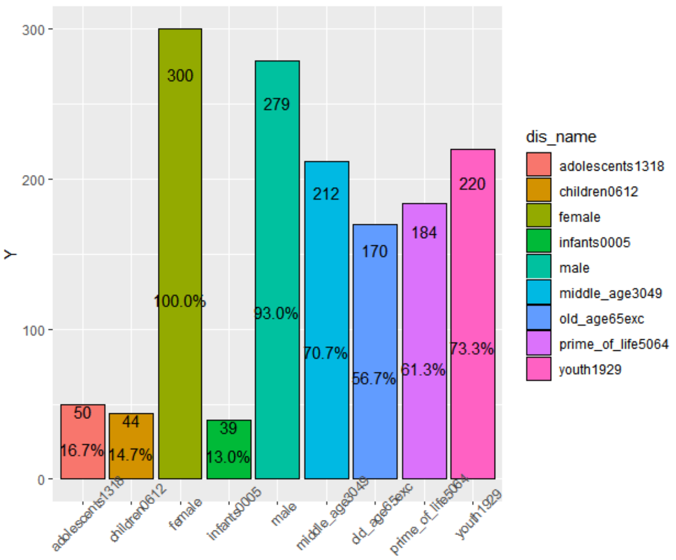


**Fig. 3.** Visualization results of public service target groups by age

In the age group, young people benefited the most with 73.3% (220 cases), followed by middle-aged 61.3% (184 cases) and elderly 56.7% (170 cases). In terms of whether men and women are eligible for public service support, women accounted for 100% and men 93%.

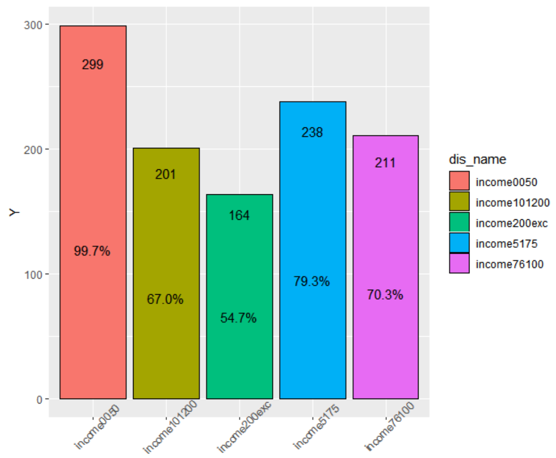


**Fig. 4.** Visualization results of public service target groups by income

In the income quintile group, the group with an income quintile of 50% or less was the highest at 99.7% (299 cases), followed by 79.3% (238 cases) of the group with an income quintile of 51% or more and 75% or less, and 70.3% (211 cases) of the group with an income quintile of 76% or more and 100% or less.

## IV. DISCUSSION AND CONCLUSIONS

In this paper, it was confirmed whether the correct visualization results were obtained by collecting data from the public service API and performing preprocessing in various ways. The JSON file was converted into a dataframe, stored as a CSV file, and read, and used for R data analysis. As a data cleansing method, a method of checking missing values and replacing them with other values was selected. The frequencies of "Y" and "N" data extracted through data preprocessing are calculated and represented by a frequency table. Each variable in the frequency table was divided into four collective abilities, stored in the analysis variable, and visualized using the ggplot2 tool. In the above method, it was possible to compare the proportion of public service recipients by group. The analysis results will vary depending on how the data cleansing technique is applied.

## ACKNOWLEDGMENTS

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# Blockchain-based Anonymous Authentication for IIoT Applications

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## Abstract

The number of security threats aimed at industrial IoT applications has increased over the past few years. Most of these attacks aim to discover data that may be used in future attacks to obtain industrial confidentiality. Due to the nature of industrial applications, it is important to ensure data security, privacy, and integrity. Blockchain is a source technology that leads to paradigm change from centralized to distributed control. This paper proposes mutual authentication to meet the security requirements of blockchain-based applications. Using an Eliptic Curve Cryptography algorithm that reduces key size, it simplifies the steps and parameters of the proposed mutual authentication procedure, and each target can establish and achieve mutual authentication without human interaction or intervention between trusted third parties or participants.

**Index Terms**: blockchain, ECC, IIoT, Authentication, Anonymity.

## I. INTRODUCTION

The Internet of Things is a growing paradigm of technical, social, and economic importance. Internet of Things (IoT) is a new concept that constitutes a broad ecosystem of interconnected services and devices such as sensors, consumer products, and automobiles and industries. Industry 4.0 focuses on creating smart products, procedures and processes. Industrial IoT (IIoT) can manage complexity and produce products more efficiently. Humans, machinery, and resources communicate with each other naturally like social networks. Devices equipped with sensors can collect important information in the environment and provide information to authorized machines for monitoring or analysis. The information is then analyzed and decisions are made to take certain measures, including sensor operation. The decision will have important consequences. These systems are vulnerable to cyberattacks because millions of sensors deployed in unprotected spaces introduce larger attack spaces, and are beyond the control of existing boundary defense mechanisms. The threats and risks associated with IIoT vary and develop rapidly. An industrial domain is a data-intensive domain in which a large amount of data is generated, distributed, stored, and accessed [1]. Manufacturing data of other devices should be attractive to cybercriminals. For example, cybercriminals seeking financial benefits from the theft of such industrial secrets may sell data to third parties [2]. It is important to satisfy

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characteristics such as data and device persistence and integrity, device authentication, and access control to data. In this paper, we propose blockchain-based mutual authentication to protect cyber threats that affect the security of objects deployed in IIoT applications.

## II. Related Works

In the recent years, several authentication protocols have been proposed for wireless sensor networks based on IoT and IoT application[3] with blockchain or without blockchain. Yan et al. [4] presented a new anonymous authentication protocol which has the ability to authenticate both pseudonyms and trust levels in order to support trustworthy pervasive social networking with privacy preservation. Anshel et al. [5] proposed a lightweight key agreement protocol (AAGL for short). The protocol achieves high performance which is better than existing public key based solutions to low-cost platforms. N.Li et al. [6] proposed a lightweight mutual authentication protocol based on novel public key encryption scheme by using Elliptic Curve Cryptography(ECC) for IoT. M. Wazid et al[7] presented secure mutual authentication between the near field communication in IoT. A.Lei, et al[8] proposed blockchain based dynamic key management for heterogeneous intelligent transportation system. He accepted blockchain technology to reduce key transfer time for secure and lightweight key management. J.Warren[9] proposed peer to peer messaging system based on blockchain. R, YU et al[10] presented an efficient privacy preserving algorithm to preserve the privacy of information in social networks. In the research[10], he made use of the recognition and non-tampering of the block chain to store the user's public key and bind to the block address, which is used for authentication. W, YIN et al[11] proposed anti-quantum transaction authentication approach based on blockchain which extended a lattice space to multiple lattice spaces accompanied by the corresponding key by using the lattice based bonsai tree signature. Many sub private keys derived from the seed in the deterministic wallet of blockchain can be generated in the scheme. In the research[11], he focused on the time to generate key which is determined by the message and generated before signature. J.LEE[12] proposed BIDaaS(blockchain based ID as a service) which works as an identity and authentication management infrastructure for mobile users registered in a mobile telecommunication company. In the BIDasS, when mobile users want to subscribe a new service provided from different service providers, the mobile users can be connected by virtual IDs issued by BIDasS. He accepted blockchain technology to protect private information of mobile users from many unguaranteed providers.

## III. Blockchain-based Authentication

We present authentication scheme based on blockchain. we use ECIES(Elliptic Curve Integrated Encryption Scheme) based on ECC to encrypt certificates of entities which includes authentic data needed for authentication. PCA(Private Certificate Authority) manages private data of entities and issues certificates. We designed the proposed protocol according to the following security requirements. An entity can accomplish direct communication for mutual authentication without trusted third party or any arbitration. An Entity doesn't open any private information including Identifier and master public key, and don't send identifier through network to prevent ID spoofing and ID sniffing.

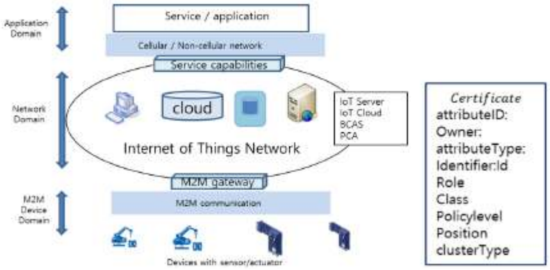


**Fig. 1.** Network Configuration

Entities send child public key for recovery of master public key and hash value of knowledge needed for recovery. Entities register encrypted information to Blockchain to preserve privacy of entities without data leakage and disclosure from the way in broadcasting transactions to every node. An entity generates onetime key before session and it is not reused after the session. Therefore No one can match up public digital signature registered with identity even though he or she catches the packet or the encrypted transaction while being forwarded to each node. In these procedures, the protocol consists of four procedures; SETUP, Key-generation, Registration, Authentication. Authentication consists of three procedures; request, get-Transaction and verification. There are two kinds of communication channels in the proposed procedures: Blockchain Communication, Mutual Communication. Blockchain communication is established between the contract and entities, and Mutual communication is established between two entities. Fig 2 shows the parameters opened and transferred to participants during mutual authentication.

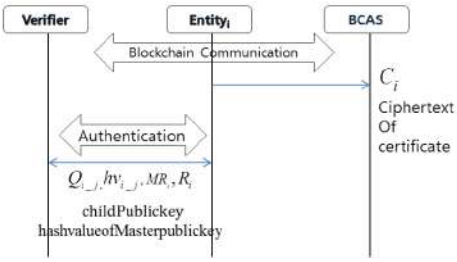


**Fig. 2.** Open data for Authentication Channel

Data is only available to the people intended to access it. Only digital signature is registered in the contract and only onetime ID and hash value are transferred through wireless network for mutual communication. Data and system resources are only changed in appropriate ways by appropriate people. Transactions transmitted are forwarded to every node and stored, and are managed in chronological order with time stamp. If integrity is broken in previous transaction, all blocks linked in the contract are broken. The message transferred is protected from illegal modification. Systems are ready when needed and perform acceptably. Entities can request mutual authentication without third party when needed. The identity of users is established and Users are explicitly allowed or denied access to resources. Digital signature and public key are verified and only identified entities can be allowed to resource. We send encrypted message by using public key cryptosystem and don't disclose crypto key to achieve anonymity. Nobody can link encrypted signature to his real identity, such as the ID and public key. If a malicious entity executes mutual authentication, it or he cannot get onetime ID of the partner because the partner verify the digital signature with decrypted public key. Finally, only honest entity can obtain the onetime ID of opposite party.

## ACKNOWLEDGMENTS

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# Development of Black Ice Area Detection in Degradation Road Images Using Deep Learning

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## Abstract

In this paper, a black ice data set of deteriorated road images was constructed by collecting road black ice images through a thermal imaging camera. We propose a lightweight network for black ice detection based on degraded road images. Next, in this paper, a black ice recognition experiment was conducted using transfer learning.

**Index Terms**: Black Ice Detection, Transfer Learning, Infrared Images, deep learning

## I. INTRODUCTION

Recently, road safety early warning system technology based on road condition detection has been attracting attention, but there are not many specific studies on black ice detection, and black ice is difficult to detect. A detection device is required to warn. Black ice recognition equipment can ensure safe driving and reduce the incidence of traffic accidents. Road surface condition detection technology is largely divided into two categories: contact and non-contact (flush type and non-flush type). Commonly used touch sensing methods include a capacitance method, a conductance method, a piezoelectric effect measurement method, and an optical fiber method. As a non-contact measurement method, as a polarization method, there are a photometric method and an image method.

## II. CNN TRANSFER LEARNING-BASED BLACK ICE DETECTION

CNN [1-2] has a powerful feature extraction function and shows excellent performance in image recognition, detection, and classification tasks. In addition to extracting image features for each layer, network efficiency can be improved through parallel learning of features and structural features. CNNs have been widely used in image classification problems as a fast and efficient method in the field of image classification and quickly become a research hotspot.

Depthwise Separable Convolution [3] is a very important design in many high-efficiency neural network structures at present. The improved network proposed in this paper uses

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Depthwise Separable Convolution. Deepwise Separable convolution is to unify the standard convolution into two parts. The first part is a deptwise convolution, the depthwise convolution is an output channel equal to the number of input channels by applying a convolution kernel to each input channel, and the second part pointwise convolution is used to linearly combine the outputs of the depthwise convolution. This is a typical 1x1 convolution.

Assume that the input feature map size is D_F×D_F×M, the output size is D_F×D_F×N, and the convolution kernel is D_K×D_K. According to the standard convolution calculation method, the amount of computation is 〖D_K×D_K×M×D〗 _F×D_F×N.

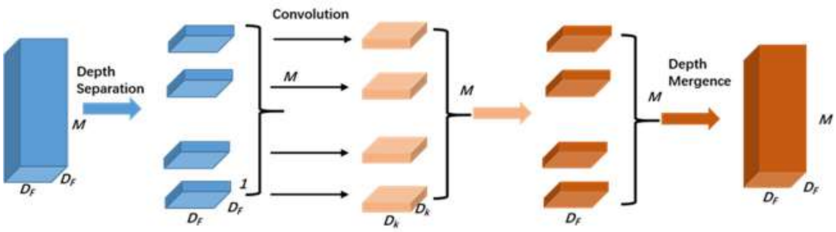


**Fig. 1.** Depthwise Convolution

## III. RESULTS

To reduce the amount of network parameters, 17 linear bottleneck structures are reduced to 7. Table 4 below shows the bottleneck coefficients used in the improved network model proposed in this paper.

**Table 1**. Improved Network Structure Parameters

| Backbone | Bottleneck Group | Expand Ratio(t) | Repeats ( n ) | Total Bottleneck |
|---|---|---|---|---|
| **MobileNetV2** | 7 | (1,6,6,6,6,6,6,) | (1,2,3,4,3,3,1) | 17 |
| **Proposed Netwok** | 4 | (6,6,6,6) | (1,2,2,2) | 7 |

## IV. DISCUSSION AND CONCLUSIONS

In this paper, a CNN-based black ice recognition algorithm for deteriorated roads was proposed to improve driving safety in winter. First, by studying the process of black ice generation, a simulated black ice generation experimental environment was created, and a black ice data set with deterioration road was constructed. Second, we proposed a CNN-based transfer learning deterioration road black ice recognition network.

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# Session IS-B

## Intelligent Information System

# Session NS-B

## Networking and Services

# Session CA-B

## Communication System and Applications

# Session MD-B

## Multimedia and Digital Convergence

# Session DA-B

## Database and Internet Application

# Design of Minimal Codes for Distributed Systems

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## Abstract

A minimal code is a linear block code, in which any two codewords are not included to each other. Because of this characteristic, minimal codes have been applied to several secret-sharing schemes. In this paper, we discuss design and application of minimal codes. Firstly, we compare previously known constructions for minimal codes. Secondly, we present a new framework for design of minimal codes. Finally, we discuss application of minimal codes to future applications such as block chain, federated learning, and so on.

**Index Terms**: Minimal codes, secret sharing, block chain, distributed system, block codes

## I. INTRODUCTION

Minimal code is a code that is not subordinate to codeword information of one user and is constantly being studied as one of the mathematical structures that can be used in secret-sharing schemes [1,2]. Researches on minimal code have been more active, as security-containing technologies such as blockchain [3] and federated learning [4] began to attract attention. [5-8]. Minimal codes have been designed using structures on a finite field, just like traditional algebraic error-correction codes. In particular, for binary very small codes, design techniques for various cases have been proposed. [5]-[7]. In addition, research on non-binary very small signs is being conducted recently. [8],[9]. In very few codes, since each user's codewords cannot completely contain other codewords, confidential information is not subordinate and is distributed to each other. Through this, it is possible to implement a distributed form of security, and original information may be obtained by synthesizing information distributed to each user.

Until now, studies on very few codes have mainly presented results for limited cases in terms of weight and length of codewords. This is because most of the design methods using known characteristics of finite bodies have been mainstream, and designing new shared codes based on the length of information and the degree of confidential sharing will be a very important issue in the study of confidential sharing techniques in the future.

In this paper, we discuss design and application of minimal codes. Firstly, we compare previously known constructions for minimal codes. Secondly, we present a new framework for design of minimal codes. Finally, we discuss application of minimal codes to future applications such as block chain, federated learning, and so on.

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## II. Mathematical Structure of Minimal Codes

A finite field consists of a finite number of elements that can be freely performed with addition and multiplication as well as their inverse operations. The finite field has been applied to various areas such as communication, error-correction codess for security, and design of pseudorandom sequences. Although the minimal code does not have the ability to correct errors, it can be designed based on matrices and vectors on a finite field, just like conventional error-correction codes.

### *A. Structure of Finite Fields*

A finite field is a set of powers of a primitive elements $\alpha$ and the additive identity 0. In addition, the finite body always has a prime number of elements. This prime number is called the characteristic number of a finite body. The number of elements is $q = p^n$ ($p$ is a prime number, $n$ is a natural number), and the finite field $\mathrm{GF}(p^n)$ having the primitive element $\alpha$ is composed as follows:

$$\mathrm{GF}(p^n) = \{0, \alpha, \alpha^2, \ldots, \alpha^{q-2}\}.$$

The finite fields is the Abelian group for addition, and other elements except 0 are cyclic groups for multiplication. Here, $\alpha$ is the root of the $n$-order primitive polynomial, and the elements of the finite body can be represented by a vector on the $n$-dimensional with respect to or a power of $\alpha$. Unlike integer rings, finite fields have been widely used in the design of ciphers and codes because they are free to add and multiply and their inverse operations.

| | | | | |
|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 0 |

| | | | | |
|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 1 |

**Fig. 1.** Two distinct codewords which are not subordinate to each other

### *B. Definition of Minimal Codes*

The support of the vector $v$ on the $n$-dimensional coordinate system is defined as the position of the nonzero coordinate. In a set of $n$-dimensional vectors, $C$ is called a minimal code if the supports of two vectors, which are arbitrary independent, are not related to each other and the entire set forms vector space. Figure 1 shows an example of two 5-dimensional binary vectors in which support is not included. Since the locations of the information are not dependent on each other, it may be applied to a system that is distributed and shared without being concentrated on one user. In distributed systems, the secrets should be shared, but not included to each other. Thus, minimal codes have a good structure to store information for secret-sharing schemes. This characteristic could be applied to recent applications with artificial intelligence [9,10].

**Table 1.** Known families of minimal codes

| Ref. | Alphabet size | Lengths, weights | Constraints |
|---|---|---|---|
| [5] | $2$ | $2^m - 1$, $3$ different weights | $\frac{w_{\min}}{w_{\max}} > \frac{1}{2}$ |
| [6] | $2$ | $2^m - 1$, $5 \sim 6$ weights | $\frac{w_{\min}}{w_{\max}} \leq \frac{1}{2}$ |
| [7] | $p$ | $p^m - 1$, $3$ weights | $p$: odd prime $\frac{w_{\min}}{w_{\max}} > \frac{p-1}{p}$ |
| [8] | $p$ | $p^m - 1$, $3 \sim 4$ weights | $p$: odd prime $\frac{w_{\min}}{w_{\max}} \leq \frac{p-1}{p}$ |

## III. Minimal Codes for Distributed Systems

In a secrete-sharing system, secret information is is delivered to multiple users, and secrete delivered from these users is synthesized by a specified method to reproduce the original information. Thus, each user should not be dependent on each other, and a minimal code may be used to implement this scheme. Until now, it can be seen that research has been conducted in the theoretical part rather than the practical aspects. The next theorem is one of the most important properties in designing very few signs.

**Theorem 1 [5].** A linear block code $C$ over $F_q$ is a minimal code if it satisfies

$$\frac{w_{\min}}{w_{\max}} > \frac{q-1}{q}.$$

Here, $w_{\min}(w_{\max})$ is the maximum (minimum) Hamming weights among all codewords.

Theorem 1 applies not only to binary codes but also to non-binary codes, and contains important information that tells each user what kind of information they can have in secret-sharing techniques. However, since this is a sufficient condition for the existence of a minimum sign, studies on a binary minimal code that is not included in the case of Theorem 1 have also been conducted. Ding *et al*. presented the first design method of the microcode for cases where the ratio between the smallest Hamming weight and the largest weight does not exceed 1/2 [6].

## IV. Concluding Remarks

Although minimal codes are difficult to design mathematically, the complexity of storing and using a single designed code can be considered very small. Therefore, not only can it be applied to secret-sharing techniques such as blockchain, but it can also have a very important value as a means of sharing and distributing secret for federated learning that satisfies efficiency and security at the same time. Currently, research on non-binary semiconductors is actively being conducted, and it can be commercialized in the future and applied to communication, security, data systems, etc., so designing non-binary codes will also be a very important issue.

## ACKNOWLEDGMENTS

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# Establishment of Smart Factory Advancement of Automobile Parts Manufacturing Companies

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## Abstract

Tens of thousands of automobile parts must be assembled to complete a single car. Automobile brands are affiliated with various parts manufacturers. The purpose of this study is to propose a more advanced smart factory construction plan in the field of production process and quality management of automobile parts manufacturers.

**Index Terms**: Smart Factory, Automobile, Quality Control, Production Process Advancement

## I. INTRODUCTION

The automobile industry is facing great difficulties and is rapidly changing due to internationally strengthened protection trade such as the Fourth Industrial Revolution. The automobile industry is undergoing comprehensive changes in all industrial areas such as products, processes, and business models. New products such as electric and hydrogen vehicles, self-driving and connected cars are developing, and automation and digitalization are accelerating in workplaces due to changes in processes called smart factories. Convergence manufacturing innovation that combines manufacturing and ICT is rapidly progressing around the world. Smart Factory refers to an intelligent production plant that improves productivity, quality, and customer satisfaction by applying ICT that combines digital automation solutions to production processes such as manufacturing, design, development, distribution and logistics.

In order for the automobile industry to succeed in such a rapidly changing environment, the competitiveness of the parts industry is paramount.

This is because new parts needed for future vehicles must be quickly developed and supplied stably. Tens of thousands of automobile parts must be assembled to complete a single car. Automobile brands are affiliated with various parts manufacturers. The purpose of this study is to propose a more advanced smart factory construction plan in the field of production process and quality management of automobile parts manufacturers.

* Corresponding author

## II. Current status of parts manufacturers in the automobile industry

The automobile industry consists of related industries and value chains, from manufacturing automobile parts to assembling and selling finished cars. Figure 1 shows the value chain of the automobile industry.

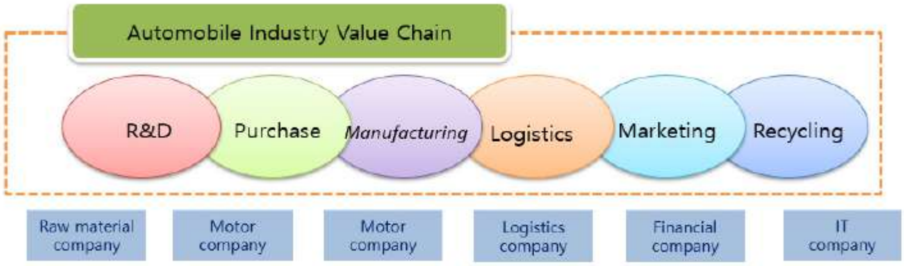


**Fig. 1.** Automobile industry value chain

Analysis of the business process by type of automobile parts factory is divided into part production and order management, part procurement and logistics management, production plan and performance management, production line and process management, sales and follow-up management.

Currently, the production process management of automobile parts companies has the following problems. The production plan manager has changed the schedule and cannot be effectively used to register the production plan. If the production plan is not registered, the automatic performance count function cannot be used. Quality management has disadvantages in that inspection registration is insufficient and quality inspection registration is insufficient when the person in charge changes frequently.

Figure 2 shows the flow chart of work procedures for smart factories.


**Fig. 2.** Work procedures for smart factories

Technical elements implementing the functions of smart factories include devices and sensors. This device and detection play a role in identifying, collecting, and transmitting various information generated during the production process of the product to the application.

## III. RESULTS

In this study, a plan to build a smart factory was proposed for the process and quality control of automobile parts manufacturers. Figure 3 is a screen showing the real-time inventory status and delivery registration of production process management.

**Fig. 3.** Inventory status and delivery registration of smart factory

After establishing a smart factory, production process management and quality management have the following expected effects. Production plan registration can proceed with efficient production registration plans as it has production plan information registration, inquiry, modification, and deletion management functions according to each schedule. In addition, inspection registration is possible for each date by the process, so it has a quality inspection function efficiently.

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# Intelligent Transportation System based on an Edge AI

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## Abstract

An intelligent transportation system (ITS) is a future system that combines various technologies to provide safety and convenience to humans. In order to implement ITS, previous systems applied an architecture that contains a large number of data centers with a high-performance general-purpose processor and graphics processing unit to collect the information of vehicles. However, this architecture not only requires a high network bandwidth but also causes the system to decrease power efficiency and makes security weak. In this paper, we propose an ITS based on an edge AI device which solves problems with the existing structure. We applied the edge AI device which is applicable to various systems in ITS to license plate recognition and the highest accuracy was 0.94. We implemented the edge AI device on a field programmable gate array (FPGA) and verified the feasibility of the entire system with the proposed edge AI device.

**Index Terms**: Intelligent transportation system, Embedded system, Artificial intelligence

## I. INTRODUCTION

ITS is a next-generation transportation system that consists of advanced public transportation system, traffic management system, and automatic parking management system. The key feature of the ITS is that the system has to handle the vast amount of data collected from various roads in real time [1]. Accordingly, a large number of data centers based on the cloud with high-performance general-purpose computing on graphics processing units are required to manage and process the data [2-3]. In addition, as the edge devices send the raw data to the data centers, a high network bandwidth is essential [2]. These characteristics cause the system to decrease the power efficiency, increase a processing time, and makes security weak.

In order to overcome these weaknesses, using the concept of edge computing is one of the solutions [4-5]. The edge computing is a distributed computing paradigm that pro-cesses the data first in the local and sends the processed data to the central data center. This method lowers the specifications of the data centers and network bandwidth by reducing the amount of data exchanged between the data centers and the edge devices. The edge computing requires edge devices that process the data before sending the data to the data centers. Generally, edge devices have limited power resources and areas [6]. Therefore, the edge devices should be applied to the embedded system that reduces waste of resources by

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performing certain functions to derive the maximum performance.

In this paper, we propose ITS based on the edge AI device. The main contribution of this paper is to increase power efficiency and security compared to conventional ITS by applying edge AI devices. Since one of the necessary elements for implementing ITS is to identify the position and speed of the vehicle in a real-time environment, we applied the edge AI device to license plate recognition among various systems. Accordingly, ITS is possible to collect vehicle information automatically while operating 24 hours a day with low maintenance cost. As the proposed edge AI device consists of the reconfigurable AI feature, the accuracy of license plate recognition can be increased by selecting the proper specifications of the edge AI [7]. In order to find the suitable specification, we simulated various specifications of the edge AI. Moreover, we demonstrated with the FPGA and verified the feasibility of the entire system.

## II. SYSTEM ARCHITECTURE

Fig. 1 shows the entire system architecture. By applying the edge AI device to multiple systems in ITS, the efficiency and security of the entire system is increased. The specification of the proposed edge AI device is determined by the size and number of N-cells built into edge AI. N-cell is a memory in which training data is stored.

The license plate recognition system flow is as follows. The license plate recognition begins when the edge AI device receives the entire image through a camera module. A microprocessor of the edge AI device detects the license plate on the entire image and segment the characters on the license plate image through an image preprocessing process using OpenCV-Python. The segmented characters are transmitted to the edge AI which is used for the characters recognition. The edge AI compares the recognition data with training data which is stored in N-cell and outputs a result. In order to increase the accuracy, we used the format of license plates. Currently, Korean license plates have 7 characters or 8 characters. The plates with 7 characters have Hangul at the 3rd digit and the plates with 8 characters have Hangul at the 4th digit. According to the format, only numbers are trained when comparing numbers and only Hangul is trained when comparing Hangul. This increases the accuracy because the edge AI does not confuse Hangeul with numbers. A comparison algorithm is selected k-nearest neighbor (k-NN) algorithm which is a lightweight algorithm [8]. By applying Manhattan distance calculation which does not require multipliers to the k-NN, the size and the power consumption of the edge AI is reduced.

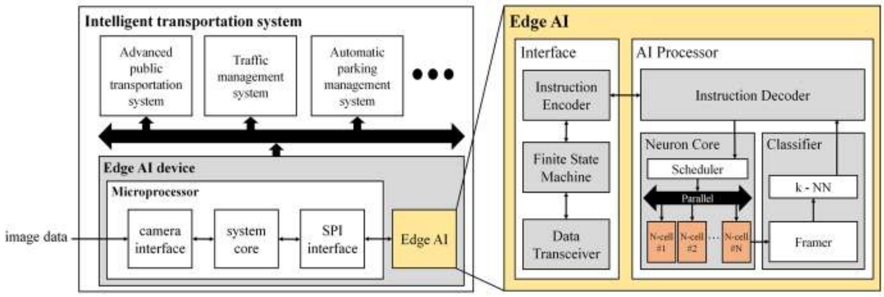


**Fig. 1.** Block diagram of ITS with the edge AI device

## III. EXPERIMENTAL RESULTS

We simulated various specifications of the edge AI through software simulation. The number of N-cell is fixed to 64 because the total training data is 50 which includes 10 numbers and 40 number of Hangul. Since the number of N-cell is fixed, the accuracy depends on the size of N-cell. Table 1 shows the experimental results according to the size of the N-cell for 500 number of image data. For all image sizes, the accuracy of numbers is close to 0.99, but the accuracy of Hangul shows a significant difference. Additionally, as the size of the character images that the edge AI has to process increases, character segmentation time increases and FPS decreases. The accuracy of the images with 32×64 resolution in Hangul is over 0.98. As a result, the maximum accuracy of the edge AI device for the license plate recognition is 0.94.

**Table 1.** Figures of the simulation result

| N-cell size (byte) | Number accuracy | Hangul accuracy | Total accuracy | License plate detection time | Character segmentation time | Character recognition time | Processing time | FPS |
|---|---|---|---|---|---|---|---|---|
| 8×16 | 0.985 | 0.734 | 0.678 | 30.406ms | 0.61ms | 9.926ms | 40.91ms | 24.443 |
| 16×32 | 0.992 | 0.963 | 0.928 | 28.544ms | 0.612ms | 13.566ms | 42.61ms | 23.468 |
| 32×64 | 0.992 | 0.981 | 0.94 | 25.394ms | 0.599ms | 19.872ms | 45.865ms | 21.803 |
| 64×128 | 0.991 | 0.971 | 0.93 | 28.087ms | 0.606ms | 47.548ms | 81.695ms | 12.24 |

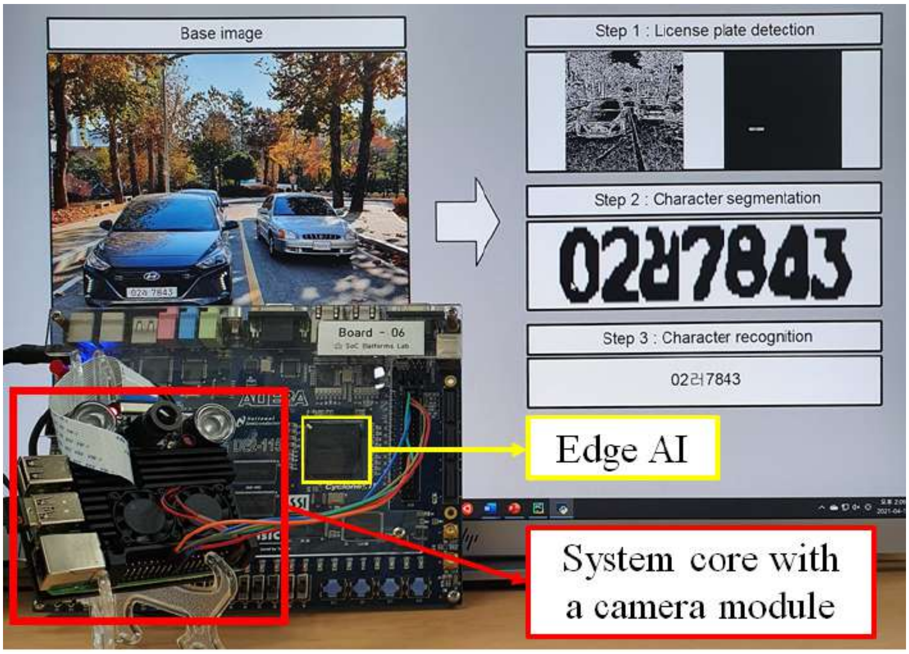


**Fig. 2.** Experimental environment

Fig. 2 shows the experimental environment. We connected the microprocessor and the field programmable gate array (FPGA) board, named DE2-115, through GPIO. We configured the edge AI logic to the DE2-115 board. At the start of the experiment, the microprocessor performed the image preprocessing and transmitted the data to the FPGA. The edge AI processed the data and transmitted the recognition result to the micro-processor. The accuracy was as same as the software simulation. Finally, we measured the accuracy of the alphabet to apply the system to license plates with English. As a result of the experiment, the accuracy of the images with 32×64 resolution is 0.904.

## IV. CONCLUSION

In this paper, we proposed ITS based on the edge AI device. The edge AI device performed the license plate recognition to verify that the proposed edge AI device is applicable to ITS. The proposed edge AI device increases the power efficiency and decreases the processing time of ITS. We simulated various specifications of the edge AI to find the maximum accuracy. When the size of N-cell was 32×64, the accuracy was highest at 0.94 and FPS was 21.803. We connected the FPGA board for verification in hardware. The results were the same as the software simulation results 0.94 of the total accuracy.

## ACKNOWLEDGMENTS

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# Fuel Cell-based Electric Powered Ship Power Operation Algorithm Design

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## Abstract

Fuel cells are in the spotlight as the main power generation device for future marine power systems. It is expected that the problem of environmental pollution can be solved by dramatically reducing carbon emissions. However, the operation algorithm of the system utilizing the existing internal combustion engine cannot be used for ships. This is because, due to the constant-output characteristics of the fuel cell, it is not possible to handle the changing load on the ship.

Meanwhile, future ships are changing from a mechanical propulsion method using an internal combustion engine to an electric propulsion method using a propulsion motor. The electric propulsion method is linked to the power generation system and the energy related to the propulsion must be supplied from the power generation source. Therefore, when the propulsion load is changed, the output of the power source also changes. Since the fuel cell cannot handle all of the change, a battery or generator that is excellent at changing the output must be used.

In this study, we design and present an operation algorithm for a hybrid power source by reflecting the load characteristics of electric propulsion ships. In order to check whether the operation of the algorithm can have stability and efficiency of power supply when it is operated on an actual ship, the algorithm was checked using simulation equipment (Power Supply, Electric Load).

**Index Terms**: Electric Propulsion Ship, Hybrid power source, simulation equipment, load characteristics, stability and efficiency

## I. INTRODUCTION

Ship owners prefer a propulsion system as an electric propulsion ship in order to meet the ship emission regulations by IMO (International Marine Organization) 2021[1]. As a result, the capacity of the power generation system is increasing and the types of power sources are becoming diversified[2,3]. A representative power source is a generator using a prime mover, and research is being conducted to link the battery and fuel cell. Since the characteristics of each power generation-source are different, the efficiency and stability will be different depending on the interlocking algorithm. The reason for the change of the propulsion system to electric propulsion is to deal with ship emission regulations, so the

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efficiency improvement represented by each algorithm is being treated as a high research task in the ship market[4].

In terms of the power generation-source characteristics, the fuel consumption efficiency of the generator rapidly decreases at a low load, and in the case of the fuel cell, the durability is rapidly reduced due to a sudden load change[5-7]. In addition, since the control of charging and discharging of the battery is different, an algorithm for the load variation of the vessel is required. Since a fuel cell has a structural lifespan of abruptly reduced when output fluctuation occurs rapidly, in general, it is necessary to maintain a constant output. Therefore, for stable and efficient power-source control, it is necessary to study the power-source control algorithm suitable for the characteristics of the ship.

Since the load of the ship varies through a certain pattern according to the operation mode, a power generation-source control algorithm according to the operation mode is required. The battery requires charge/discharge control using DC power, and it is necessary to develop a management system that can be linked with the ship's controller[8]. Since the fuel cell also uses DC power, it is supplied to the ship through power conversion. When supplied on board, the characteristics of the fuel cell must be considered, so it must be designed and operated to fit the fuel cell. However, since the output is entirely determined by the use in the load, an algorithm that considers the load must be accompanied.

In this paper, the capacity for each power generation-source is designed by designating a ship. And the algorithm is built to fit the characteristics of each power generation-source. In order to check the function of the algorithm, a test bed that can simulate the real-time controller and the ship's power environment is produced. And it creates a scenario to fit the operation mode of the ship, tests the TEST BED, and analyzes the results.

## II. OPTIMZE SOURCE CAPACITY

### A. Object ship

The target ship type for testing the algorithm produced in this study is an LNG carrier, and the generator is an electric propulsion ship using a dual fuel engine. Table 1 below shows the specifications of the target vessel.

**Table 1.** specifications of the target vessel

| Dimensions | | | |
|---|---|---|---|
| Length overall (LOA) | 289.98 | Length between perpendiculars (LBP) | 284.00 |
| Extreme breadth | 46.40 | Moulded breadth | 46.40 |
| Moulded depth | 26.40 | Height, Keel to masthead | 64.18 |
| Distance bow to bridge | 229.60 | Height, Keel to masthead(folded) | 63.16 |

| Engine Specification | | | | | |
|---|---|---|---|---|---|
| Main Engine | 2 x ASYNCHRONE INDUCTION MOTOR | MCR | 68RPM x 22,104kW | NCR | 68 RPM x 22,104kW |
| Propeller | Fixed Pitch Type | Screw Pitch | 8,731.64 MM | Screw Dia. | 8,500MM |

The vessel used in this study is an electric propulsion vessel, and in order to design the capacity for each power generation-source, it is necessary to check the load used for each operation mode. Table 2 below shows the Electric Load Analysis (ELA) Table of the target vessel.

**Table 2.** ELA table of the target vessel

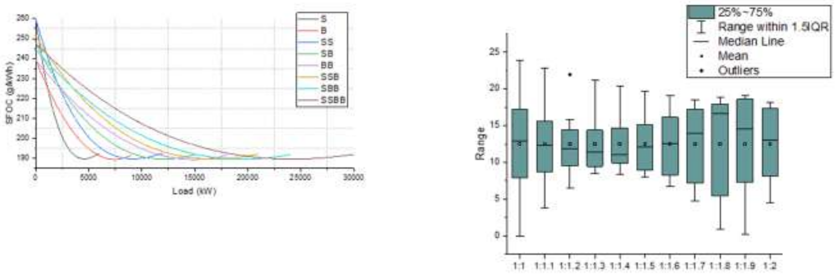
| | Sea Full | Port In/Out | Port Discharging | Port Loading |
|---|---|---|---|---|
| Continuous load | 1,755.2 | 4,350.3 | 2,432.4 | 2,436.5 |
| Propulsion load | 23,507.6 | 4,815.7 | 39.0 | 39.0 |
| Intermittent load | 207.1 | 194.2 | 192.6 | 192.6 |
| Group diversity factor | 0.4 | 0.4 | 0.4 | 0.4 |
| Actual intermittent load | 82.9 | 77.7 | 77.1 | 77.1 |
| Cargo part load | 928.8 | 922.9 | 5,308.9 | 3,180.0 |
| Deck machinery load | 0 | 383.0 | 0 | 0 |
| Preferential load | 405.3 | 364.6 | 5,008.3 | 624.6 |
| Total load | 26,274.5 | 10,549.5 | 7,857.3 | 5,732.6 |

## B. OPTIMIZE CAPACITY

When selecting the capacity of the power generation source, first, the fuel cell and the battery are selected. Thereafter, the generator capacity is evaluated for the remaining generated power, and the capacity of the generator is selected based on the result. The role of the fuel cell proposed in this paper consists of two parts. First, it is responsible for the main power source during anchorage. Second, it is responsible for the base load during voyage. Meanwhile, the maximum power used during anchorage of the target vessel is 7857.3 [kW], and the maximum base load during voyage is 5733.8 [kW]. Therefore, the capacity of the fuel cell was set to 8 MWh.

The purpose of using the battery is to catch the change to the intermittent load. In the ELA table, the intermittent load is maximum 207.1 [kW]. Lithium-based batteries show the highest efficiency at 0-0.3C. Therefore, the capacity of the battery should be selected higher than 690.3 [kWh], which can output 207.1 [kW] at 0.3C. In this paper, 1 [MWh] is selected as the battery capacity in consideration of the margin-rate.

The generator is responsible for the propulsion load of the ship. In addition, in case the use of the fuel cell is impossible, a capacity that can handle the entire load should be selected. The total capacity in this study was selected as 30 MWh. The total number of generators installed was 4 units. The capacity of each generator was set to be the same for two units. Then, the capacity ratio is set for 30MWh, and the optimum operation efficiency is evaluated for the load range and selected. Dose assessments evaluate the distribution of combinations used in ranges for efficiency. Figure 1 (a) shows the SFOC curve for a combination of generators in a 1:1.5 ratio. In addition, Figure 1 (b) shows the deviation of the optimal operating combination ratio by varying the ratio.




(a) SFOC Curve for a combination of generators in a 1:1.5 ratio

(b) deviation of the optimal operating combination ratio by varying the ratio

**Fig. 1.** SFOC Curve for a combination of generators in a 1:1.5 ratio and deviation of the optimal operating combination ratio by varying the ratio

Considering the mean and the actual median, it was confirmed that the dose evaluation of 1:1.5 was the best dose ratio. Therefore, the capacity was selected as 6,000 kWh * 2, 9,000 kWh *2. In conclusion, the combination of power generation-source used in this study is shown in Table 3.

**Table 3.** Capacity of source

| Kind of source | Type 1 | Type 2 |
|---|---|---|
| Generator | 6,000 kWh * 2 | 9,000 kWh * 2 |
| Fuel Cell | 8,000 kWh | |
| Battery | 1,000 kWh | |

## III. SOURCE CONTROL STRATEGY

### *A. Load Characteristics of Electric Propulsion Vessel*

In an electric propulsion ship, the power load consists of a propulsion load and a service load. The propulsion load refers to the load consumed by the propulsion motor, and the service load refers to the load excluding the propulsion load. The power load has the characteristic of being used in a certain range according to the ship operation mode. The ship operation mode is largely composed of a navigation mode, a port in/out mode, and a port mode. The characteristics of the load according to the ship operation mode are shown in Table 4.

**Table 4.** The characteristics of the load according to the ship operation mode

| | Propulsion load | Service load |
|---|---|---|
| At sea | - Occupies high load<br>- Occupies about 90% of the total load depending on the speed of propulsion | - Smallest load out of 3 modes |

| | | |
|---|---|---|
| Port in/out | - Occupies low load<br>- Because the propulsion speed is low, it accounts for about 20-30% of the total load. | - Relatively high value due to load related to Port in/out<br>- The operating cycle of the device is shortened |
| Port | - No propulsion load | - High load is used due to the operation of cargo-related equipment |

In at sea mode, the value of the propulsion load is large, and it accounts for about 90% of the total load depending on the propulsion speed. However, the size of the service load shows the smallest value among the three modes. In the port in/out mode, the propulsion load is smaller than at sea mode's propulsion load. However, the service load is higher than that of the at sea mode due to the deck equipment used for entry and departure. Since there is no propulsion in port mode, the propulsion load converges to zero, but shows a high service load due to the operation of cargo-related equipment. By using these loads, the source must behave differently. It is necessary to check the range of use of the load in order to accurately operate the source and prevent chattering of the device operation. In this paper, in order to check the usage range of the load, the power usage range is checked through the band.

Band is composed of Criteria and Width. The reference point is used to mark the position of the band. The width indicates the size of the band, and Band_supremum and Band_infimum can be obtained with the center of the width at the reference point. Band_supremum and Band_infimum can be obtained from Equations 1 and 2.

$$Band_{Supremum} = Criteria + \frac{1}{2}Width \tag{1}$$

$$Band_{infimum} = Criteria + \frac{1}{2}Width \tag{2}$$

Where, $Band_{supremum}$ is Band_supremum [kW], $Band_{infimum}$ is Band_infimum [kW], $Criteria$ is the criteria of the band [kW], and $Width$ is the width of the band [kW].

The corresponding band should monitor the use of power. Looking at the meaning of the band, it means that the use of the load is made only within the band in the current operating state. Of course, the value may vary depending on the change of the operation mode of the vessel or the change of the propulsion speed. However, it can be said that it is reasonable to operate according to the band since the same operation mode is performed for a long time due to the nature of the operation of the ship. Band measures the width through data stored according to unit time [s] for the time [h] that sets the range of power, and compares the collected current power [kW] with the band to calculate a reference point. The algorithm for controlling the band is divided into the Criteria control algorithm and the Width control algorithm. The band's Criteria and Width control algorithms are as follows, respectively.

$$\begin{aligned}
&Stack_n = \{P_1 . P_2, \cdots, P_n\} \\
&\mathrm{I} = \mathrm{ceil}\left({}^{CST}/_{SI}\right) \\
&\text{if}, Band_{supremum} < P_{load} \\
&\{Criteria{+}{=}\ Band_{supremum} - Min(Stack_I)\}
\end{aligned} \tag{3}$$

$$
\begin{aligned}
& if, Band_{infimum} > P_{load} \\
& \{Criteria -= Max(Stack_I) - Band_{infimum}\}
\end{aligned}
$$

$$
\begin{aligned}
& Stack_n = \{P_1 . P_2, \cdots, P_n\} \\
& \mathrm{I} = \mathrm{ceil}\left({BST}/{SI}\right) \\
& \mathrm{Width} = [(Max(Stack_I) - Min(Stack_I)] \times \left(1 + {SF}/{100}\right) \\
& if, Width > BMW \\
& \{Width = BMW\}
\end{aligned} \tag{4}
$$

Here, $Stack_n$ is the $n$ power [kW] matrix, $n$ is the number of stacked power data [pcs], $P_n$ is the nth power data [kW], $Band_{infimum}$is the upper boundary of the band [kW], $Band_{infimum}$ is the lower boundary of the band [kW], $Criteria$ is the criteria of the band [kW], $Width$ is the width of the band [kW], $I$ is the data check range for control of the reference point [pcs], $P_{load}$ is the current onboard power load [kW], $CST$ is the sampling length to check the reference point [s], $SI$ is the time interval of data accumulated in the stack [s], $SF$ is the safety factor for the band width [%],$BMW$ is the minimum width of the band.

## B. Source control strategy

The source control algorithm was constructed using separate conditions for the generator, battery and fuel cell. The construction of the algorithm considered two-patterns. The first pattern is the source configuration when the propulsion load is used, and the generator, battery and fuel cell are all configured to be used. The second pattern is the source configuration when the propulsion load is not in use, and the battery and fuel cell are configured to be used. Therefore, there is no exhaust gas emission by the diesel engine in the port.

In a power control system using a generally used generator, start/stop is decided in consideration of the surplus power of the power-source. When the surplus power is low, the surplus power is supplied by starting the generator. Conversely, if the surplus power is high, the surplus power is lowered by stopping the generator. However, there is no case in the power system where the generator does not run. In this study, there is a state in which the generator does not run, so a condition for stopping the generator must be added. The conditions for starting and stopping the generator are shown in table 5.

**Table 5.** The conditions for starting and stopping the generator

| | No. | Condition | Delay |
|---|---|---|---|
| Start | 1 | $PMS_H^N = \{PMS_H^1 = 88, PMS_H^2 = 90, PMS_H^3 = 93\}$ $LF_G \geq PMS_G^{RUN} + 3$ | 5 |
| | 2 | $PMS_H^N = \{PMS_H^1 = 88, PMS_H^2 = 90, PMS_H^3 = 93\}$ $LF_G \geq PMS_G^{RUN}$ | 300 |
| | 3 | $(B_{state} = Discharging)$ & $(\frac{C_{ca}}{D_{power}} \times 60 > B_U^S)$ & $(G_{out} + FC_{object} < Band_{supremum})$ | 300 |
| | 4 | $(B_{state} = Discharging)$ & $\left(\frac{C_{ca}}{D_{power}} \times 60 > 10\right)$ & $(G_{out} + FC_{object} < Band_{supremum})$ | - |
| | 5 | $(N = 0)$ & $(Ship_{state}! = Inport)$ | - |
| Stop | 1 | $(N = 1)$ & $\left(\frac{B_{soc} - M_{soc}^S}{100} \times B_{ca} > \frac{Band_{supremum} - FC_{ca}}{T_{BattCanHandle}^S}\right)$ & $(B_{ca} \times C_{max}^{Disch} + FC_{object} > Band_{supremum})$ | 300 |
| | 2 | $(N = 1)$ & $(Load_{propulsion} = 0)$ & $(Ship_{state} = Inport)$ | - |
| | 3 | $(Light_{LF}^a \leq Light_{factor}^N)$ | 300 |

Here, $PMS_H^N$ is the Heavy Load Parameter when $N$ generators are operating [%], N is the number of generators operating [units], $LF_G$ is the load factor of the generator currently in operation [%], $B_{state}$ is Battery status [Discharging/Charging/StandBy], $C_{ca}$ is the charging capacity of the battery [kW], $D_{power}$ is the battery discharge power [kW], $B_U^S$ is the set battery usable time [s], $G_{out}$ is the generator output power [kW] ], $FC_{object}$ is the fuel cell target output [kW], $Band_{supremum}$ is the upper boundary of the power usage monitoring range [kW], $B_{soc}$ is the battery SOC [%], $M_{soc}^S$ is the set maximum battery SOC [%] , $B_{ca}$ is the battery capacity [kWh], $T_{BattCanHandle}^S$ is the set battery operating time [s], $C_{max}^{Disch}$ is the maximum battery discharge c-rate [dimensionless number], $Load_{propulsion}$ is the propulsion load [kW], $Light_{LF}^a$ is the load factor [%] for the current onboard load when the generator a is stopped during the current operation of the generator, and $Light_{factor}^N$ is the stop load factor [%] of the set number of generators operating $N$.

The LCS Battery algorithm determines the charge/discharge and output of the battery. The charging and discharging of the battery is related to the efficiency of the battery and determines the charging and discharging. In addition, the algorithm is different by dividing into a case in which the generator is operated and a case in which the generator is not operated. Basically battery is operated to increase the efficiency of the generator. In order to check the efficiency, it is necessary to check the efficiency of the generator and the loss of the battery. The loss of the battery is a natural occurrence in the use of the battery, and the magnitude of the loss depends on the c-rate of the battery used. In general, it is expressed that the efficiency converges to 100% at a c-rate smaller than 0.3C in the c-rate. However, when it exceeds 0.3C, the efficiency is dramatically lowered. Therefore, when the C-rate is operated at a high rate, the loss of the battery increases and the loss of the battery is greater than the increase in the efficiency of the generator, so it is difficult to expect an increase in efficiency due to the operation of the battery. Therefore, it is essential to compare the efficiency increase of the generator and the loss of the battery. The table 6 shows the algorithm built using the efficiency of the battery and increasing the efficiency of the generator.

**Table 6.** The algorithm built using the efficiency of the battery and increasing the efficiency of the generator

| From | To | Condition |
|---|---|---|
| Stand By | Charging | - SOC [%] < Setting SOC (90%)<br>- Load Factor(UP) if on charging < E range max<br>- Efficiency if on charging > Battery Efficiency |
| | Discharging | - SOC [%] > Setting SOC (40%)<br>- Load Factor(UP) if on discharging < Heavy Load Factor<br>- Efficiency if on Discharging > Battery Efficiency<br>- Predict Discharging c-rate != 0 |
| Charging | Stand By | - SOC ≥ Setting SOC (95%)<br>- Load Factor(Down) if on S/BY > Efficiency Range Min<br>- Load Factor(UP) if on charging > Efficiency Range Max |
| Discharging | Stand By | - SOC ≤ Setting SOC (35%)<br>- Load Factor(UP) if on S/By < Efficiency Range Max<br>- Discharge C-rate == 0 |

## IV. EXPERIMENT AND RESULT

### *A. TEST BED*

To check the algorithm presented in Chapter 3, a test bed that can simulate the ship's environment was produced, and the performance of the algorithm was verified through the scenario. TEST BED consists of a programmable power supply, a programmable electric load, a power monitoring device and a controller. The figure 2 shows the schematic diagram of the test bed.

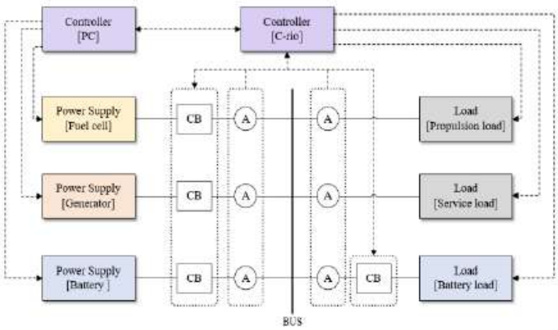



**Fig. 2.** The schematic diagram of the test bed

### *B. Scenario*

The load-one simulator on the TEST BED is driven by the scenario. The table 7 shows the scenario of the load simulator.

**Table 7.** The scenario of the load simulator

| No. | Type of Load | Ship state | state |
|---|---|---|---|
| 1 | Propulsion load | In port | - |
| | Service load | Discharging | About 8,000 kWh |
| 2 | Propulsion load | Stand By | Engine Throttle = Stop |
| | Service load | Port in/out | About 5,300 kWh |
| 3 | Propulsion load | Stand By | Engine Throttle = Dead slow |
| | Service load | Port in/out | About 5,300 kWh |
| 4 | Propulsion load | Stand By | Engine Throttle = Slow |
| | Service load | Port in/out | About 5,300 kWh |
| 5 | Propulsion load | Stand By | Engine Throttle = Half |
| | Service load | Port in/out | About 5,300 kWh |
| 6 | Propulsion load | Stand By | Engine Throttle = Full |
| | Service load | Port in/out | About 5,300 kWh |
| 7 | Propulsion load | At sea | Object Speed = 18 knts |
| | Service load | Port in/out | About 2,700 kWh |
| 8 | Propulsion load | At sea | Object Speed = 10 knts |
| | Service load | Port in/out | About 2,700 kWh |

When the scenario in Table 7 is converted into power, it is shown in Figure 3.

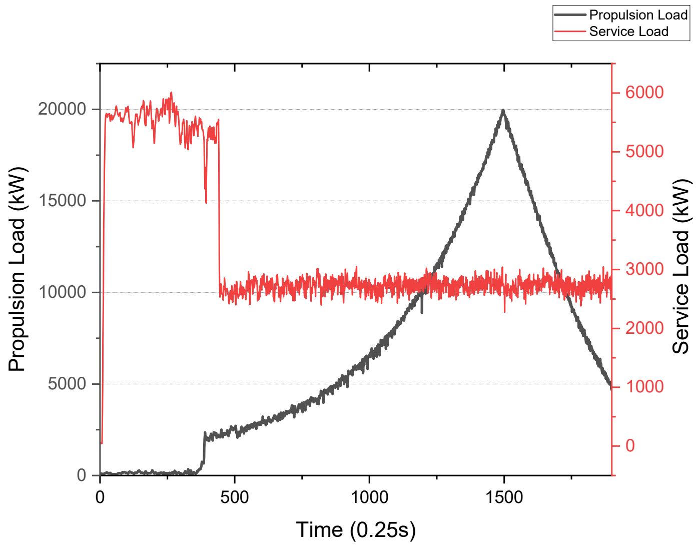



**Fig. 3.** The scenario of the load simulator

## C. Results

After the power-source control algorithm proposed in this study is operated for the above scenario, the result shown in Figure 4.

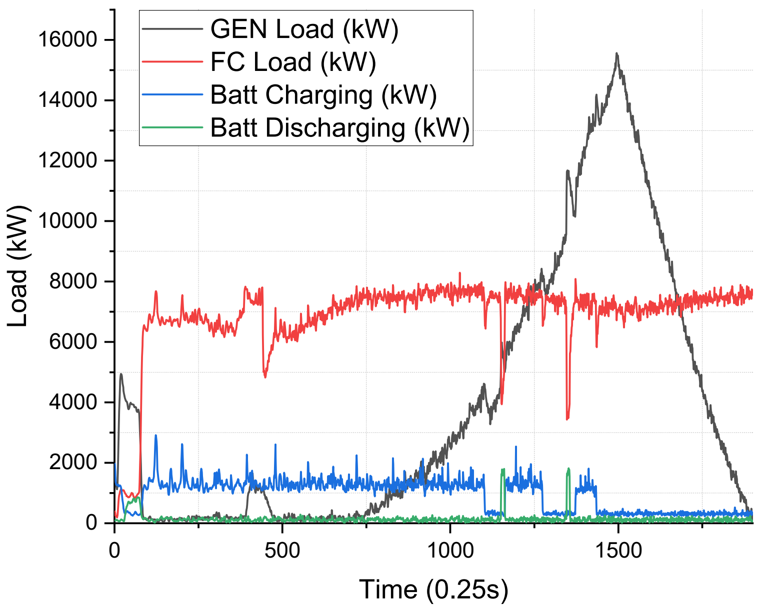



**Fig. 4.** Result of experiment in scenario

Looking at the above algorithm, the power is initially supplied through the operation of the generator. In addition, although the fuel cell is being used, it can be seen that the fuel cell exhibits low output. This indicates that the distribution of power has not yet been made. After a while, the generator stops, and the total power on board is supplied by batteries and fuel cells alone. And it can be seen that the output of the fuel cell is significantly increased. Since this adversely affects the fuel cell, there is a need to add an algorithm for high output fluctuation at this time. Afterwards, the generator does not operate, but the propulsion motor is used as it enters Stand By, and the generator is operated at this time. And while the electric power is being supplied, the output of the fuel cell is fluctuated. Also, the battery is constantly charging, indicating that the power on board is less than expected. And as the output continues to increase, the load on the generator goes up, and when the load goes up a lot, power is supplied to the ship by discharging the battery.

In conclusion, the following problems were confirmed in the corresponding algorithm, and it is necessary to study the algorithm that improved the problem in future research.

1) There is a point where the rate of change in output of the fuel cell is large.
2) There is a point where the load-rate of the generator is low.
3) Power distribution is not done properly

## ACKNOWLEDGMENTS

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# A Study on the Power Control System Algorithm for HEPS Applying ML Methods

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## Abstract

Pollutants emitted by ships have a major impact on global warming and climate change. And the International Maritime Organization (IMO) amended the Convention on the Prevention of Pollution from Ships to limit greenhouse gas emissions through ship energy efficiency regulations. The Hybrid Electric Propulsion System (HEPS), which meets these requirements and minimizes fuel consumption, provides the optimal solution.

Electric powered ships play a major role in reducing fuel consumption as well as increasing energy efficiency. However, in order for the battery and generator to be used in conjunction with each other, an optimization algorithm is required. Also, in the case of electric propulsion ships, propulsion loads and pulse loads have a great effect on the onboard power system.

To solve this, a reliable power management strategy is needed that can manage the distribution of power between different power sources in real time and reduce fuel consumption. Therefore, in this paper, we propose an LCS (Load Control System) algorithm for systematic power supply of generators and batteries. It also calculates the generator and battery capacity according to the maximum required power to apply the optimized algorithm.

And when the LCS algorithm was applied by creating a load scenario according to the operation mode of the ship, the operating ratio in the optimal efficiency range was investigated. In addition, if the abnormal state of the system interlocked with the LCS is identified, the operating loss can be minimized. To this end, based on the flight data acquired through LCS, basic research necessary to implement an ML (Machine Learning)-based anomaly detection function is performed.

**Index Terms**: Electric Propulsion System, Hybrid power system, Energy saving algorithm, Machine learning, Anomaly detection

## I. INTRODUCTION

Exhaust gases from the combustion of diesel fuel in ships are a major cause of air pollution[1]. Currently, carbon dioxide emissions from the marine industry account for about 3.3% of global greenhouse gas emissions[2]. The International Maritime Organization (IMO) expects greenhouse gas emissions to increase by 250% by 2050 unless further mitigation measures are taken[3]. In order to reduce such greenhouse gas emissions,

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research on electric powered ships equipped with hybrid power sources is being actively conducted[4]. Hybrid Electric Propulsion System (HEPS) is a system that supplies power on board by using a generator and a battery as a power source. HEPS is being evaluated as an eco-friendly system through flexible installation of equipment mounted on ships and reduction of fuel consumption and greenhouse gas emissions[5]. A related study has been conducted to control a hybrid vessel equipped with a generator and a battery.

However, in order to increase the energy efficiency, the stability is lowered. Conversely, if stability is secured, efficiency cannot be obtained[6]. In order to control different types of power sources, a control strategy considering the characteristics of each power source is required, and in this paper, LCS is proposed. In this paper, we propose a Load Control System (LCS) algorithm to adjust the power to be output by each generation-source. The proposed strategy controls the generator-source so that the generator operates at high efficiency. Since it is operated in a section with a high load factor, it may not be able to respond to unexpected variables due to insufficient power. Taking this into consideration, anomaly detection is applied to ensure the stability of the LCS. Through the proposed ML-based anomaly detection, an error in the power system is detected and an alarm is generated, and the LCS transmits the operation command of the generator-source reflecting the abnormality detection result in some cases.

## II. Proposed methodology

### *A. Power control strategy*

HEPS is an electric propulsion system equipped with a different type of power source. When controlling in consideration of power generation-sources with different characteristics, the required load on board should be managed. However, in the case of electric propulsion systems, the scope of load distribution and management has been expanded as the propulsion load is included in the required load on board. Management in consideration of the extended load range requires a load control system (LCS) to which the concept of energy demand management is applied. In a hybrid power system, the generator provides a continuous output, and the battery can handle temporary demand.

The LCS is designed based on the SFOC curve of the generator. The SFOC curve shows that as the load factor of the generator increases, the fuel consumption decreases, and then the fuel consumption has the minimum fuel consumption at a specific load factor. And when the load factor is increased from the specific load factor, the fuel consumption is increased again. Based on the characteristics, the state of the generator can be classified into five types. Figure 1 shows the state of the SFOC-based power source.

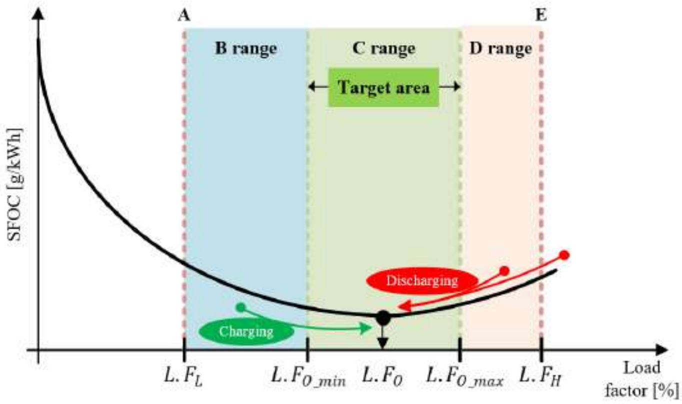



**Fig. 1.** Power source state based on SFOC curve

If the load factor of the generator currently in operation is less than point A, the generator must be stopped, and if it is higher than point E, additional operation is required. The range C between points A and E was designated as the target range of the LCS and the optimal efficiency range. Range C includes the load factor with the minimum fuel consumption of the generator and has an error of ±2%. When the battery is charged, the load factor of the generator increases, and it is possible to move from the B range to the C range. Alternatively, when the battery is discharged, the load factor of the generator is reduced, and it is possible to move from the D range to the C range. Therefore, the more the generator is operated in the C range through the operation of the battery, the advantages of fuel reduction and greenhouse gas emission reduction can be obtained. Figure 2 shows the algorithm of the proposed LCS strategy.

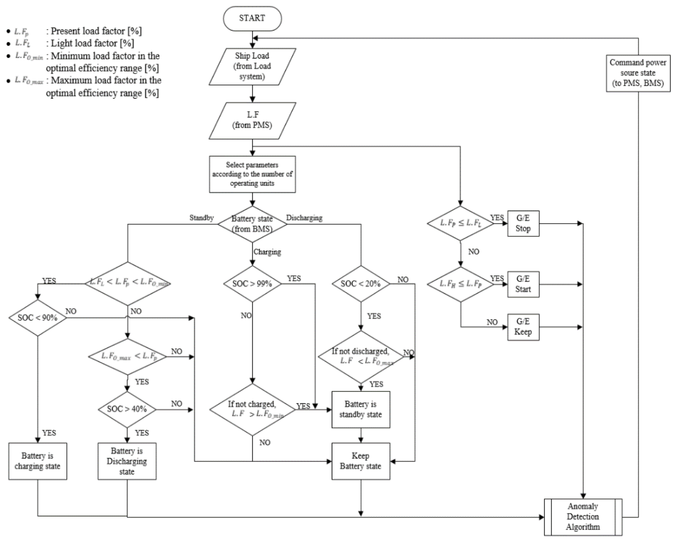


**Fig. 2.** Flowchart of LCS algorithm

### B. Anomaly detection

In the case of the proposed power control strategy, if only the efficiency is considered, the stability of the power device may be lowered. Since the LCS algorithm controls the generator to operate with a relatively high load factor, the remaining surplus power is low. Considering this, an anomaly detection function was added to secure the stability of the LCS. Anomaly detection is an analysis that finds anomalies that deviate from or are about to deviate from the general pattern in time series data. Traditional rule-based anomaly detection takes a long time to detect anomalies. In addition, it has limitations in that it is difficult to do it in real time and it is difficult to process a large amount of data at the same time. In order to improve this fact, the ship data collected in real time can be updated through machine learning to update the anomaly detection model, so that the function can be performed even in the changing environment of the ship.

In this paper, a machine learning (ML) technology that can learn patterns from data generated from the power control system and detect anomalies in data different from the distribution is applied. Unsupervised learning method is also applied in this paper because it is suitable for application to environments where data that is difficult to label, such as ships, is generated. Among the unsupervised learning methods, the LSTM autoencoder model was constructed. Figure 3 shows the procedure for implementing the anomaly detection function by applying the machine learning method.

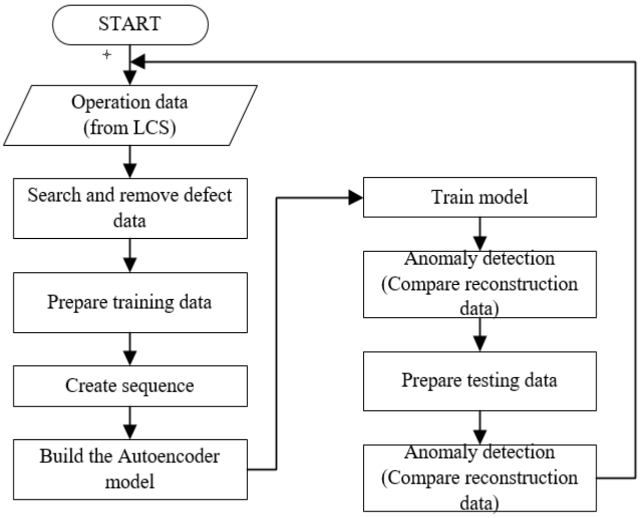



**Fig. 3.** Procedure for performing anomaly detection using machine learning method

#### 1) data collection

The operation data receives the load required by the ship, the number of generators and the load factor, the status and SOC of the battery, and the power in charge. In addition, equipment abnormalities or erroneously measured missing data are removed from the operation data, but in this study, they were not considered because they consisted of experimental data. Prepare the prepared driving data as training data, and since it is time series data, a sequence is generated. Table 1 shows the operation data output through the application of the LCS algorithm.

**Table 1.** Collected data list from LCS

| Parameter | Unit |
|---|---|
| Ship load | kW |
| Number of running D/G | Set |
| Load factor of D/G | % |
| Battery power | kWh |
| State of charge | % |
| Battery state | - |

### *2) Build a learning model*

Autoencoder consists of encoder and decoder. The encoder layer accepts high-dimensional input data and transforms it into latent low-dimensional data. The input size to the encoder layer is larger than the output size. The decoder layer receives input from the output of the encoder. The purpose of the decoder is to reconstruct the input data, and the output size is larger than the input size. In the case of autoencoder, there is no need to set latent variables that are not directly observed or measured by the concept of composition of the input data. It is possible to learn the characteristics of the normal region, which is the main component of the data, without setting the latent variable.

That is, the characteristics of the training data are extracted through a process of minimizing the difference between the original data and the reconstructed data. Then, the anomaly detection is performed by comparing the difference between the reconstructed data and the input original data through the model in which the extracted features are learned. In this case, the reconstructed data and the original data are set as coordinates in an n-dimensional space, and the distance between the two coordinates is called reconstruction error. Since the autoencoder is trained to reconstruct normal data well, when anomaly data is input, it cannot effectively perform compression and reconstruction, and has a large reconstruction error. The reconstruction error is an anomaly score indicating the degree of abnormality of the anomaly data. If the anomaly score is greater than a set threshold, the data is considered anomaly, and if it is small, it is considered normal. Figure 4 shows the structure of the LSTM autoencoder.

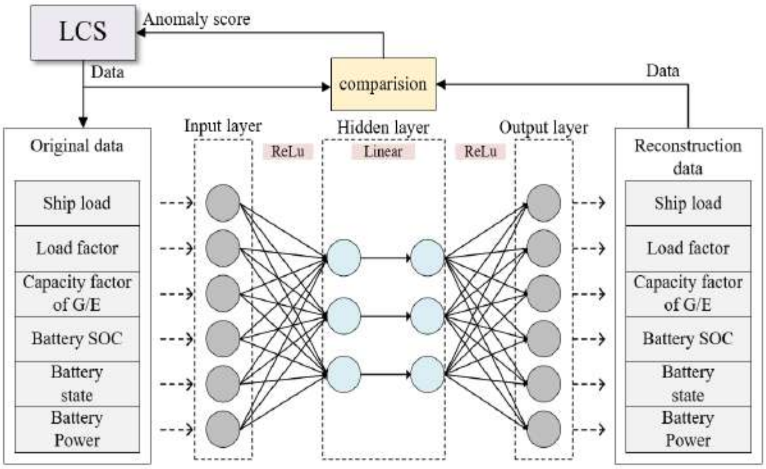



**Fig. 4.** LSTM autoencoder architecture

### *3) Validation learning model*

After the autoencoder model is built and trained, the accuracy of the model is checked using a loss function that can determine the difference between the predicted value and the actual value of the model generated through training. The loss functions used in this study are Mean Squared Error and Mean Absolute Error.

MSE is the average of the squares of the loss, and MAE is the average of the absolute values of the loss. MSE loss is used in the learning process because it is easy to converge to the optimal value because the moving distance changes differently when the MSE approaches the optimal value. Since MAE can easily determine the accuracy of the learned data, MAE loss was used during the inference process. Figure 5 shows the MAE loss value during the inference process to verify that the learning model is well constructed.

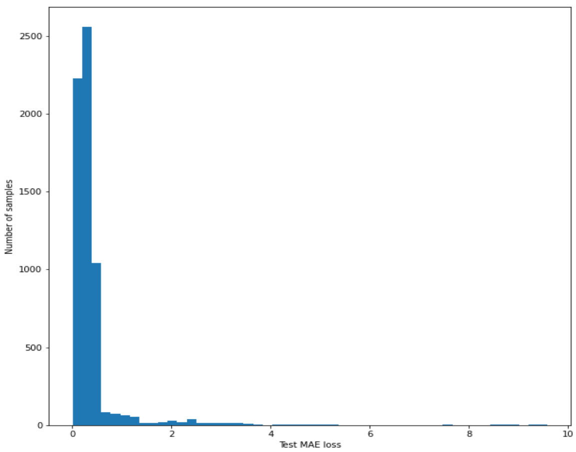



**Fig. 5.** MAE value of the training model

## III. RESULTS

To perform anomaly detection, a load profile of 1 voyage was prepared as shown in Figure 6. As the speed of a voyage changes, the power of the propulsion load also changes. Moreover, the value of the required service load varies according to the operating mode of the vessel.

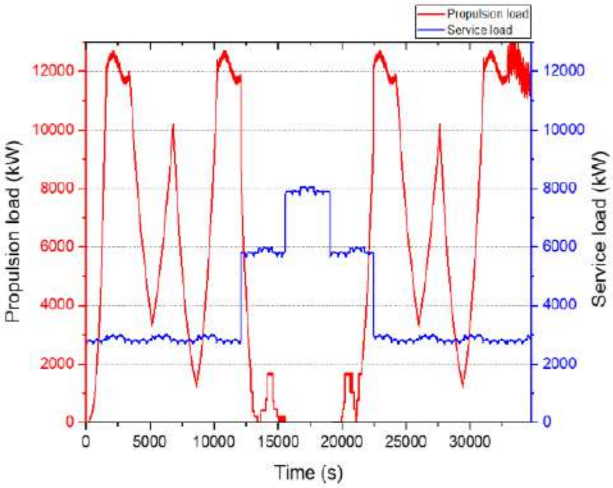



**Fig. 6.** Load profile of 1 voyage

Considering the generator and battery capacity differently, the ratio of the generator operating in the optimal efficiency range was different. Table 2 shows the rate at which the generator operates in the optimal efficiency range by generator and battery capacity.

**Table 2.** Operating ratio in the optimal efficiency range by power source capacity

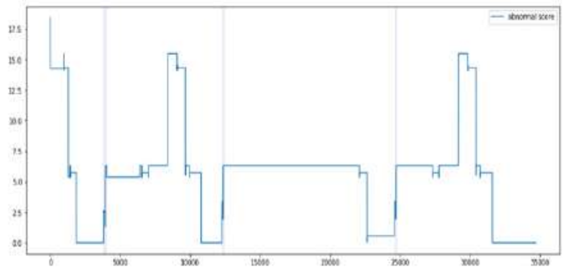
| Generator | Battery [kWh] | Operating ratio |
|---|---|---|
| 7.56MW *2, 11.34MW*2 | 0 | 8.28 % |
| 7MW*2 10.5MW*2 | 2.8MWh | 29.49% |
| 6.5MW*2, 9.8MW*2 | 5.2MWh | 91.04% |

Anomaly detection was performed for each battery capacity in the table. When the battery has no power, learning is not performed due to lack of learning data, so only two cases were tested. Figure 7-(a) shows the results of abnormality detection when the battery capacity is 2.8MW and the generator is operated 29.48% in the optimal efficiency range.

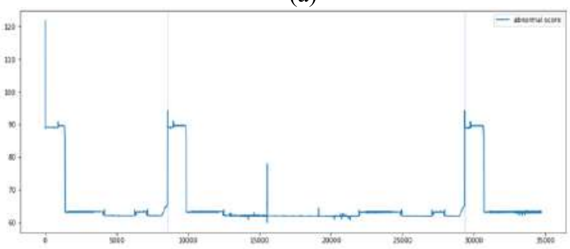
Figure 7- (b) shows the results of abnormality detection when the battery capacity is 5.2MW and the generator is operated 91.04% in the optimal efficiency range. In the figure, the gray line is the part where there is an anomaly point.

Anomaly detection was performed well when the abnormal score of the corresponding part was high, and the score was low in other sections.

However, in (a), the performance was not performed well because it had high scores other than the abnormal points. Conversely, in (b), anomaly detection was performed well by having a high anomaly score only at a relatively anomaly point and a low score in other sections. Based on the above results, it was confirmed that the higher the operating ratio in the optimal efficiency range, the better the anomaly detection learning model was trained, and it was also confirmed that the anomaly detection function was performed well.



(a)



(b)

**Fig. 7.** Anomaly detection result

## IV. DISCUSSION AND CONCLUSIONS

The recent increase in popularity of hybrid electric propulsion systems for marine applications is due to its advantages of quite operation, low emissions and high efficiency. The dynamic behavior of these systems is highly dependent on the strategy used to divide the required power between the different components of the hybrid system. Therefore, the development of a power control strategy that contains different strategies and chooses the suitable LCS during the voyage based on a specific criterion is necessary. In this paper, a power control strategy with anomaly detection applied to HEPS has been presented. Then, the anomaly detection was applied according to the ratio operating in the optimal efficiency range, which is the purpose of the proposed strategy. Simulation results show that the higher the operating ratio in the optimal operating range, the better the anomaly detection function works.

## ACKNOWLEDGMENTS

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# An Experimental Analysis of Factors for Effective Subset Selection During Training Neural Networks

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## Abstract

The quality of training data is one of the most critical factors under constructing artificial intelligence systems using convolutional neural networks (CNNs). It is well known that larger data leads better performance on the convolutional neural networks. However, training a CNN with massive data requires tremendous training time under the restricted computing power condition. In some researches, pruning overlapped data can help to reduce the training time while keeping similar accuracy.

In this paper, we conduct an experimental analysis of the subset selection scheme according to various datasets, models, and data augmentation. The influential subset selection conditions for the deep learning model and its performance are described. Therefore, we believe that the reported experiments and information can be helpful for training deep learning models efficiently.

**Index Terms:** Subset selection, Subset, efficient training, CNNs, etc.

## I. INTRODUCTION

Convolutional neural networks (CNNs) became the major methodology for image processing in recent years. While the performance through CNN has progressed, it requires a larger dataset to achieve better performance. However, training on those large datasets is almost impossible under limited computing power. Training with a large dataset requires enormous training time and computing powers, which is a bottleneck to developing artificial intelligence algorithms. To solve this problem, some researchers proposed a method called subset selection that uses a part of a dataset rather than entire data [1, 2, 3]. These methods try to reduce training data to save training times while preserving their performances. The performance of the subset selection schemes depends on the used network, dataset, data augmentation, etc.

In this paper, we conduct a variety of combinational experiments for the subset selection based on the latest method, GradMatch [1], to provide insights in choosing the conditions for that.

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## II. INFLUENTIAL FACTORS FOR SUBSET SELECTION METHODS

The performance of the subset selection method depends on several conditions. Influential factors considered in our experiment are described in this section.

### A. Data augmentation

Data augmentation is a scheme that makes a neural network learn more diverse representations from a dataset by transforming training data. It is known that it has an ability that can prevent overfitting problems and also can contribute to achieving better performance. The recently proposed RandAug [4], which chooses what augmentation to use for every iteration randomly, is used in our experiment as an additional augmentation method.

### B. Model architecture

For our analysis, two neural network architectures, ResNet [5] and EfficientNet [6], are selected. ResNet [5], based on residual connection, is widely used as a backbone network for segmentation, detection, etc. EfficientNet [6] is a recently proposed architecture based on a neural architecture search, which is an automated method of searching optimal network architecture. It is recently used as a backbone network and shows high performance in smaller model sizes compared to the previous networks.

### C. Subset selection

GradMatch [1] extracts a subset, $S$, from a universal set, $U$, based on measuring the similarity between their gradients. To be specific, a method that evaluates the gradient of mini-batches, per-batch scheme, is used in the analysis. Also, a warm-up scheme that utilizes the full dataset in early training and then applies the per-patch method in the last training is used in the experiment.

### D. Dataset

For our analysis, we used three datasets; CIFAR-10, CIFAR-100 [7], and STL-10 [8]. CIFAR-10 and CIFAR-100 that consist of 60,000 images with 32 by 32 pixels has the 10 and 100 classes, respectively. The dataset is split into a train set with 50,000 images and a test set with 10,000 images. STL-10 consists of 5,000 train images, 8,000 test images, and 100,000 unlabeled images with 96 by 96 resolution. For the analysis, we used labeled images only.

## III. EXPERIMENTAL ANALYSIS OF SUBSET SELECTION

### A. Result performance

Figure 1 and table 1 shows classification accuracy according to the subset size, network architecture, dataset, and augmentation scheme. For CIFAR-10 and CIFAR-100, *augA* indicates the augmentation by the random crop and random horizontal flip, besides color jittering is added for STL-10. Also, *augB* denotes that RandAug is used in addition to *augA*, with the parameters of $n$=1 and $k$=2, where $n$ is a number of selected augmentation and $k$ is its strength.

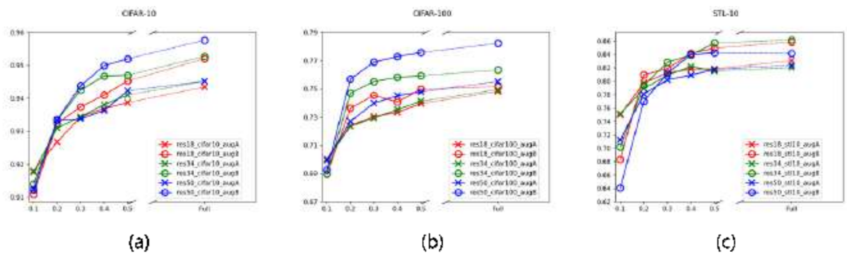


**Fig. 1.** Classification accuracy vs. subset size. Different model sizes are distinguished by color. (a) CIFAR-10, (b) CIFAR-100, (c) STL-10

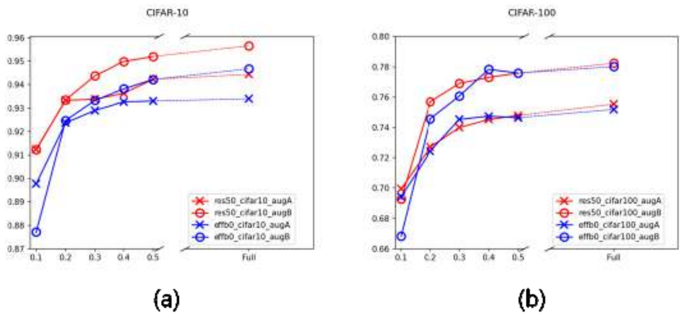


**Fig. 2.** Performance comparison according to network architectures: (a)CIFAR-10, (b)CIFAR-100

Figure 2 and table 2 show the performance according to network architectures; ResNet and EfficientNet. EfficientNet-b0 is used for the experiment and its input images are resized to 224 by 224 pixels.

Networks are trained for 300 epochs with learning rate 0.01 and batch size 100, except ResNet-50 network on STL-10, which is trained with learning rate 0.005 and batch size 50 due to the memory size of a computing system.

**Table 1.** Classification accuracy with subset size, dataset, and augmentation in subset selection. Results of ResNet-34 are shown only

| Dataset | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | Full |
|---|---|---|---|---|---|---|
| CIFAR10-augA | 0.9177 | 0.9310 | 0.9344 | 0.9381 | 0.9410 | 0.9444 |
| CIFAR10-augB | 0.9141 | 0.9333 | 0.9425 | 0.9468 | 0.9470 | 0.9518 |
| CIFAR100-augA | 0.6999 | 0.7235 | 0.7293 | 0.7353 | 0.7413 | 0.7495 |
| CIFAR100-augB | 0.6987 | 0.7470 | 0.7552 | 0.7582 | 0.7593 | 0.7634 |
| STL10-augA | 0.7515 | 0.7889 | 0.8090 | 0.8220 | 0.8153 | 0.8204 |
| STL10-augB | 0.7019 | 0.7938 | 0.8283 | 0.8394 | 0.8569 | 0.8618 |

**Table 2.** Classification accuracy with networks and data in subset selection

| Network | Dataset | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | Full |
|---|---|---|---|---|---|---|---|
| ResNet-50 | CIFAR10-augB | 0.9122 | 0.9335 | 0.9438 | 0.9499 | 0.9520 | 0.9566 |
| | CIFAR100-augB | 0.6927 | 0.7569 | 0.7690 | 0.7730 | 0.7758 | 0.7823 |
| EfficientNet-b0 | CIFAR10-augB | 0.8771 | 0.9247 | 0.9333 | 0.9382 | 0.9422 | 0.9468 |
| | CIFAR100-augB | 0.6683 | 0.7456 | 0.7607 | 0.7783 | 0.7758 | 0.7801 |

## *B. Analysis*

### *1) Impact analysis of data augmentation*

The augmentation scheme *augB* generates more diverse data representation than *augA*. As shown in Fig. 1 and Table 1, classification performance with *augB* is lower than performances of *augA* when the subset size is smaller than 0.2. On the other hand, the accuracy with *augB* has higher performance than that of *augA* when the subset size is greater than *0.2*. It means that the lower performance of the stronger augmentation is because of using insufficient data, and indicates that the strong augmentation has a positive effect on the subset selection but the strength of the augmentation should be controlled by the subset size.

### *2) Effect of model and dataset*

As shown in Fig. 1 (a), the *1%* performance decrease of resent18, resnet34, and resnet50 happens at subset size is *0.5, 0.4, and 0.3*, respectively. It indicates that when the same dataset and augmentations are used, the performance degradation is related to the used networks. When different datasets, CIFAR-10 and CIFAR-100, are applied into the same ResNet-50 network, the *1%* performance decrease occurs at a subset size of *0.4* identically in two datasets as shown in Fig. 2. In other words, the performance degradation of a network by the subset selection does not strongly depends on the type of a dataset.

# IV. CONCLUSIONS

In this paper, we demonstrated an experimental analysis of influential subset selection conditions for the deep learning model. From our analysis, we know that the strength of the augmentation should be controlled according to the subset size and the dataset has a lower effect on the performance degradation of the subset selection. Therefore, we believe that the reported experiments and information can be helpful for an efficient training of deep learning models.

# ACKNOWLEDGMENT

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# Reducing Speaker Error Rate in Multi-speaker Speech Synthesis with GST

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## Abstract

The speech embedding technique is generally used for multi-speaker speech synthesis algorithms based on deep learning architecture. Initially, the speaker index has been embedded to represent speaker characteristics but, recently global style token (GST), which is proposed for speech style transfer, has been used for speaker embedding. However, it often generates different speaker's speeches from the target speaker's one.

This paper proposes a robust speech synthesis algorithm with GST for multi-speaker. For this, a different reference speech is used for GST, unlike a conventional GST method which uses the same reference speech as target speech. To evaluate the performance of the proposed method, speaker accuracy measurements were conducted. It is shown that the proposed method improved the speaker accuracy of synthesized speeches.

**Index Terms**: TTS, GST, training, multi-speaker, etc.

## I. INTRODUCTION

In the past few years, speech synthesis algorithms based on deep learning have developed at a rapid pace [1-3]. Speech synthesis algorithms are used in many fields such as audiobooks, AI speakers, and AI announcers in our society [4-6].

The database used in TTS in the early stage consisted of single speaker speech [1]. However, after Deep voice 2 had been proposed, multi-speaker databases have been considered to train the speech synthesis algorithm in many researches [7, 8].

The speech embedding technique is generally used for multi-speaker speech synthesis algorithms based on deep learning architecture. In Deep voice 2 [7], the speaker index was used as an input signal. Recently, the reference speech signal has been used as an input signal for speaker information [9]. The reference encoder in global style token (GST) methods which were originally proposed for speech style delivery has been used as a speaker encoder [10]. However, these provide wrong speaker speech even though target speaker speech is put into speaker encoder in some cases. The reason for the problem is that an expected output speech from TTS is used as a reference signal for GST in the training phase. In the inference phase, it's practically impossible because the expected output speech cannot be used before synthesis.

In this paper, to solve this problem, the reference encoder was designed differently from the speech used to learn the speaker's information. Therefore, when the speech entering the

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reference encoder is randomly set and referenced, stronger speech synthesis can be performed regardless of whether the reference encoder contains speech of different lengths of the same speaker. As a result of processing by the above method, it reduces the speaker's error rate than the GST method.

## II. GST based Multi-speaker Speech Synthesis

In this paper, Tacotron2 and GST have been used for the baseline TTS model and speaker encoder, respectively. The baseline model, speaker encoder, and the proposed method are described below.

### *A. Baseline Speech Synthesis*

The Tacotron was proposed by Wang *et al*. [1] as an end-to-end TTS model. The Tacotron model can be broadly divided into three modules: encoder, attention, and decoder. The encoder receives input text sequentially and converts it into a hidden vector with a fixed length. After that, the attention mechanism extracts information from a fixed-length hidden vector generated by the encoder and delivers it to the decoder. And then, the decoder generates mel-spectrogram of the current frame through long short-term memory (LSTM), linear projection, and post-net along with the information generated in the past. Finally, the mel-spectrogram is converted into speech that we can hear using a vocoder such as the Griffin-Lim method [11] or Hifi-gan [12].

### *B. Speaker Encoder*

#### *1) GST-based Multi-speaker Speech Synthesis (MS-GST)*

GST is a method in which style token architecture is added to the Tacotron2 model [2]. Style token architecture can be divided into two modules: reference encoder and style token layer. The reference encoder consists of a convolutional stack and a gated recurrent unit (GRU). Mel-spectrogram transformed from reference speech signal is converted into reference embeddings which is used as an input signal for style token layer. And then, the style token layer gives GST by weighting and combining reference embeddings for each token through attention. It is then converted to style embedding and added to embedding from the text encoder. In [10], the reference encoder and the style token layer in the GST can be used as a speaker encoder for multi-speaker speech synthesis tasks.

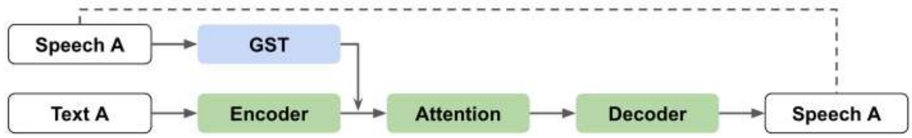


**Fig. 1.** The process of MS-GST training

### *2) GST-based Multi-speaker TTS using Different Reference (MS-GST-Diff-Ref)*

The GST-based multi-speaker speech synthesis has a discrepancy between the training phase and the inference phase. This is because the speech used in the reference encoder in the GST method is the same as the speech used in the decoder at the training phase, but this is not able to reproduce at the inference phase. To compensate for this, in this paper, the speech sample that enters the reference encoder was designed differently. As shown in Fig. 2, the reference speech signal entered as speaker information, Speech B, is used as a different speech signal to be output speech, Speech A. Speech B is randomly selected from among the speech signals of the same speaker in the training. After that, it proceeds the same way as the GST did.


**Fig. 2.** The process of MS-GST-Diff-Ref training

## III. Performance Evaluation

For the experiment, two different DB is conducted to evaluate the performance: the ETRI TTS DB [13] and the public DB which is selected from the KAIST Audio Book DB [14]. The ETRI TTS DB consists of two men and two women, and it has totally 36 hours long. Among the various topics of KAIST Audio Book DB, we selected subset which were composed of news and self-development topics for a total of 18 hours, with 2 males and 2 females each. Validation-set, evaluation-set, and training-set were split into 250 samples, 250 samples, and the rest of the DB, respectively. Speaker accuracy was measured by human listening.

Table 1 shows that the number of speaker error of different experiment results in ETRI TTS DB. In the case that MS-GST and MS-GST-Diff-Ref were used as a training method and an inference method, respectively, 41 out of 250 samples had the wrong speaker which is the worst accuracy in the evaluation. We believe the reason is why it was not trained using different reference signal. In the proposed algorithm, which MS-GST-Diff-Ref was used as both of a training and inference phase, only 4 out of 250 samples had the wrong speaker. It was also confirmed that speaker errors were reduced by using the proposed method in the KAIST Audio Book DB.

**Table 1.** Evaluation-set results in ETRI TTS DB and KAIST Audio Book DB

| Training Method | Inference Method | # of Speaker Error (ETRI TTS DB) | # of Speech Error (KAIST Audio Book DB) |
|---|---|---|---|
| MS-GST | MS-GST | 26 / 250 | 12 / 250 |
| MS-GST | MS-GST-Diff-Ref | 41 / 250 | 15 / 250 |
| MS-GST-Diff-Ref | MS-GST-Diff-Ref | 4 / 250 | 9 / 250 |

## IV. CONCLUSIONS AND FUTURE WORKS

This paper proposed GST-based multi-speaker speech synthesis algorithm with difference reference signal. From our analysis, we found that a speaker error may occur if the GST method is used as a speaker encoder with no change in training phase. To overcome this, the difference speech sample with same speaker was used as a reference speech signal which was same as in the inference phase. Using the proposed method in this paper, it was confirmed that the number of speaker errors was reduced. In future works, we plan to study how to further reduce the error rate and improve the sound quality.

## ACKNOWLEDGMENTS

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# False Identification of Personal Computer by Altered EFI-SMBIOS

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## Abstract

Identification of a person is a serious issue in these days since the e-commerce, fintech, and contactless payment through digital communications are in common. A personal computer is one of the identification targets since the machine is tightly coupled to the person who are using it for the identification processing. A personal computer has its own information that includes model name, serial numbers, production date, and manufacturer name, and sometimes this information includes some part of the identification of a person. In this paper, we show a method of altered EFI-SMBIOS that makes a false identification of personal computer, and exhibit an execution of restricted application which was not allowed to a personal computer in general.

**Index Terms**: False identification, Personal computer, SMBIOS

## I. INTRODUCTION

Personal identification is the key of contactless communication between a people to others. Thus, various technical components are used for the identification, i.e. ID and password pair, cookie of web browsers, USB token for digital signature, and MAC addresses for data communications [1]. Some of unique seed numbers are generated by on-line random number generation and build-up to credentials by cascaded handshaking protocols, other seed numbers are originated from inherent strings and numbers. Examples of the inherent strings and serial numbers are media access control (MAC) address of the Wi-Fi Ethernet, production serial number of a unit, model name stings, and etc. [2]. These inherent string and numbers are written at the flash and NVRAM devices that handled by manufacturer's specialized writing process. Since the inherent string and numbers are seeds of the credentials of a personal computer and a user, this string and values are serious data that can be misused for false identification. Fig. 1 shows an example of identification data from Intel NUC unit.

As system management basic input output system (SMBIOS) contains inherent information of the unit, this permanent data are used as some seed of credentials and privilege of some specific applications. Fig. 2 is one of the restricted application that

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constrained by matching of SMBIOS string, thus Bixby application by Samsung electronics can be applicable only for Samsung unit [3]. Fig. 2 (a) shows a screen capture that has a privilege, while Fig. 2 (b) shows a rejection of application that does not have a privilege.

## II. ALTERED EFI-SMBIOS

In Fig. 2, the sensitive application, Samsung Bixby, checks the privilege of the machine that manufactured by Samsung electronics. The application is user sensitive application, which provides a guided result upon user's requests. This is a sort of Siri alternative applications which introduced by Apple Computer. The example application, Samsung Bixby, checks the SMBIOS string of the computer upon an execution, and the application allow or denial of execution by the matching of the SMBIOS strings as shown in Fig. 2.

Since x86 processors were applied to the desktop computer by Apple Computer, several high-level developers tried to emulate the low-level system interface layer for act as the desktop computers by Apple Computer. Clover and OpenCore bootloaders are successful projects that can emulate a generic x86 computer to a Macintosh computer by Apple Computer [4]. OpenCore bootloader has lots of detailed low-level system parameters that conceal the native SMBIOS parameters. Furthermore, its features make possible to emulate to other machines, the emulation to Macintosh computer is one of the possible SMBIOS alteration of OpenCore [5].

We focus the SMBIOS alteration of OpenCore to make the pass-through of restricted application such as Bixby by Samsung electronics. This shows the possibility of false identification of personal computer, and consequence, it means the risk of false identification of a user. Clover and OpenCore bootloaders are unified extensible firmware interface (UEFI) programs that positioned between operating system and system firmware [6]. The system firmware holds SMBIOS data of the system, and the wrapper, such as Clover and OpenCore, take over the role of the system firmware with altered SMBIOS. Fig. 3 is part of the altered SMBIOS data that breaks the restriction of Bixby.

## III. CONCLUSIONS

Personal identification is the core of the contactless communications, contracts, agreements, and payments processed online. Therefore, the identification must be confirmed by the various information surrounding the person. One of the main devices of digital communication is a personal computer of the user. The SMBIOS data of the personal computer is the serious information that compares the continuity of the same user. In this paper, we show the alteration of SMBIOS data by using OpenCore bootloader, and that can break the restriction of Bixby application. Consequently, it exhibits the risk of SMBIOS-based identification.

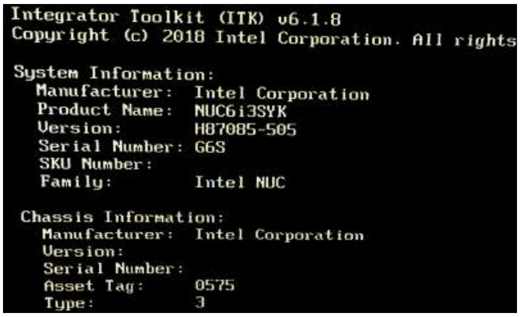
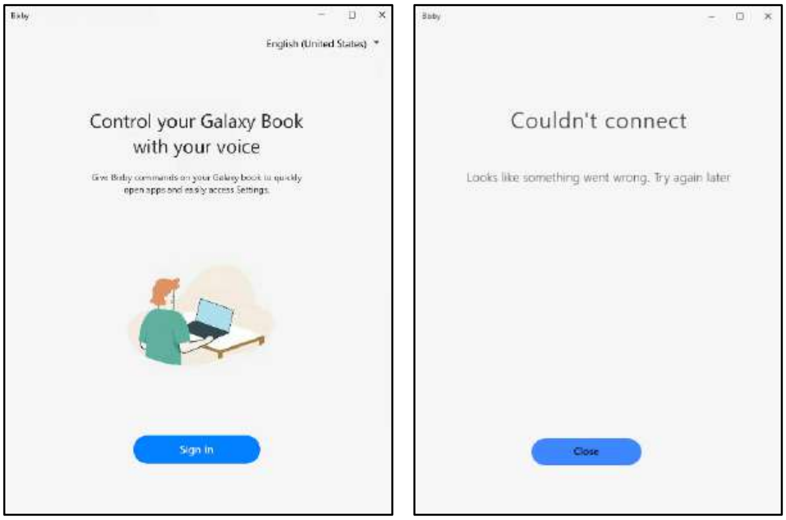



**Fig. 1.** SMBIOS information of Intel NUC unit




(a) Bixby allowed (b) Bixby blocked

**Fig. 2.** Samsung Bixby as a sample of the restricted application

**Fig. 3.** Part of the altered SMBIOS

## ACKNOWLEDGMENTS

This research was supported by the National Research Foundation of Korea (2016R1D1A1B01006716). It was supported by Korea Ministry of SME and Startups Fund(S3119103)

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# A Deep Learning Method for Human Activity Classification using Wearable Sensors

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## Abstract

Due to the widespread of smartphones and the growing interest in health and wellness, the use of smartphones for recognizing human behaviors using built-in smartphone sensors has been extensively applied to many different areas of health and disease. In this study, we will find out how to recognize human behavior using a smartphone accelerometer by applying deep learning techniques. The Signal Vector Magnitude obtained from the built-in acceleration sensor in a smartphone was used for human behavior recognition using deep learning.

**Index Terms**: Human activity classification, Accelerometers, Smartphone, Deep learning

## I. INTRODUCTION

Human behavior recognition is an important and challenging research issues in various fields including intelligent monitoring of patient's health, security, and human-computer interaction. In particular, human behavior recognition is used in the healthcare domain to predict or prevent patient's disease, or to monitor the progress of a particular disease [1,2]. With the recent rapid aging of the older population, human behavior recognition technology is used to detect emergency situations of an old adult living alone. Human behavior recognition technology is positioned as a core technology in the era of the 4th industrial revolution by integrating the smart home service and telemonitoring system [3].

Human behavior recognition is divided into two categories. One category includes the approaches based on image analysis methods while the other category utilizes wearable sensors. The method using wearable sensors typically recognizes human behavior by analyzing the variations of acceleration of continuous and discontinuous movements of the subject [3, 4]. With the widespread use of smartphones, research on how to utilize the accelerometer sensor built into the smartphone for human behavior recognition has been conducted. This study presents a human behavior recognition technique using the smartphone's acceleration sensor and deep learning technique [4, 5].

* Corresponding author

## II. HUMAN ACTIVITY RECOGNITION USING DEEP LEARNING

The accelerometer built into a smartphone has x, y, and z axes, so it is also referred to as a three-axis accelerometer. When placed on the floor, the left and right are the x-axis, the top is the y-axis, and the upward direction is the z-axis. Since all objects on Earth are subject to gravitational acceleration, 9.8 $m/s^2$ of gravitational acceleration is output in the z-axis direction even when placed on the floor even in a stationary state. In this study, the Signal Vector Magnitude (SVM) ($M = \sqrt{x^2 + y^2 + z^2}$) is used for the detection of human activities.

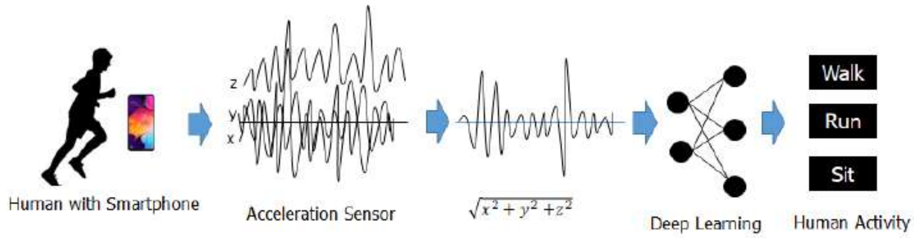


**Fig. 1.** Deep learning based human activity classification with smartphone accelerometer

The proposed method for detecting human activities is based on the SVM of three-axis accelerations. We apply a deep learning method to classify more complex behaviors that are difficult to identify based on the SVM only.

## III. DISCUSSION AND CONCLUSIONS

With the spread of smartphones, a method for recognizing human behavior using the accelerometer built into the smartphone is studied. In this talk, the SVM obtained from the built-in acceleration sensor in a smartphone was used for human behavior recognition using deep learning.

## ACKNOWLEDGMENTS

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2018R1D1A1B07048675).

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# Introduction of Freshness Ratio of Information

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## Abstract

The age of information (AoI) refers to the amount of time that has elapsed since the generation of the most recently successfully received message. In this paper, we explain the disadvantages of conventional metrics, average AoI and peak AoI, and introduce an improved metric, freshness ratio of information (FRoI).

**Index Terms**: Age of Information, Freshness Ratio of Information, Peak AoI

## I. INTRODUCTION

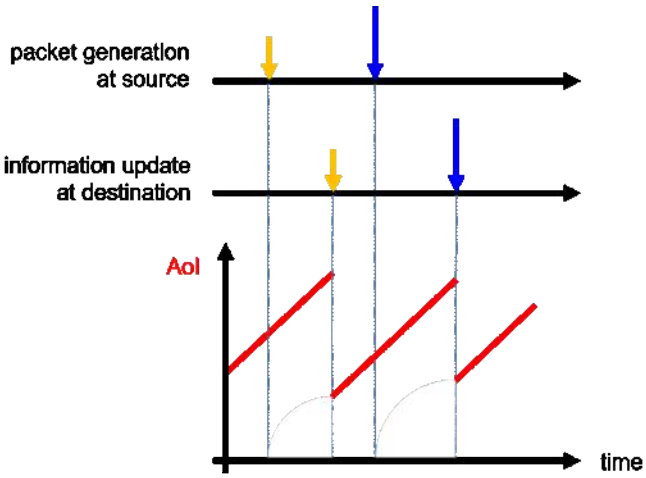


**Fig. 1.** The overall shape of the AoI change

Age of Information (AoI) measures how fresh information is. The overall shape of the AoI change is shown in Fig. 1. At the time of updating the packet information, AoI corresponds to the time taken from the time when the packet is generated until the information is updated. In the time interval between updates, AoI takes the form of increasing over time.

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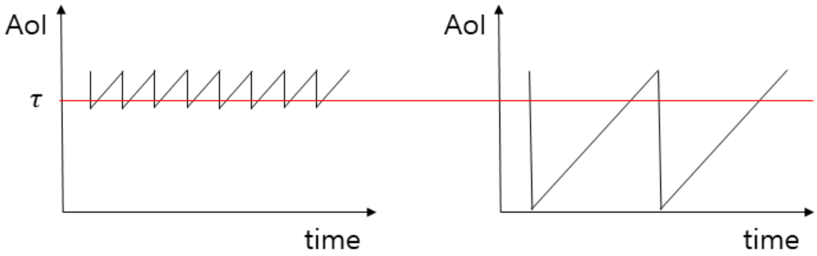


**Fig. 2.** Same peak values but different AoI types

The metrics related to AoI include average AoI and peak AoI. Average AoI means the time average of AoI and peak AoI means the peak value of AoI. That is, the AoI immediately before the information is updated corresponds to the peak AoI. Consider a case where the freshness of information needs to be kept below a threshold τ. A smaller average AoI is more likely to remain below the threshold, but cannot be judged by the average AoI value alone. Peak AoI is sometimes inefficient because it only considers the peak values and not the time interval between peaks. In Fig. 2, the left shows the AoI above the threshold for most of the time period and the right shows the AoI stays below the threshold for the most of the time period. The problem is that in both cases the peak AoI values are the same.

## II. FRESHNESS RATIO OF INFORMATION

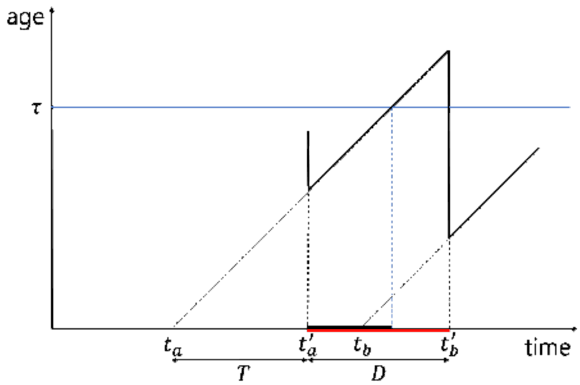


**Fig. 3.** Example of age evolution

The FRoI is defined to be the fraction of time the age does not exceed a predefined freshness threshold τ. To characterize the FRoI, we observe the AoI in the sawtooth curve (Fig. 3). Let T be the system time of a randomly chosen tagged update packet which is successfully transmitted to the destination. Let D be the inter-update time, defined as the time elapsed between the tagged update and the next successful update at the destination. Then, the FRoI can be expressed as follows:

$$\mathrm{FRoI} = \frac{\mathrm{E}(\max(\min(\tau - T, D), 0))}{\mathrm{E}(D)}$$

We are interested in high FRoI in order to maintain fresh information. The FRoI can be utilized in time-critical applications where we need to apply a threshold restriction on AoI.

## ACKNOWLEDGMENTS

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# Fake News Detection Using Deep Learning Techniques

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## Abstract

News on social media is a great source of information these days. But with the increase of technology usage, some people are spreading fake news on social media to enhance the audience. Twitter is one of the most famous platforms used for the sharing of these types of fake news worldwide. In this paper, we have proposed a deep learning model to classify real and fake news shared on Twitter. our experimental results demonstrated that Long Short-Term Memory (LSTM) model got maximum accuracy.

**Index Terms**: Fake news, Twitter, social media, deep learning, LSTM.

## I. INTRODUCTION

In the last few years, the number of users of digital media has been increased rapidly because of fast-speed internet and less expensive modern technology. According to a report of 2020, there are around 4.75 billion users of digital media and 300 million users of social media in the world [1]. Due to this fast-growing usage of technology, the whole world has been converted into a global village. People are one click away from any information in the world. Despite several advantages, social media and technology have come up with some drawbacks also. The problem of fake news is one of the biggest issues for the people who are taking advantage of this technology.

Fake news shared on social medial like Facebook, Twitter, Instagram, and Snapchat are the biggest threat that misguides and mislead the online community. People can know about current affairs and keep updated about the world on social media, but they can be a victim of wrong information and fake news equally [2].

Fake news on social media has become a hot topic after the US presidential election of 2016. Without any assistance humans can predict about the authenticity of news is only up to 54% [3]. Therefore, there should be a proper system that can classify fake and authentic news automatically. Different researcher has worked in this field but still, a lot of work need to do in the future. In this paper, we have presented a model to classify fake and authentic news automatically.

The rest of the paper is organized as follows. In section 2 literature reviews are discussed, section 3 explains the methodology of the proposed work, section 4 explains data set and data set preprocessing, section 5 contains experimental setup, and lastly section 6 gives conclusion and future work.

* Corresponding author

## II. METHODOLOGY

This part will discuss the description of the dataset and its preprocessing. Moreover, deep learning Model LSTM will also discuss in it. **Fig.** is summarizing the overall methodology.

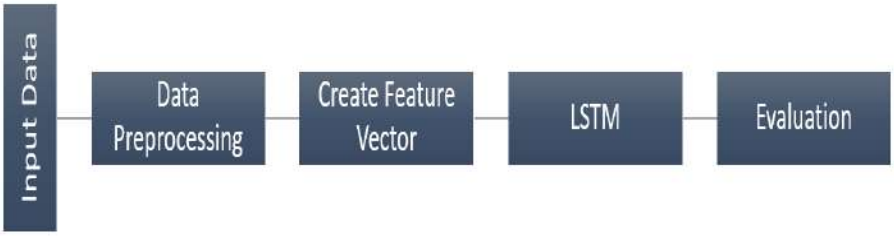


**Fig. 2.** Methodology

### *A. Dataset Description*

Dataset used in our research contains 20800 news in the training set and 4550 news in the testing file. Training files contain five columns including id, title, author, text, and label of the news and each news is labeled with 0 and 1.

### *B. Dataset Preprocessing*

Different preprocessing techniques were applied to the data set which we discuss in the next part.

1) ***Tokenization:*** In the next step, text in each review was converted into a sentence and then sentence into words. This process is called tokenization.
2) ***Stop Word removal:*** There were many stop words in our text reviews like your, I, it, another, but this, etc. we removed these types of all stop words because these type words don't have any meanings in the text.
3) ***Stemming:*** In this method, we reformed the inflected words and removed derivational affixed from each word.

### *C.Tfidf Vectorizer*

After tokenization and stemming text reviews are then vectorized into n-gram integers vectors using TF-IDF Vectorizer. TF-IDF is a technique that is widely used in the field of machine learning and text mining. This technique helps to evaluate the association of every word in the document [4].

TF helps to find particular words present in documents or reviews. On the other have IDF will assign a higher weight to more unique, important, and less accruing words as compared to less accruing and less important words [5].

$$TF\_IDF = TF \times IDF \qquad (1)$$

### *D. LSTM Training*

After representation of each word as a vector by using Tfidf Vectorizer, the sequence of words are fed into the LSTM model as shown in Fig 2.

After the conversion of each term *Ti* into corresponding vector xi using the *Tfidf* model fed into LSTM one by one. Every time j, output W produced from hidden layer $H_j$ will be sent back to the hidden layer together with the next coming input x $_{j+1}$ at the next point.

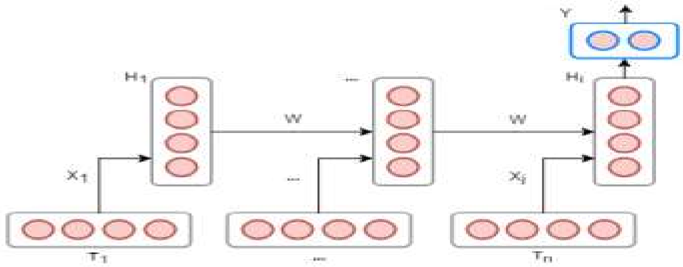


**Fig. 3.** LSTM Model

### *E. Results and Evaluation*

We trained our LSTM model on a fake news dataset. After training, we evaluated our model on the testing dataset. Four different types of classification performance measures were selected such as precision, recall, F1-Score, and accuracy. the equation for the performance measure computation can be expressed as:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{2}$$

$$Precision = \frac{TP}{TP + FN} \tag{3}$$

$$Recall = \frac{TP}{TP+FP} \tag{4}$$

$$F1\,Score = 2 \times \frac{Precision \times Recall}{Precision + Recall} \tag{5}$$

A comparative analysis of results is given in. As it is clear from the table below that our proposed LSTM model got 92% accuracy which is much better than previous research done in past.

**Table 1.** Results

| | Accuracy | Precision | Recall | F-1 Score |
|---|---|---|---|---|
| LSTM Model | 92 | 93 | 93 | 93 |

## III. Conclusions and Future Work

LSTM model was used during our research. Despite getting good results, we can try more deep learning models like CNN, RNN, and BERT in the future to increase the accuracy. Moreover, we can also tune more parameters and do some data preprocessing techniques to enhance the efficiency of our model.

## ACKNOWLEDGEMENT

This work was supported by the Commercialization Promotion Agency for R&D Outcomes (COMPA) grant funded by the Korean Government (Ministry of Science and ICT)" (R&D project No.1711139492)

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# Teleported Virtual Human Framework for Multi-User Remote Collaboration

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## Abstract

Compared to the traditional 2D tele-conference systems, a shared tele-conference system situated in an augmented space with 3D teleported virtual humans would be more natural and realistic, and the system can give an enhanced and immersive communication experience. In this paper, we carried out a preliminary framework toward the effectiveness in communication performance of 3D tele-conference systems.

**Index Terms**: Tele-conference, Teleported, Virtual human, Communication

## I. INTRODUCTION

In our study, it aims to create a method of collaboration between remote users by expressing teleported avatar (virtual human form) in the tele-conference system as a non-face-to-face business meeting or a multi-participation communication method between remote locations[1-5]. Thus, we propose a method for automatically adapting virtual human expressions (visualization and interactive behavior expression) to the situation of remote users and environments based on the user's surroundings and environment information for remote multi-user collaboration.

## II. IMPLEMENTATION

Figure 1 shows an example of multi-user collaboration based on virtual humans. Virtual human visualization tailored to the user's display environment, virtual human behavior representation matching the user's surrounding environment (e.g. virtual human visualization/motion representation matching the local context, or behavior matching the real object when interacting with a real object in the local environment)[6-10]. It is necessary to provide an experience environment that increases the level of immersion in virtual humans for users who interact with virtual humans through expression, virtual human motion expression that controls objects in the Internet of Things environment, etc.).

* Corresponding author

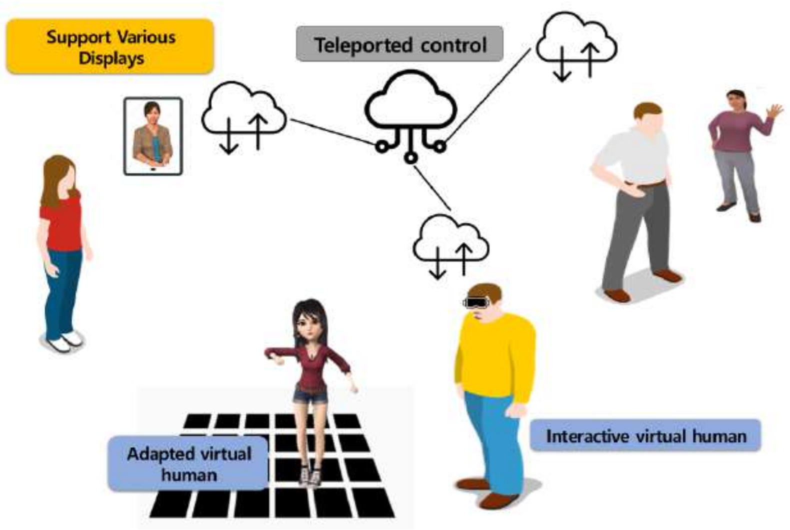


**Fig. 1.** Virtual humans for multi-user collaboration

## ACKNOWLEDGMENTS

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# Differential Evolution Algorithm Based on Ecological Model

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## Abstract

In this paper, we introduce an island model to implement the parallelization of different evolutionary strategies and propose a new parallel DE based on the ecological model algorithm called PDE-EM that utilizes the Monod model to maintain the balance between resources. Each island evolves with a different strategy with the same resources. Each designated number of generations is graded according to the degree of evolution of the island, and various resources are allocated to each island using the Monod model.

**Index Terms**: island model, different evolutionary strategies, ecological model, PDE-EM

## I. INTRODUCTION

Competition and coexistence among populations in the natural ecological environment is a hotspot of ecology. Many researchers have proposed various ecological dynamics models to explain the relationship between population competition and cooperation. That is, Logistic [1], Lotka-Volterra [2], Monod [3].

## II. DIFFERENTIAL EVOLUTION

. DE is a heuristic optimization algorithm for global search. The DE algorithm mainly includes four steps: initialization, transformation, intersection, and selection. The pseudocode is given in Algorithm 1.

In Algorithm 1, the loop structure includes three steps (mutation, intersection, and selection). All three strategies operate until the criteria are met. Finally, the best individual in the population is returned.

* Corresponding author

**Algorithm 1**: DE algorithm

**Input**: *NP, D, CR, F, and f (.)*
**Output**: *best* is the best solution to the population
1. Randomly initialize *NP D*-dimensional population *X*
2. Evaluate the fitness of each individual.
3. **while** the criterion is not satisfied **do**
4. *best* ← select the smallest fitness from the population.
5. Randomly select three different indices $i_1$, $i_2$, $i_3$
   /* *Mutation* */
6. Generate a mutate vector *V* by mutation for target individuals.
/* Crossover */
7. Generate a trial vector *U* by crossover operator.
/* Select */
Choose the best individual from X and U based on fitness.
8. **end while**
9. Return *best*.

## III. PDE-EM

Spark is an efficient and generic cluster framework that introduces an abstraction called Resilient Distributed Dataset (RDD) for performance-dominant parallel operators.

RDDs are partitioned in-memory data sets that can support fault tolerance and parallel processing. Spark comes with two basic RDD operations: transforms and operations. The job starts all calculations in the RDD.

Based on the above analysis, the RDD partition population of DE improves the parallelism of DE. Information migration helps improve population diversity. Figure 1 shows the computational process of DE based on Spark (SparkDE). DE's population is divided into different islands. Each island runs the DE algorithm in parallel. This model uses the partitionBy operation to migrate information between islands.

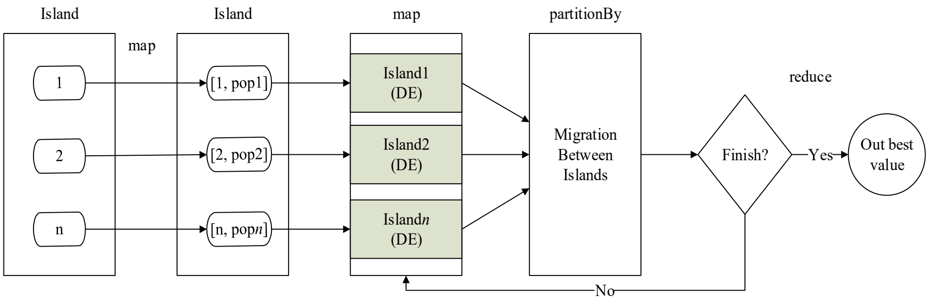


**Fig. 1.** Spark island model based DE

The PDE-EM pseudocode is shown in Algorithm 2 to improve DE performance by combining the Island model and the Monod model.

---

**Algorithm 2**: The PDE-EM algorithm

---

**Input**: *NP, D, CR, F, and f (.), m: number of islands,*
**Output**: *best* is the best solution of the population

1. Randomly initialize *m* subpopulation *pop*
2. Evaluate the objects in each island.
3. *FEs=NP*.
4. Randomly assigned evolution strategy to each island.
5. **while** FEs < *MaxFEs* **do**
6. Parallel execute evolution strategy on each island.
7. Calculate rate of change in the optimal fitness of each island.
8. Calculate the growth rate (*gr*) of each island according to equation (8).
9. Calculate the function evaluations rate (*fer*) of each island according to equation (9).
10. Assign individual number $NP_i$=$NP_i$+gr for each island.
11. Assign the function evaluations $FEs_i$=$FEs_i$+*fer* for each island.
12. **end while**
13. Return the minimum solution of function.

---

## IV. EXPERIMENT

The speedup is used to highlight the parallel performance of PDE-EM. Speedup is defined

$$S_k(M_n) = \frac{T_k(1)}{T_k(M_n)}$$

as:

where *Tk*(1) denotes the average time of *k* executions in the partition and *Tk(Mn)* denotes the average time of k executions in the *Mn* partition.

The speedup snippet is shown in Figure 4. For every function, three different function evaluations are established (eg 5.00E+05, 2.50E+05 and 5.00E+04). From Figure 2, it can be seen that the execution time decreases as the partition increases. On the other hand, when the partition reaches a critical point, the speedup curve decreases. Three similar curves indicate the stability of the acceleration.

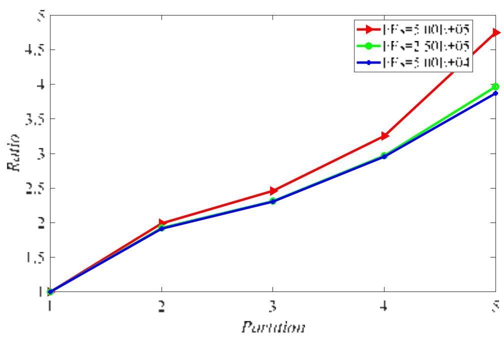


**Fig. 2.** Speedup by PDE-EM on all functions

## V. CONCLUSION

This paper presents a novel parallel differential evolution for solving large and complex optimization problems. The presented algorithm uses an island-based scheme that divides the population into multiple islands by parallelizing the operators in Spark's RDD. Each island has adopted a different algorithm for exploitation. In the course of population evolution, the Monod model allocated resources to islands according to evolution.

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# Few-shot Learning-Based Image Classification

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## Abstract

In this paper, we try to solve model overfitting and non-convergence in image classification tasks on small data sets. And we propose a new image classification method based on several training runs, which is mainly used to increase the accuracy of classification.

**Index Terms**: model overfitting, non-convergence, image classification

## I. INTRODUCTION

In recent years, deep learning models have been applied to computer vision tasks such as face recognition, object recognition, image classification, semantic segmentation, etc. [1-3]. In addition, many excellent deep learning models such as LeNet, AlexNet, GoogleNet, VGG, ResNet, etc. have appeared [4-8]. These deep learning models based on convolutional neural network (CNN) models have different characteristics and can achieve satisfactory results for different tasks. Deep learning models can automatically learn features from data that typically requires large amounts of available training data, especially for very high-dimensional input samples such as image and video processing. A small number of samples minimizes the features a deep learning model can extract, and the expected results the model produces are unsatisfactory.

## II. PROPOSED METHOD

When there are sufficient data samples, CNN models can be suitable for most image recognition and classification tasks due to their simple structure, small amount of parameters, fast data feature extraction, and high prediction accuracy.

However, when dealing with image classification tasks on small datasets, the pre-trained model can extract more data features, but the results of the pre-trained model increase the number of model parameters.

As a result, a deeper model layer is created. The model training time is too long. Therefore, we mainly reconstruct and optimize the CNN model structure without significantly increasing the model parameters, including the following aspects: The proposed model structure is shown in Figure 1.

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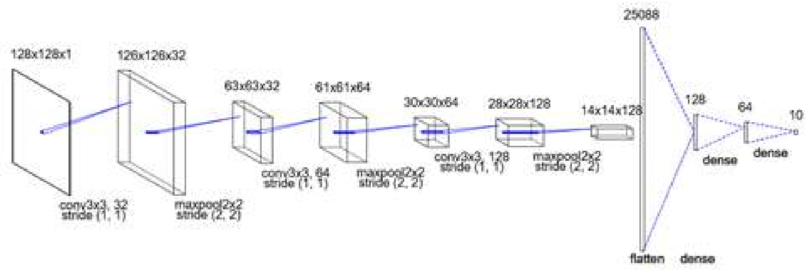


**Fig. 1.** Proposed model structure

## III. EXPERIMENTAL RESULT

To test the classification effectiveness and performance of the proposed model, a deep learning model was constructed using the Python computer programming language and the model was deployed on a graphic workstation equipped with an Inter core i7-4790 chip, 16G memory, 2T hard drive. It is equipped with a disk, GTX960 graphics display card.

Figure 2 shows the accuracy and loss rate curves of the CNN model, and Figure 3 shows the accuracy and loss rate curves of the proposed model during training.

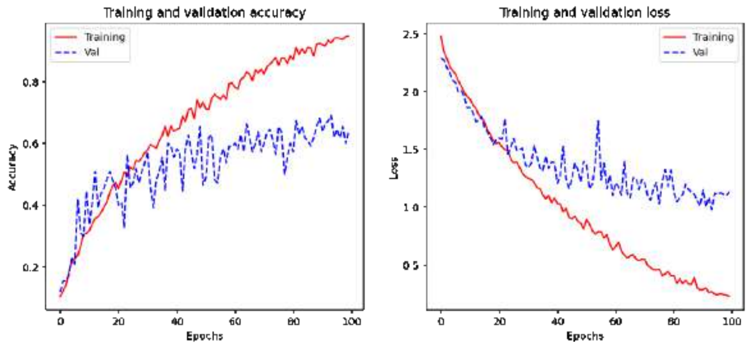


**Fig. 2.** Accuracy and loss rate curve of CNN model

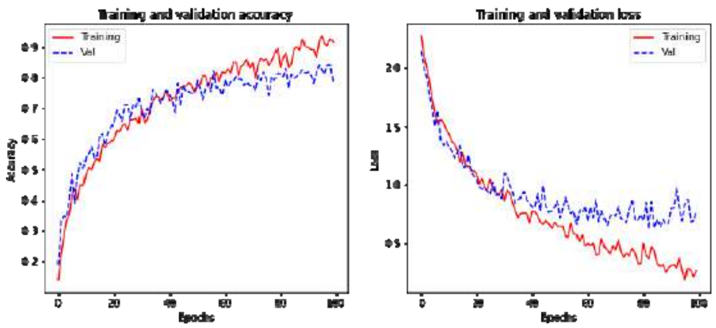


**Fig. 3.** Accuracy and loss rate curve of proposed model

The test results obtained are shown in Table 1.

**Table 1.** Model performance

| Model | Accuracy | |
|---|---|---|
| | Training | Test |
| CNN | 0.8876 | 0.6974 |
| VGG16 | 0.9191 | 0.8213 |
| ResNet50 | 0.9268 | 0.8696 |
| Ours | 0.9358 | 0.8792 |

## IV. CONCLUSION

This paper proposed a novel image classification method based on several rounds of training in monkey species. This method uses a method of increasing the number of convolutional layers to quickly extract sample data features from a small data set based on CNN. Then, we improved the classification accuracy by fine-tuning the fully connected layer and adopting a dropout mechanism to keep the most extensive functional data in the classification function to achieve fast and accurate classification.

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# Analysis of the Recent Research Trends in Image-based 3D Human Shape Estimation

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## Abstract

The image-based 3D human shape estimation technology refers to estimating the appearance of a person's body, hands, face, and clothes in 3D from single or multiple image data. With the recent introduction of the metaverse concept, a 3D human shape estimation technology that allows users to easily and quickly create an avatar is drawing attention as a very important research topic. Currently, with the development of Deep Neural Network (DNN) algorithms, it has reached the level of reconstructing a 3D human appearance and modeling clothes even from a single-color image. In this paper, we discuss recent research trends and topics for a quick understanding and approach to image-based 3D human shape estimation technology.

**Index Terms**: 3D Human shape estimation, deep neural network, avatar.

## I. INTRODUCTION

The image-based 3D human shape estimation technology refers to a research field that estimates the 3D appearance of the body, hands, face, and clothes from single/multiple color or depth image data. Recently, the 3D human shape estimation technology is playing a key role in virtual and augmented reality (VR/AR), metaverse, digital character creation, virtual try-on, and game/animation production. In particular, it is a very important study that can significantly improve the user's virtual world experience by quickly and easily creating an avatar that enables realistic and free movement in VR/AR or metaverse environments. Due to the recent popularization of sensors that provide depth information [1] and the development of Deep Neural Network (DNN) algorithms [2], it is developing to a level where a three-dimensional human shape can be estimated using a single-color image. In this paper, we describe the latest research trends and challenges for a quick understanding and approach to image-based 3D human shape estimation.

## II. Research Trends and Topics

Research trends on image-based 3D human shape estimation have largely changed according to two perspectives: (1) the development of deep neural network algorithms and (2) the securing of high-quality datasets.

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The recent development of deep neural network algorithms (DNN) has brought about innovative changes in the fields of artificial intelligence, computer vision, machine learning, and computer graphics. In particular, it is widely used in human pose estimation, image classification, object detection, voice recognition, action recognition, and so on. DNNs include Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Auto-Encoder (AE), and Generative Adversarial Network (GAN). It has been directly or indirectly proven that these algorithms can represent a data configuration space with high dimensionality. Therefore, recent studies on whole body pose estimation, mesh reconstruction, motion capture, and clothed human modeling are being conducted based on DNN.

In order to properly train a deep neural network algorithm, it is most important to secure a high-quality dataset. In general, datasets are acquired using depth or color sensors, but recently, computer graphic synthesis technology is used to efficiently obtain data of various and complex environments and 3D ground truth data. It is modeled by sufficiently reflecting the body shape, movement, race, cloth, and texture of a person, and created by considering the interaction situation that may occur in a real situation. However, it is still unnatural to express the appearance or movement of a person, and there is a sense of heterogeneity with the actually acquired image.

The latest research topics on image-based human shape estimation are divided into two categories: (1) 3D human pose and shape estimation, and (2) clothed human modeling.

The 3D human pose and shape estimation is to estimate the positions of major 3D joints of the human body in depth or color images and to reconstruct 3D shapes. Recently, many studies have been proposed that can estimate 3D poses and shapes from color images thanks to deep neural network (DNN) algorithms. They can be broadly divided into two approaches: the top-down method and the bottom-up method.

The top-down method [3-4] uses an optimization algorithm to fit a 3D human full body model onto an image (or image features). The features such as 2d joints [3], silhouettes [4] and body part segments [5] are used. Although this method shows good estimation results without much 3D training data, it is sensitive to the initial motion of the human model and has the disadvantage of being prone to falling into the local minimum area. The bottom-up method [6-9] is to train a deep neural network that can regress the parameters of a 3D human body model from image pixels using image patch [7], heat map [8], two-dimensional joints [6], and three-dimensional joints [9], etc. These regression neural network-based methods generally show good estimation results. Figure 1 shows examples of both approaches.


**Fig. 1.** Examples of two different approaches. (a) Top-down [3] and (b) Bottom-up [7]

Another important research topic in recent years is modeling people and clothing while simultaneously estimating three-dimensional poses and shapes. Existing methods do not consider the state of clothing or consider only minimal clothing, so it is not easy to express people in various clothes with non-linear geometric shapes. In order to overcome these problems, studies [10-11] that additionally model clothes have been proposed. The first method considers the body and clothes as one entity and simply captures the whole. They use the roulette [12], implicit function [13], and volume information [14] to capture the person wearing the clothes. These methods allow detailed clothing expression, but have the disadvantage that poses, shapes, and clothes cannot be changed. The second method is to separate the clothes and body and estimate them as separate layers using a three-dimensional vertex [15], mesh [16], and displacement map [17]. Although these methods have the advantage of being able to change poses, shapes, and clothes, it is still not easy to freely express clothes deformation. Figure 2 shows examples of modeling a clothing while estimating a 3D pose and shape.

(a) Example 1 (b) Example 2

**Fig. 2.** Two examples of results based on the clothing modeling algorithms.
(a) Example 1 [11] and (b) Example 2 [13]

## III. DISCUSSION AND CONCLUSION

This paper analyzes recent research trends on image-based 3D human shape estimation technology. The 3D human shape estimation is currently a very popular research field, and recent advances in deep neural network algorithms have resulted in significant improvements in estimation performance. However, there are still unresolved problems such as complex shapes, severe occlusion, low input image resolution and complex clothing. Therefore, it is necessary to develop an algorithm to solve these problems. In conclusion, it is expected that this will become a core technology that can lead to the popularization of virtual and augmented reality and metaverse fields in the future.

## ACKNOWLEDGMENTS

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# Immersive Avatar Creation Techniques for "Another Me" in Metaverse

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## Abstract

'Metaverse' is a compound word of 'meta' meaning processing and abstraction and 'universe' meaning the real world. is developing A new ecosystem has been created beyond virtual reality, one of the core basic technologies of the 4th industrial revolution era, and technically, it is establishing itself as an integrated technology of immersive technologies such as AR/VR/MR. The Metaverse platform requires various attempts to construct another world that it truly wants to realize through the convergence of virtual reality technology with technologies such as blockchain.

The more advanced 'Metaverse' appears in the form of the virtual world absorbed into the real world on the web and the Internet. In addition, the fact that face-to-face communication has become difficult due to the recent Corona 19 virus has further amplified the social demand for Metaverse. As the production of non-face-to-face content has become more active due to the corona pandemic, methods to increase immersion in various ways have been studied to overcome the limitations of non-face-to-face content. In addition, there is a high demand for realistic avatars that can protect privacy and maximize immersion in virtual space.

In this study, research is conducted to increase the similarity and immersion of avatars who will live as "another me" in the virtual reality world that results in the metaverse.

**Index Terms**: metaverse, immersive avatar, gan, similarity

## I. INTRODUCTION

Due to the COVID-19 pandemic, research on non-face-to-face communication methods is being actively conducted throughout society. Most of the lectures in the school were conducted non-face-to-face, and broadcast programs were also conducted in a non-face-to-face format. However, so far, any form of non-face-to-face communication has not come close to the realism of face-to-face communication. In addition, the metaverse, a concept that first appeared in the 1992 American science fiction writer Neil Stevenson's novel <Snorkel>, is attracting attention, and the demand for technology for this is also rapidly increasing. 'Metaverse', which is more advanced than the state-of-the-art virtual reality that

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allows people to experience the real world in a virtual world created by a computer, is a form in which the virtual world is absorbed into the real world on the web and the Internet. appears as

In this study, when creating a personal avatar that symbolizes "another me" to be used in the metaverse ecosystem, we propose a method that can be produced in consideration of similarity and immersion.

## II. Related Works

As social distancing expands, office workers are working from home, students are gradually expanding non-face-to-face online classes, and in reality, face-to-face communication has become impossible. We intend to utilize the metaverse as a way to solve these problems and find another way of communication between students.

In this study, we propose a method for projecting a real human figure to the 3D metaverse environment as closely as possible. We develop a feature-based random generation system using cGANs as a method for real-time transmission of massive 3D point cloud data.

In terms of real-time transmission technology of 3D point cloud data, which is a core required technology for telepresence systems, we implemented cGANs-encoder to transmit 3D point cloud data captured through a kinect system equipped with a depth camera in real time, It implements cGANs-decoder to reproduce 3D objects in real time in the mobile terminal that has received the characteristic information, and when the receiving side reproduces the 3D object, it receives only the characteristic information of the 3D object sent from the sending side and is randomly generated. In order to quantify the perception of the difference from the original, we study the human cognitive change and response relationship according to the level of similarity and level of detail.

## III. Avatar creation model

Recently, global metaverse companies are introducing systems that can host meetings in a virtual space. It allows multiple people from a remote location to gather in a virtual space to conduct a meeting. At this time, the facial expressions and actions of the virtual people make the other person feel immersive and provide a more realistic feeling.

In the metaverse environment, the subject of action is my avatar. The way I can give the other person a sense of immersion through my avatar is the realistic expression of the avatar[1].

The integration of various VR devices that have already been released into the metaverse environment is in full swing. 3D virtual space provides people with a very realistic sense of immersion. Therefore, it can be said that the natural expression technology of 3D objects is very important for the success of the metaverse environment.

Whenever a person's changing facial expression is captured in 3D, it requires a lot of computing power to be transmitted in real time and then displayed. In addition, an important axis of the avatar system is individual privacy. Therefore, there is a need for a proper balance between personal privacy and improved immersion. In order to express an avatar, a system that can freely create an avatar that meets the needs of the user by subdividing the expression elements is needed. In this study, we propose a feature point exchange method for communication with the avatar system in order to transmit human facial expressions to the avatar system in real time[2].

**Fig. 1.** mld digits - Avatar System

Figure 1 shows the Avatar System of mld digitsd. Through this system, various changes of facial expressions can be implemented.

We propose a system in which an avatar is randomly generated in a virtual space through a pre-learned GAN network after identifying characteristic information from a person's facial expression and transmitting only the characteristic information to the avatar system.

## IV. DISCUSSION AND CONCLUSIONS

This study conducted a study to increase the immersion and similarity of the avatar called “another me” to be used in the metaverse platform.

As a method to solve the coding delay and transmission delay that may occur when a vast amount of 3D point cloud objects are visualized as avatars, a character random generation method using cGAN is proposed.

Through this, a base technology was developed to enable 3D virtual characters to act in real-time in the metaverse environment through the 5G network.

It is expected that it will develop into a technology for realizing more realistic services in the virtual world of metaverse, which will grow rapidly in the future.

## ACKNOWLEDGMENTS

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# Object Detection and Localization on Map using Multi-Camera and Lidar PointCloud

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## Abstract

Autonomous vehicles are the future transportation system anticipated to be driverless, efficient in handling road curvature and avoiding crashes. The visual perception and accurate localization are two significant points for the autonomous vehicle. This paper leads the approach of fusing multiple RGB cameras for visual objects recognition based on deep learning with convolution neural network, and 3D Light Detection and Ranging (LiDAR) to observe the surrounding environment and match into a 3D world in estimating the distance and position in a form of point cloud map. The goal of perception in multiple cameras is to extract the crucial static and dynamic objects around the autonomous vehicle, especially the blind spot which assists the AV to navigate according to the goal. Numerous cameras with object detection might tend slow-going the computer process in real-time. To eradicate this problem the computer vision convolution neural network algorithm must be suitable also to the capacity of the hardware. The localization of detected objects comes from the bases of a 3D point cloud environment. But first the LiDAR point cloud data undergoes parsing and the algorithm is based on the Euclidean clustering method which gives efficiency on localizing the object. We evaluate the method using our dataset that comes from VLP-16 and multiple web cameras and the results show the efficiency of the method and multi-sensor fusion strategy.

**Index Terms**: Autonomous vehicle, Sensor Fusion, Object Detection, Clustering Point Cloud

## I. INTRODUCTION

Autonomous vehicles or self-driving vehicles not only provide the transportation capabilities of conventional vehicles, but also are largely capable of perceiving the surrounding environment and self-navigating with minimal or no human intervention. The ideal autonomous vehicles in the future can go anywhere, be convenient to ride and are safe [1]. In this paper, we research about the perception and localization of the environment. The sensors being used in it are VLP-16 LiDAR and multiple cameras which are fused to perceive the environment. Lidar sensor parses the point cloud data which determines the distance of all objects in the environment, and multiple cameras can perceive the objects using deep learning method. Therefore this combination of the sensors is adequate for the

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autonomous car. The fusion of multi-cameras and lidar sensor has the advantage by which objects can be classified as dynamic or stationary as well as the object type (e.g. vehicle, pedestrian, or other). The ability of sensors that can detect objects using deep learning method and thus identify the distance estimation can be utilized in terms of avoiding the collision [2].

## II. SYSTEM MODEL AND METHODS

The fusion of sensors perceives the surrounding environment by obtaining the data from multiple cameras and lidar through the following steps.

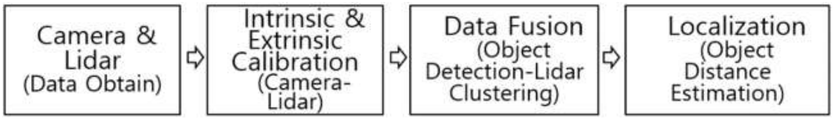



**Fig. 1.** Implementation Method of Sensor Data Fusion

### *A. Calibration*

The lidar and camera calibration estimates the rigid transformation matrix that establishes the correspondences between the points in the 3D lidar plane and the pixel in the image plane.

#### *1) Camera Calibration*

Is the process of estimating the intrinsic and extrinsic parameters using Zhang's algorithm [3]. The analysis of this calibration is done using the MATLAB tool to analyze the data and the reprojection error of the camera [4]. We use the planar checkerboard as the basis object on the image for calibration. The purpose of this is to remove the distortion on the image that caused by the camera lens.

##### *a) Intrinsic Parameter Calibration*

The intrinsic parameters deal with the camera's internal characteristics, such as its focal length, skew, distortion, and image center.

##### *b) Extrinsic Parameter Calibration*

The extrinsic parameters consist of rotation and translation.

#### *2) Lidar and Camera Calibration*

The image plane and lidar point cloud data are used to calibrate the extrinsic camera and lidar [5]. The point cloud data is a 2D representation of 3D data that is projected onto an image plane using the PnP algorithm [6]. The process uses a planar checkerboard which obtains the feature points in the image plane and the lidar.

## B. Data Fusion

The data fusion comes from multiple cameras and lidar. We have the camera used for object detection and the lidar which gives us the 3D map environment and the distance estimation. The goal of this data fusion is to improve the signal's robustness or the information's quality [7].

### 1) Object Detection

This project uses multiple cameras for object detection which is located in the front, left and right side views. We used the Tiny YOLO v3 object detection algorithm because it is fast, less processor-consuming and thus can perform in real-time situation [8-9]. The detected object is localized on the image using a bounding box. Because we calibrate the camera and lidar, turn the 3D point cloud into 2D form and project it into an image plane, we can extract the point cloud data inside the bounding box.

### 2) Clustering

The lidar sensor collects point cloud data which has the property of a high amount of data. The purpose of clustering is to find distinct groups or clusters within the dataset [10-11]. Also it reduces the high amount of data by extracting the outliers which are not applicable in our dataset.

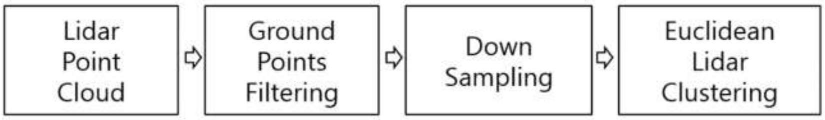



**Fig. 2.** Implementation Method of Point Cloud Clustering

#### a) Ground Points Filtering

It uses the RANSAC algorithm to identify the ground points of the point cloud map.

#### b) Down sampling

It reduces the overfitting of the point cloud data while still preserving the shape.

#### c) Euclidean Lidar Clustering

The data is built into k-d tree form in which Euclidean distance is used to distinguish the different classes in the point cloud.

## C. Localization

The depth estimation of an object is done using sensor fusion data [12]. By the earlier process, we calibrate the camera to fix the distortion caused by the camera lens. Undistorted image is needed to process onto the next level which is the lidar and camera calibration. The 3D LiDAR point cloud is converted into a 2D form in which the region of interest in the 2D image is the same as the region of interest in 3D point cloud projection. Each detected object is represented in the bounding box. The point cloud data within the bounding box is extracted and calculated using a spherical coordinate system intended for the point cloud to identify the distance and angle of the object in a 3D map.

## III. RESULTS

***Calibration of Lidar and Camera***

The transformation of lidar and camera calibration parameters is shown below. Image coordinates is resulted from Intrinsic parameter matrix, extrinsic parameter and 3D lidar environment coordinates.

$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} f/dx & 0 & u_o & 0 \\ 0 & f/dy & v_o & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} R & t \\ 0 & 1 \end{bmatrix} \begin{bmatrix} X_L \\ Y_L \\ Z_L \end{bmatrix} \tag{1}$$

***Euclidean Lidar Clustering***

The Euclidean distance is used to distinguish different classes. Euclidean distance between points P and Q is the length of the line segment connecting them. In Cartesian coordinates, if p = (p1, p2,..., pn) and q = (q1, q2,..., qn) are two points in Euclidean n-space, then the distance from p to q is given by the Pythagorean formula.

In three-dimensional Cartesian space, points have three coordinates each. To find the distance between p(x1,y1,z1) and q(x2,y2,z2) , use the formula in Eq(2):

$$\mathrm{d(p,q)} = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2} = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \cdots + (q_n - p_n)^2} \tag{2}$$

p, q= two points in Euclidean n-space
$q_i$, $p_i$ = Euclidean vectors, starting from the origin of the space (initial point)
n = n-space

***Object Detection and Localization on Point Cloud Map***

Consider $O_{\text{object detect}}$ on the image with rectangular box coordinates Rec(h1, h2, h3, h4) and the 2D projected LiDAR points $Q_{3DPoints}$(x, y, z). Inside the rectangular box Rec(h1, h2, h3, h4) determine a LiDAR point cloud $Q_{3DPoints}$(x, y, z) that lies in the bounding box if not then it is excluded. After getting the LiDAR points (x,y,z) inside the bounding box of $O_{\text{object detect}}$, calculate the distance(r) and angle either using the 3D spherical coordinate system as shown below Eq(3).

$$\mathrm{r} = \sqrt{x^2 + y^2 + z^2}$$

$$\theta = arccos\frac{z}{\sqrt{x^2+y^2+z^2}} = arccos\frac{z}{r} \tag{3}$$

$$\varphi = arctan\frac{y}{x}$$

## IV. DISCUSSION AND CONCLUSIONS

### *A. Data Fusion of Lidar Point Cloud and Image Object Detection*


**Fig. 3.** Data fusion of Lidar and Camera

Data fusion by the calibration of lidar and camera is shown in Fig. 3. The purpose of this is to extract the clustered point cloud data inside the bounding box, calculate the distance estimation of this object detected and localize it on point cloud map.

### *B. Object Detection and Localization*

This is the indoor result in which the multiple cameras detected objects and localized them on a point cloud map. The distance estimation is identified in a real-time situation.

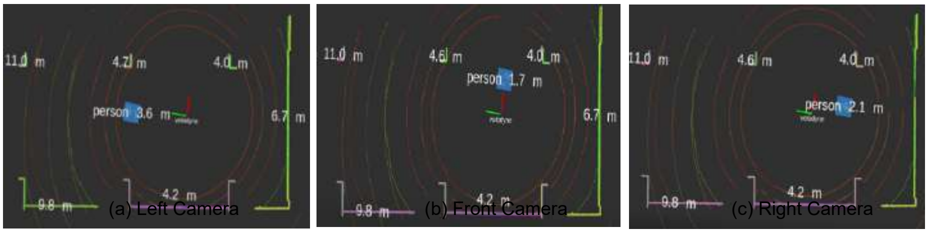
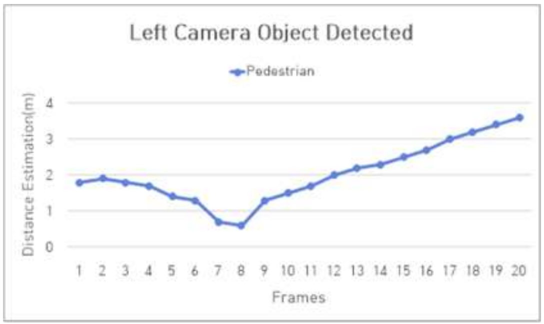


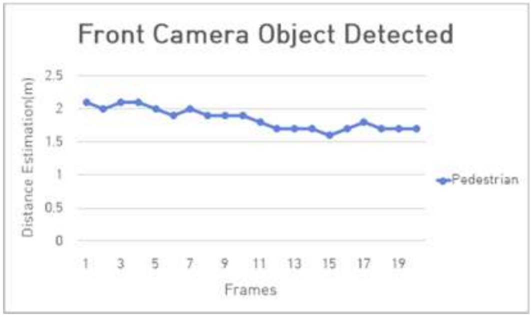

**Fig. 4.** Object Detection and Localization on Map

### *C. Distance Estimation*

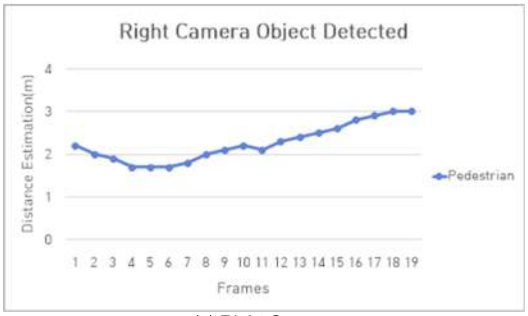
This is the indoor result about only one object detected around the multiple cameras. The distance estimation is identified in real-time situation. The distance estimation extraction in Fig. 5 is on different timestamp.




(a) Left Camera




(b) Front Camera




(c) Right Camera

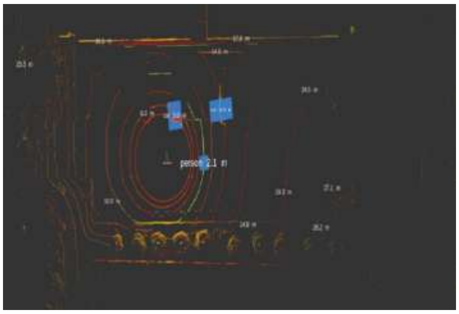
**Fig. 5.** Tracking of the detected object distance(meter) per frame

## *D. Outdoor Result*

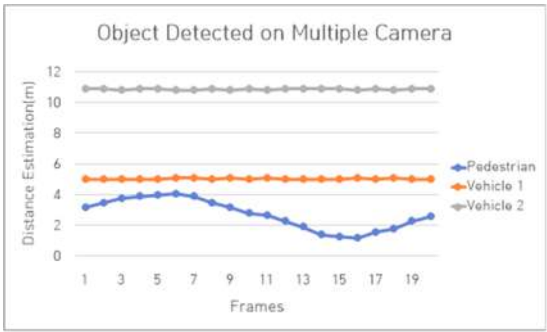
Below are the outdoor results in which we have a lot of important objects such as cars and pedestrians. As long as the object detection bounding box contains lidar points we can extract that and calculate to identify its distance estimation and angle.

(a) Point Cloud Overlay on Image


(b) Object Detection on Multiple Camera




(c) Object Detection and Localization on Point Cloud Map




(d) Tracking of the detected objects distance(meter) per frame

**Fig. 6.** Outdoor Result

### E. Conclusion

We can eliminate a lot of things in this project by combining multiple sensors. The first is that by merging the sensors' data we can eliminate the drawbacks of each. We all know that a camera produces a color image, which we can recognize by using our eyes or a computer vision object detection algorithm to determine what is on it. The downside of a camera image is that it cannot estimate an object's depth. For that reason, we combine the camera into another sensor which is the LiDAR sensor. LiDAR can estimate the distance of an object by about 120 meters which is good to fuse to our camera sensor. This combination of sensors is perfect for an autonomous vehicle.

The relationship between an autonomous vehicle and multiple sensors is that it can give us very detailed information that acts like humans. We have multiple cameras that serve as object detection in every angle from the right side angle, left side angle and front side angle. We use the Tiny YOLOv3 object detection algorithm for our multiple cameras and also although the accuracy may have been reduced because of lightness, still it is applicable for indoors. The aim of this project is the object detection and localization, that is, recognizing the object, identifying its distance and localizing it to the point cloud map. The advantage of the method we are using is that it can run in a real-time situation.

## ACKNOWLEDGMENTS

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# Resilience Analysis according to Cross-School Class in Mobile Application Programming Class

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## Abstract

Due to the COVID-19 pandemic in Korea, there have been cases of cross-school due to temporarily conducting online classes. In this study, the difference in resilience was analyzed based on the results of studying the classes that learned mobile application programming. As a result of the study, ten people had resilience less than 150, 35 people who had the resilience of 150 or more and less than 180, and 10 people who had 180 or more in the online class. On the other hand, in the school attendance class, there were nine people with resilience less than 150, 25 people with resilience less than 150 and less than 180, and 21 people with more than 180. Therefore, in the subject of mobile application programming, the laboratory and practice environment should be able to proceed properly as much as possible.

**Index Terms**: COVID-19, Cross school classes, Mobile application programming, Programming Learning

## I. INTRODUCTION

In the second semester of 2020, after experiencing an unprecedented situation in Korea that classes were delayed in the first semester of 2020 due to COVID-19, students were divided into two or three groups and started to take online-offline parallel classes. Even in the bright future of 2021, parallel online-offline classes are in progress. In particular, in Meister High School or Specialized High School, online classes are conducted for theory subjects, and offline classes are conducted for laboratory and practice subjects. The academic schedule is carried out in such a way that students cross-school. The reason for doing this is that, although there are many difficulties in the online class due to the characteristics of the place, the situation of material supply and demand, and the preparation

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of equipment, there is no difficulty in the theory class if it is conducted like the existing online education site [1].

In particular, mobile application programming subjects often experience various difficulties in the course of learning because they learn programming and learn while handling smartphones.

Recently, while research on laboratory practice due to COVID-19 has begun, this study analyzed the resilience of cross-school classes in mobile application programming [2].

The structure of this study is as follows. Following the introduction, Chapter 2 explores resilience and cross-school classes, and Chapter 3 describes the research procedure and research results. Finally, Chapter 4 concludes with conclusions and suggestions.

## II. RELATED RESEARCH

### *A. Resilience*

Among studies in the field of education, in studies related to learning, resilience is widely used to solve helplessness in learning. Resilience has sub-components of controllability, sociality, and positivity. Unlike other programming subjects, the mobile application programming subject deals with smartphones, so hardware difficulties and software difficulties may occur at the same time. In order to overcome the helplessness caused by the difficulty of the learning process, it is necessary to solve the hardware and software difficulties, and to be more interested in the mobile application programming subject, and to solve the learning helplessness [3].

### *B. Cross School Class*

Due to COVID-19, most educational sites are conducting a lot of online learning. However, in specialized high schools and Meister high schools, it isn't easy to teach only online classes unconditionally compared to elementary, middle, or general high schools. Therefore, to comply with the government's quarantine guidelines, there are many cases of cross-commencing classes by forming groups of two or three and having them attend school. In addition, if a confirmed case of COVID-19 occurs at the school, it must be switched to online classes to operate the bachelor. In particular, compared to other programming classes, mobile application programming classes follow errors and difficulties due to smartphone operation, so additional measures are required [4, 5].

## III. RESEARCH PROCESS & RESULT

### *A. Research Process*

In this study, based on the academic calendar, the practical class was started unconditionally attending school according to the cross-school class method. Therefore, a resilience test was conducted on the study subjects at the beginning of the semester. However, an unexpected situation occurred in which a confirmed case of COVID-19 happened in the school of the study, and online classes were held temporarily. Teachers in charge of some practical subjects, including researchers, became close contacts and self-quarantined for two weeks. The subjects of this study were 51 male students and four female students. After completing online classes and self-quarantine for two weeks, the resilience test was conducted again.

### B. Research Result

As a result of calculating the average resilience of mobile application programming subjects, as shown in Figure 1, 10 students showed the resilience of less than 150, 35 students with the resilience of 150 or more and less than 180, and 10 students with 180 or more. On the other hand, in the school attendance class, there were nine people with resilience less than 150, 25 people with resilience less than 150 and less than 180, and 21 people with more than 180. For this reason, errors may occur in setting up a smartphone due to the nature of the mobile application programming course. In addition, errors such as typos or grammar may occur during the process of practicing programming. In this situation, it is presumed that it is difficult for teachers to provide direct instruction in online classes. Therefore, if an online class for a subject with hardware and software elements, such as a mobile application programming class, is conducted online, the lab and practice class should be conducted in the school class, and the online class content should be faithful to the theory as much as possible.

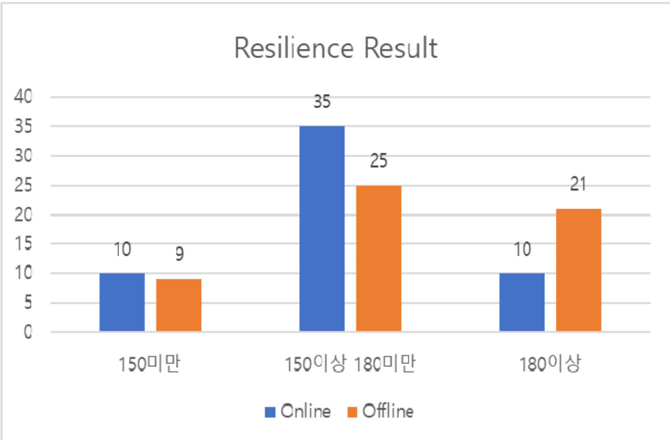


**Fig. 1.** Resilience Result

## IV. DISCUSSION AND CONCLUSIONS

This study was conducted in the context of cross-school classes due to COVID-19 at Meister High School and Specialized High School. Therefore, a resilience test was conducted and analyzed for learners in the mobile application programming class.

In classes that deal with hardware and practice programming, such as mobile application programming classes, it is necessary to proceed to school so that students can practice in the field as much as possible. However, when the self-isolation period is over, it must be dealt with in a way that focuses on practical classes.

A future research project is to conduct research by adding a sense of presence or learning satisfaction to the research variables.

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# Aquaponics System Design with Artificial Intelligence Technology

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## Abstract

The Aquaponics system is a method of cultivating crops through water in which minerals generated through freshwater fish farming are dissolved, and has great advantages in preserving the natural environment because eco-friendly farming methods are safe for consumers and do not use pesticides and chemical fertilizers.

In this paper, we propose the design of an artificial intelligence-based aquaponics system that can set an optimal environment by time-series analysis and learning of various sensor data generated in the state and aquaponics environment to increase and efficiently manage the productivity of these aquaponics system.

**Index Terms:** Aquaponics, Hydroponics, Multi level Site, AI

## I. INTRODUCTION

Aquaponics is a system that can cultivate fish and grow eco-friendly hydroponics at the same time, and is a production system close to eco-friendly farming [1][2].

In this paper, we propose a system that reflects the characteristics of the aquaponics system.

Beyond building simple aquaponics, the proposed system refers to a system that can collect raw sensor data generated from the system, conduct artificial intelligence learning for each cultivation environment, and predict optimal growth environment and quantitative production based on this.

## II. SYSTEM MODEL AND METHODS

Table 1 describes the characteristics of the aquaponics system.

* Corresponding author

**Table 1.** Characteristics of Aquaponics System

| Type | Advantage | Disadvantage |
|---|---|---|
| Eco-Friendly | - Minimize the use of water through the circulation system.<br>- Space-saving production is possible.<br>- Since only feed for aquaculture fish is used, chemical fertilizers are not used. Does not cause contamination of soil and water quality.<br>- No pests, no weeds. | |
| Economical | - Minimize manpower input.<br>- Work intensity for input personnel is low.<br>- High productivity.<br>- Increase value added.<br>- Sales of cultivated plants and cultured fish at the same time.<br>- No restrictions on the location of installation, such as downtown, buildings, apartment complexes, outskirts of the city, islands, farming and fishing villages, closed schools, buildings, etc. | - In Korea, the possibility of initial failure is higher due to the lack of accumulated information and experience data than general farming or plant cultivation.<br>- Initial setup cost is high.<br>- System configuration is more complex than general farming or plant cultivation. |

While it has a great advantage in the eco-friendly area, it has advantages in minimizing manpower and installation restrictions in terms of economy, and requires high cost and technology compared to the existing cultivation system.

Many current studies focus on building the environment of aquaponics-Aquaponics in Korea [3], and RAS-based modern aquaponics research [4][5][6] focus on verifying the cultivation environment.

In addition, previous studies point to doubts about productivity, and if this is not resolved, it is predicted that commercial introduction will be difficult to succeed.

To solve this problem, this paper proposes the construction of an aquaponics system that can have better productivity through artificial intelligence learning based on various meaningful sensor data and growth data generated by the aquaponics system.

## III. RESULTS

Figure 1 is the structure of the intelligent aquaponics production management system proposed in this paper.

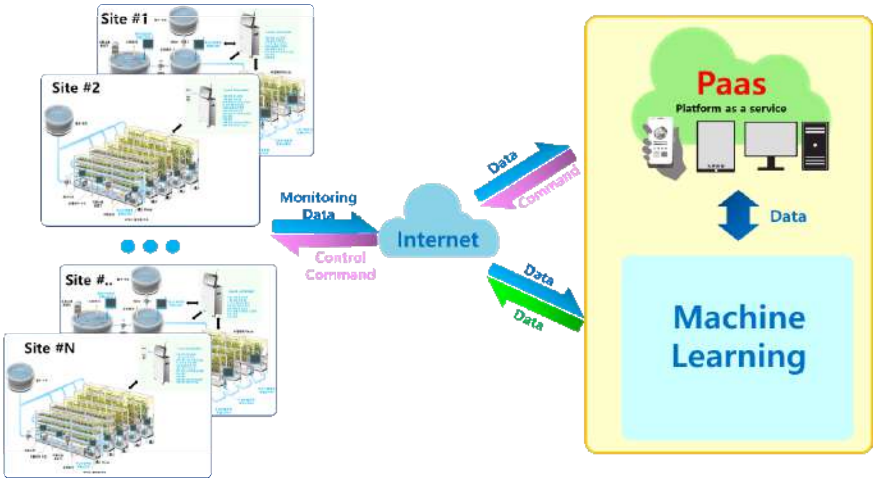


**Fig. 1.** Intelligent Aquaponics System

The main element development targets consist of a network structure that can link the IoT-based aquaponics system site with each site's aquaponics system, cloud-based passes for raw data collection and computation processing, and data servers and user interfaces to derive optimization conditions.

Among the entire systems, the part currently covered in the paper photographs information on plants grown in the artificial intelligence part and cloud area through the vision measurement system and provides sensor information such as illuminance, inorganic mass, ph concentration, temperature, and humidity collected during the cultivation process to the cloud.

Through this, it is possible to collect artificial intelligence learning data by constructing various types of aquaponics sites as shown in Figure 2.

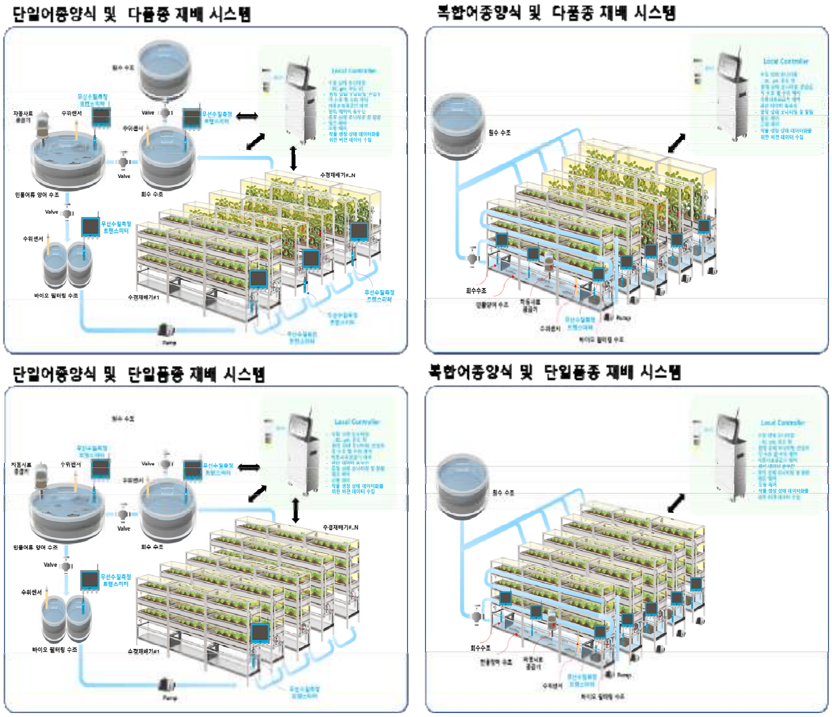


**Fig. 2.** Aquaponics system based on various conditions

## IV. DISCUSSION AND CONCLUSIONS

This paper proposed an IOT convergence aquaponics exclusive operation technology that can build an optimal aquaponics environment based on the generated data, not a system that uses the aquaponics system alone.

If the proposed technology is used, it is expected that consumer-tailored data through a new combination of crops and fish can be used within the proposed platform, and if expanded, the accuracy of the optimal growth environment algorithm will increase by securing an analysis and serviceable platform and learning through big data.

In addition, it is predicted that production prediction algorithms for cultivated crops can be secured through multiple data analysis and can be used in fields that require production and management of various cultivated crops.

As a result, consumers will be able to consume high-quality vegetables regardless of environmental pollution and climate change, and will be reborn as a system that can solve situations where stable food supply is difficult depending on the environment and climate change.

Currently, Aquaponics of building type, house type, and greenhouse type will be built in three regions in Korea, and the proposed contents will be verified through raw data collection and analysis by establishing an aquaponics system applied with this system.

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# A Study on User-recommended Video Analysis Techniques

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## Abstract

In this paper, among the techniques for content recommendation of the educational video service system, the efficiency of the video comparison technique using the keyframe of the video and analysis using voice data-based subtitles is compared. In addition, through the experimental results, the type and environment of image content in which each analysis technique can be efficiently utilized are proposed.

**Index Terms**: User Recommendation, Voice and Subtitle Analysis, Keyframe Analysis, Bigdata

## I. INTRODUCTION

With the recent rapid development of data communication, the video content provision business is expanding. Along with this, content recommendation algorithms are widely used to recommend videos suitable for user interest. The recommended service is a service that supports users to select only content of high interest among scattered information, and Internet services such as portals and social network services (SNS) have recently developed, and as related content increases exponentially, more and more users want to select and use only necessary information. In this paper, a video recommendation system reflecting this trend is proposed.

Chapter 2 examines research related to the recommendation system of the video providing platform. Chapter 3 proposes and describes a big data analysis technique of a video for user recommendation. Chapter 4 verifies the efficiency of the proposed technique. Finally, Chapter 5 concludes.

## II. SYSTEM MODEL AND METHODS

Google supports AutoML Vision [1] and Vision API [2] to support image search, and image analysis is possible. AutoML Vision can predict categories defined using labeled images as learning data. It has the advantage of making it easy to build a model for existing

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video analysis. However, in the case of a large amount of video, the processor's high processing power is required.

Meanwhile, unlike a general recommendation system that uses keywords designated by users to reflect the characteristics of video content, a study [3] on keyword-oriented search for videos analyzes and orders the frequency of keywords inherent in videos to express the characteristics of content. Using these characteristics, a technique used in the recommendation system by grasping the similarity between videos was proposed.

The difference from the study [3] is that related research [4] proposes a cooperative filtering technique that reflects the user's preference and frequency of words, reflecting various items in deriving similarities, while utilizing only limited word sets and frequencies.

ResNet has a 3×3 size two-dimensional convolution layer as a network for processing images that are 2D data [5]. However, in the case of videos, 3D Resnet, which changed the size of the convolution layer to 3×3×3 to process video data, was proposed because the time dimension was added to the image data to have a three-dimensional shape. Through this, videos can be classified without metadata, but datasets with vast sizes such as Kinetics and Sports-1M are well classified, while relatively small datasets such as UCF-101[6] do not show effective performance due to overfitting of models.

So far, there have been studies on various user recommendation systems, but there has been no comparative analysis of studies using the frequency of words inherent in videos, and no studies have conducted performance comparisons on educational video sharing platforms that serve continuously changing content with a wide variety of categories.

## III. RESULTS

Voice and subtitle-based curation algorithms [3,7,8,9] are algorithms that analyze the user's viewing patterns and recommend the most similar images compared to voice and caption-based keyword tables built for each video.

The user's viewing image is analyzed and morpheme is extracted to compare the correlation coefficient with the existing user in the cluster of similar users as shown in Figure 1.

| | 0min0 | adios | adios6 | adios9 | classA | classA2 | erter4 |
|---|---|---|---|---|---|---|---|
| 0min0 | 1.000000 | 0.951686 | 0.960864 | 0.972993 | 0.951815 | 0.982113 | 0.978799 |
| adios | 0.951686 | 1.000000 | 0.999506 | 0.996867 | 1.000000 | 0.992482 | 0.994405 |
| adios6 | 0.960864 | 0.999506 | 1.000000 | 0.998860 | 0.999519 | 0.995838 | 0.997233 |
| adios9 | 0.972993 | 0.996867 | 0.998860 | 1.000000 | 0.996900 | 0.999053 | 0.999645 |
| classA | 0.951815 | 1.000000 | 0.999519 | 0.996900 | 1.000000 | 0.992534 | 0.994449 |
| classA2 | 0.982113 | 0.992482 | 0.995838 | 0.999053 | 0.992534 | 1.000000 | 0.999858 |
| erter4 | 0.978799 | 0.994405 | 0.997233 | 0.999645 | 0.994449 | 0.999858 | 1.000000 |

**Fig. 1.** Correlation coefficient between items and users

The voice and subtitle-based curation algorithm analyzes the user's viewing pattern and recommends the most similar video compared to the voice and subtitle-based keyword table built for each video.

The user's viewing image is analyzed and morpheme is extracted to compare the correlation coefficient with the existing user in the cluster of similar users as shown in Figure 1.

In the case of voice data and subtitle data in an image, since it is data that accurately expresses the content of the image, it is possible to recommend an image with a high degree of similarity when used for curation.Voice and subtitle-based curation algorithms [3, 7, 8, 9] are algorithms that analyze the user's viewing patterns and recommend the most similar images compared to voice and caption-based keyword tables built for each video.

## IV. DISCUSSION AND CONCLUSIONS

The test video used to experimentally evaluate the performance of the technique proposed in this paper converted 64 lecture videos into 2048-dimensional vectors through Video2Vec, five videos each in four categories: news, soccer highlights, space documentaries, and movie trailers.

Videos 0 to 4 are news, videos 5 to 9 are soccer, videos 10 to 14 are space, and videos 15 to 19 are movie trailer videos. The 18th video has a relatively high similarity to the space documentary video because the universe appears a lot in the movie trailer.

The results of measuring the cosine similarity between the converted video vectors of the lecture are as follows. The results of Figure 2 show high similarity by category.

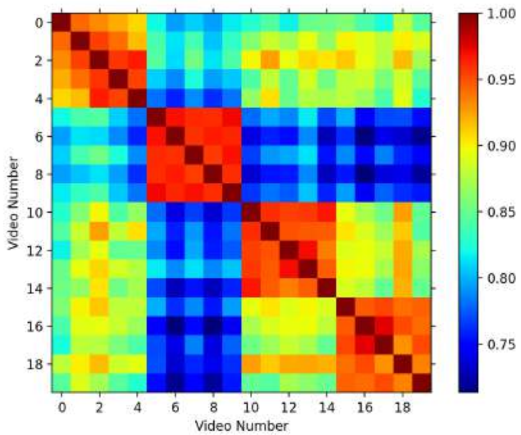


**Fig. 2.** Similarities among Several Categories

Next, 64 lecture videos classified into 4 categories were compressed through VFD and converted into 2048-dimensional vectors. Videos 0 to 23 are videos on information security lectures, 24 to 40 on safety education, 41 to 51 on practical training, and 52 to 63 on self-introduction writing lectures.

Figure 3 shows the results of measuring the cosine similarity between the converted video vectors of the lecture. As a result of the experiment, it can be seen that the accuracy of category classification within the same category is poor.

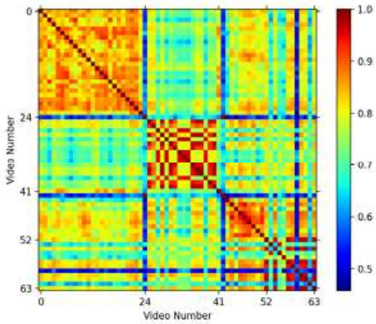


**Fig. 3.** Similarities among Educational Video

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# Session IS-C

## Intelligent Information System

# Session IT-C

## IT Convergence Technology

# Session CA-C

## Communication System and Applications

# Session NS-C

## Networking and Services

# Session IB-C

## IoT and Big Data

# Computer Vision-based System Design for Classifying Workplace Dangerous Situation

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## Abstract

As this phenomenon has been pointed out as a social problem, such as fatal accidents or injuries caused by industrial accidents, which have recently led to civil accidents, the Act on Accidents Occurs in Industrial Sites is being implemented. According to the 2020 industrial accident statistical data published by the Ministry of Employment and Labor in 2020, the manufacturing industry accounted for 25% by industry. Also, workplaces with 5 to 49 employees accounted for 45.6% of the number of injured workers. Efforts to ensure the safety rights of workers and citizens and to prevent disasters in advance are required in various industries. In order to develop technology to prevent safety accidents, deep learning-based object detection technology is being used in a variety of ways. It takes a lot of effort to learn a model with an image of an industrial site. In this paper, it is thought that it can be used as an initial study to predict dangerous situations early by constructing learning data for industrial site worker safety accident management and learning various models.

**Index Terms**: Dangerous situation, Distance estimation, Industrial safety, Object Detection, YOLO

## I. INTRODUCTION

Looking at the status of industrial accidents published by the Ministry of Employment and Labor in December 2020, the number of industrial accidents in 2020 was 108,379, of which 2,062 died, showing a 2.1% increase from the previous year[1]. In addition, the construction industry accounted for 26.6% of the number of casualties by industry and the manufacturing industry accounted for more than half of those in other workplaces, accounting for 25%. In this reality, the government, construction and manufacturing companies have introduced institutional and technical devices to prevent safety accidents and are actively researching them. In order to detect dangerous situations, object detection technology based on computer vision and deep learning is essential. It is also being used in dangerous situations where people approach[2, 3]. Since CCTVs are already installed in

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many business sites, it will be possible to determine risk situations by creating a model for data collection and situation detection based on these technologies.

However, training data is required to create such a model, and there is a limitation that it is impossible to use a large amount of datasets widely used in object detection or instance segmentation fields such as Microsoft Common Objects in Context (COCO) and Cityscapes, which are already available. exists[4, 5]. This is because these datasets lack images of construction sites or industrial sites, so you have to build them yourself.

Therefore, in this paper, it is thought that this study can be used as an initial study for constructing a system that predicts dangerous situations by directly constructing such learning data and analyzing it through the performance results of the model.

## II. SYSTEM DESIGN

The system collects CCTV images collected in the workplace and detects objects through them. Objects are such as workers, forklifts, trucks, loaded cargo, safety gear (hat), and sanitary gear (mask, sanitary cap) in the workplace. For these objects, the objects to be detected are slightly different for each workplace industry. For object detection, YOLO-v4 was used[6].

Through these objects, the case of a dangerous situation such as the distance between objects and the case where safety or sanitary equipment is not worn is finally determined.

In the case of a system, it can be implemented using related technologies as shown in Figure 1 below. In order to recognize a dangerous situation, object detection must be preceded, and it is important to divide the area within the CCTV image. Although it is referred to as zone detection here, in the vicinity of the cutting tool, the CCTV will be part of the image because it is installed at a fixed elevation. Since the moving object is tracked during data labeling, it can be determined as the same object when training the model. Moving objects, such as forklifts and trucks, and workers can be classified separately and the distance between them can be predicted, thereby determining a collision risk situation.

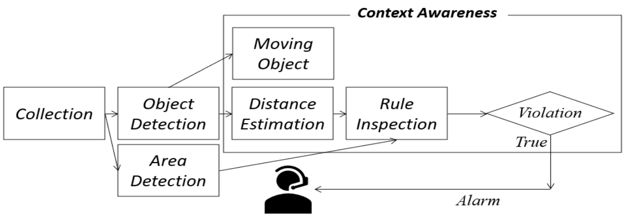


**Fig. 1.** Overall structure

Table 1 shows the scenario selection as follows to classify risk situations separately. In a scenario where two or more simultaneous workers are detected in a hazardous equipment or sanitary equipment area, and a moving object such as a forklift comes in due to the nature of the workplace, it must be detected. Consideration should also be given to the wearing of sanitary equipment during operation or the loading of articles in aisles or corridors. In the case of outdoors, a case in which a moving object such as a forklift or truck collides with a worker should be regarded as a hazardous scenario. In the case of an entrance door, it is to check whether sanitary equipment or safety equipment is worn, so it is common to inspect most of the entrance door, so it was photographed separately.

**Table 1.** Units for magnetic properties

| | Scenario | CCTV Installation |
|---|---|---|
| Indoor | 1. Detection of 2 or more simultaneous workers in hazardous equipment areas | High angle |
| | 2. Detection of more than an appropriate number of simultaneous workers in the sanitary equipment area | |
| | 3. The movement direction of the moving object and the position of the operator within the radius | |
| | 4. Detecting the loading of goods in the aisle area | |
| | 5. Inspection of wearing sanitary equipment while working | Horizontal angle |
| Outdoor | The movement direction of the moving object and the position of the operator within the radius | High angle |
| Entrance | 1. Inspection of wearing sanitary equipment | Horizontal angle |
| | 2. Inspection of wearing safety equipment | |

## III. RESULTS

The implementation result is shown in Figure 2 below. It is a dangerous situation result when an operator collides when a moving object is moving from the outside. The number of dangerous workers is displayed on the upper left, and the red box means dangerous objects. In non-hazardous situations, trucks and forklifts are indicated by yellow boxes, and workers are indicated by green boxes.


**Fig. 2.** Example results for non-dangerous(left) and dangerous(right) situations for moving objects

## IV. DISCUSSION AND CONCLUSIONS

In the dangerous situation warning system developed in this study, scenarios for dangerous situations were selected and built using Darknet API and OpenCV library based on this. In addition, since the environment in which the alarm system is installed may be different, it is implemented using a virtual environment. There are operator and driver identification problems in a moving object, a detection problem in a simple fixed area, a threshold problem and an indicator problem, and it is thought that these points need to be supplemented.

In future research, we will study a system that can help protect the safety of real workers by selecting a more appropriate model, diversifying risk situation determination scenarios, and applying related algorithms by supplementing these points.

## ACKNOWLEDGMENTS

This work was supported by the Korea Medical Device Development Fund grant funded by the Korea government (the Ministry of Science and ICT, the Ministry of Trade, Industry and Energy, the Ministry of Health & Welfare, the Ministry of Food and Drug Safety) (Project Number: P0015365)..

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# Implementation of Multi-LSTM Model for Water Level Prediction

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## Abstract

Recently, many countries around the world have suffered a lot from flooding. In order to minimize damage to human life and property due to flood, it is essential to evacuate quickly through flood prediction. One of the most important factors for judging a flood is river level data. In this paper, we propose a LSTM-based water level prediction model using water level data of the Han River. The performance of the Multi-LSTM model is verified by comparing the results with the Multi-LSTM model proposed in this paper, the Multi-GRU Model based on the GRU model widely used for time series data processing, and the GRU-LSTM model. It is believed that the proposed model can be used as an initial study to identify floods through water level prediction.

**Index Terms**: Gated Recurrent Unit, Long short term memory, Multi-lstm, Time series data, Water level prediction

## I. INTRODUCTION

From the past to the present, many countries, including Korea, have suffered a lot of damage from flooding. If the flood can be predicted in advance and evacuation can be carried out quickly, the financial loss and loss of life due to the flood can be greatly reduced. A number of variables must be considered to predict a flood, but the most important factor is water level. Therefore, in this paper, the upstream water level is predicted by using the upstream and downstream water level data of the river.

Recently, it has been confirmed that it shows good performance in various fields due to the development of deep learning technology, and in particular, it can be confirmed through several studies that RNN (Recurrent Neural Network) has strength in time series data processing [1-4]. The data used in the model proposed in this paper is a time series data set for the water level dataset of Yeojubo in the Han River from 2013 to 2021. A multi-LSTM model was designed to learn the above data and predict the water level, and the results were compared with the RNN-based LSTM and GRU models.

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## II. DATASET AND MODEL

This chapter describes the entire data set and model structure including the data preprocessing process used.

### A. Dataset and Data Preprocessing

#### 1) Dataset

The data used as the learning data are water level data upstream and downstream of Yeojubo in the Han River from October 2, 2013 to November 12, 2021. The upstream and downstream water levels have similar regional characteristics, so they generally have a mutual relationship. The visualization of upstream and downstream data of Yeojubo can be seen in Figure 1.

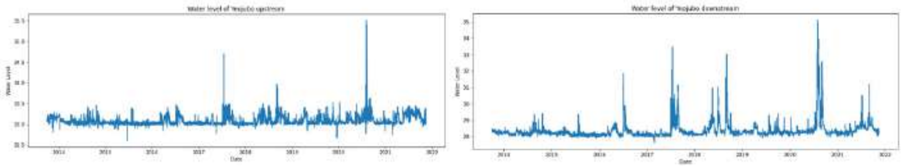

**Fig. 1.** Water level of Yeojubo upstream and downstream

Data were measured every hour, and the total number of data was 71136.

#### 2) Data Preprocessing

In order to improve the performance of the model, data preprocessing was performed. There are missing values due to station anomalies in the data used for training. If the missing values are removed or replaced with an average value, the reliability will decrease due to the continuous nature of the time series data. Therefore, the missing value was replaced with the average value of the data for the past 2 hours and the data for the future 2 hours. After data normalization, the shape of the data was changed to match the GRU model input layer. Finally, data division for training and verification was performed 8:2, and the overall system structure can be seen in Figure 2.

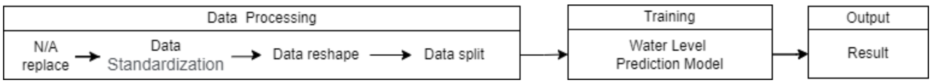


**Fig. 2.** System Structure

### B. Model

Figure 3 shows the configuration of the model. In the input layer, upstream and downstream water level data of the past 20 hours are used as input data. Two LSTM layers are passed through the hidden layer, and the total number of hyperparameters used is 790,785.

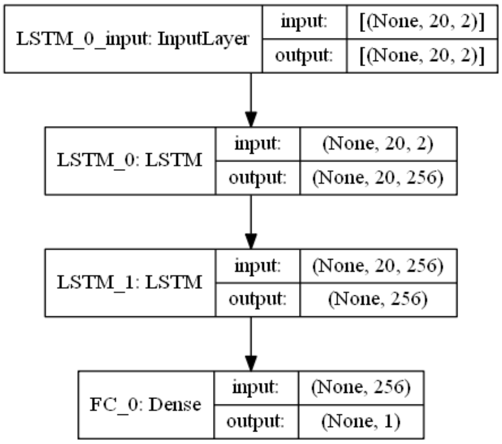


**Fig. 3.** Multi-LSTM Model structure

## III. RESULTS

The Multi-LSTM Model proposed in this paper obtained the best results when comparing the results between the Multi-GRU Model and the LSTM-GRU Model. The data set used is the same as the data described in Chapter 2, epoches is 200, and the optimization function is adam. In addition, the loss function mse is used as a performance evaluation indicator widely used in regression problems. The training results of the three models can be seen in Figure 4, and finally, the results can be seen in Table 1.

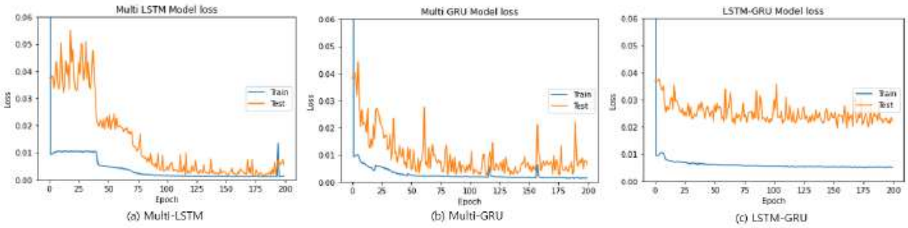


**Fig. 4.** Model train loss graph

**Table 1.** Models comparison result

| | Multi-LSTM | Multi-GRU | LSTM-GRU |
|---|---|---|---|
| **Hyperparameter** | 790,785 | 594,689 | 660,225 |
| **Training Time** | 2248.09sec | 2013.36sec | 2269.84sec |
| **Train Loss** | 0.0011 | 0.0014 | 0.0051 |
| **Validation Loss** | 0.0044 | 0.0065 | 0.0223 |

## IV. DISCUSSION AND CONCLUSIONS

It is very important to predict in advance to minimize flood damage. It was confirmed that the proposed model showed good performance compared to GRU and LSTM-GRU, and very good results were obtained when the actual loss value was checked. If a time-series data-based discrimination model is added in the future by using the model, it is judged that the system will be able to predict future floods and determine the level of risk to determine evacuation in advance. Although a sufficient amount of data is used in this paper, it is judged that better results can be obtained if the spatial characteristics of the upstream and downstream water level data used as input parameters can be studied deeply. As a future study, spatial correlation learning will be conducted to supplement the current study.

## ACKNOWLEDGMENTS

This study was carried out with the support of ´R&D Program for Forest Science Technology(Project No. 2021340A00-2123-CD01) provided by Korea Forest Service (Korea Forestry Promotion Institute).

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# Efficient Computer Aided Foot Stress Fracture Detection

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## Abstract

Accurate diagnosis of bone fracture from X-ray images is hard problem. Inexperienced doctors/technicians may miss shallow cracks on bones that can be developed into stress fracture. Thus, automatic stress fracture detection system is much-needed tool for medical doctors. In this paper, we propose an adaptive Gaussian filtering method to generate robust Difference-of-Gaussian images in the image pre-processing phase of foot stress fracture detection system. The proposed method aims for minimizing the side effect of different filming angles. In experiment, the proposed method is better than the static Gaussian.

**Index Terms**: Stress Fracture, Gaussian Filtering, X-ray, Bone Area Extraction

## I. INTRODUCTION

Stress fracture refers to the bone condition having tiny cracks caused by repetitive force often from overuse but. it can be also developed from normal use of a bone that's weakened by a condition such as osteoporosis. There are three normal situations such as accidents [1], bone malignancy [2], and heavy load [3] encountering with such condition. Stress fractures are most common in the weight-bearing bones of the lower leg and foot thus track and field athletes and military solders carrying heavy packs over long distances are at highest risk.

Diagnosing stress fractures can be challenging and warrants consideration of the differential diagnosis, based on location. When stress fracture is suspected, plain radiography should be obtained initially but it may need magnetic resonance imaging (MRI) test if urgent. It is reported that these two modalities have similar level of sensitivity bit MRI has higher specificity [5] but X-ray is preferred since it is cheap and convenient for first examination. However, due to common characteristics of an x-ray image that are greyscaled colour space, high noise, low intensity, poor contrast, and weak boundary representation, inexperienced doctors may make diagnostic error in Accident and Emergency (A&E) units with missing fractures visible in X-ray images [6].

Stress fractures often aren't visible on X-rays immediately after the injury. The fracture may become visible a few weeks after the injury takes place, when a callus has formed

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around the healing area. Even if the prediction is positive, it is rather difficult to understand if a surgically invasive procedure is necessary to heal it. Thus, we need compiter aided monitoring system for more correct diagnosis.

Automatic bone fracture detection systems typically examine if the X-ray image contains edges or objects that are not negligible size and recognized as a crack. In order to achieve that goal, the system typically has image preprocessing phase to enhance the quality of image, followed by image segmentation, feature extraction, and fracture classification [7,8].

In this paper, we propose an adaptive Gaussian filter for enhancing quality of X-ray images that have foot stress frastures. Gaussian filtering is a basic yet powerful filtering algorithm in noise reduction. Due to the fuzzy nature of X-ray image for stress fracture detection, we need to enhance the qquality of the image in the pre-processing phase, We propose an adaptive Gaussian filter in which the size and position of the filter are dynamically set according to the angle of the photographing part. Adaptive dynamic Gaussian filters have been successfully applied to many engineering and medical domains to have noise removed images [9-11].

## II. METHODS

The Gaussian filter is known as a 'smoothing' operator, as its convolution with an image averages the pixels in the image, affectively decreasing the difference in value between neighboring pixels. In Gaussian filtering, one can use either Low pass filter(LPF) or High pass filter(HPF). In this paper, we use HPF and construct Gaussian pyramids. The algorithm is as follows

| Adaptive Gaussian Filtering Process |
| --- |

Step 1. Generate HPF Image by applying the filter shown in equation (5)

$$HPF = \frac{1}{9} \times \begin{pmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{pmatrix} \quad (5)$$

Step 2. Explore the HPF image with 9x9 mask and perform binarization with threshold such that the center of the mask becomes 'white' if the high-frequency component in the mask is higher than the ratio of the foot area in the entire image, otherwise, it is binarized to black.

Step 3. Explore the resultant image with 45 x 45 mask and set the Gaussian point as the center of gravity of it contains both black and white.

Step 4. Compute the Gaussian standard deviation as equation (6)

$$\delta = \frac{(FilterWidth-1)/4}{1+e^{-2(d-\frac{SearchFilterWidth}{2})}} \quad (6)$$

Step 5. Generate Gaussian Filter with respect to the result of Step 4 and apply it to the Gaussian point generated at Step 3.

The characteristics of the X-ray image may vary according to the angle of the specialist and the area to be photographed. Therefore, when a static standard Gaussian filter is applied to remove the skin area from the image, the filtering performance os expected to be sensitive to the environment. Thus, we propose an adaptive Gaussian filter as following with HPF.

## III. RESULTS

The proposed method is implemented using Visual Studio 2017 C# with Intel® Core™ i5-6200 CPU @ 2.50GHz and 8GB RAM with 18 X-ray foot images containing stress fractures obtained from Baek Hospital located in Busan, Korea. Figure 1 shows the process of the proposed Stress Fracture bone area extraction.

(a) Input Image (b) Binarized HPF

(c) Binarized by Center of Gravity (d) Final Result

**Fig. 1**. Effects of Proposed Adaptive Gaussian Filtering Processes

## IV. DISCUSSION AND CONCLUSIONS

Early and accurate bone fracture detection is one of important problems to maintain and secure the quality of life. Stress fracture is typically discovered after a rapid increase in exercise. These conditions can be commonly noticed in athletes and military individuals as well as older citizens whose quality of life can be affected.

In this paper, we propose an adaptive Gaussian filtering method to separate skin area and bone area nore robust than the static Gaussian filter for correct monitoring and detection of foot stress fracture images. This step is one of pre-processing of stress fracture detection system but we try to minimize the effect of different angles of X-ray testing in real world testing situation. In experiment, the proposed system shows better performance than the static one for all tested images. However, the difference between them is not that much.

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# Shortest Distance Algorithm Based Path Detection System in case of Flash Flood

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## Abstract

In recent years, the damage caused by natural disasters has increased, resulting in loss of life and property. Among these natural disasters, disasters affected by the seasons have flood damage. Damage due to typhoons or the rainy season increases with the concentration in summer, and countermeasures and research related to disaster response are being conducted to prevent such damage. In this paper, as a study related to disaster response, we propose a path detection system based on the shortest distance algorithm in the event of a flash flood centered on the forest area selected as the test bed. If the selected area is provided to the user by using the Dijkstra algorithm, which creates a route using shape and GPX file of terrain data using QGIS (Quantum Geographic Information System), and provides the shortest distance in case of a flash flood, the route is searched and provided to the user. We believe that we will be able to safely evacuate from disaster damage that may occur in the future.

**Index Terms**: Dijkstra algorithm, flood, GPX, path detection, Quantum Geographic Information System, shortest distance

## I. INTRODUCTION

Recently, as the damage caused by natural disasters has increased worldwide, there have been rapid signs of climate change beyond climate change to the term climate emergency and climate crisis, and the amount of damage from natural disasters in Korea is also on the rise. Among natural disasters in Korea, flood damage is a disaster caused by flooding basin topography, valleys, rivers, or rivers beyond average as precipitation due to torrential rains, which is the biggest factor, increases. These floods are concentrated in summer, leading to damage to lives and property caused by typhoons or rainy seasons[1].

Flood damage caused by precipitation cannot flow into rivers due to various factors, so flooding out of levees or flooding areas other than rivers also occurs in forest areas. When rainfall occurs in forest areas, it is absorbed into the ground, permeated into the underground rock, and groundwater and sewage surfaces increase, resulting in surface flow. It is

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impossible to predict at what point the amount of water absorbed from the place where this surface stream occurs, escaping into valleys, rivers, and rivers, leading to flooding[2,3].

To solve this problem, a path detection system using the shortest distance algorithm is proposed by identifying the user's location in an unexpected flood situation. In this paper, terrain, track log, and buildings are generated as data using shape and GPX file using QGIS application program, and path detection system is designed and implemented using Dijkstra algorithm. In the event of an unexpected situation, the current location is identified using user GPS data, and information on the shelter and evacuation route are detected and provided. It is considered that the proposed evacuation route system will reduce casualties by providing the shortest evacuation route close to user's location[4-7].

## II. SYSTEM DESIGN

When the user agrees to the location information, the user's location is searched. QGIS generates data in the form of terrain, track logs, buildings in the form of shape and GPX file, and stores information such as the name and address of the recreational forest using public data. Database stores and manages data collected in advance, identifies the user's location, and prepares for unexpected situations.

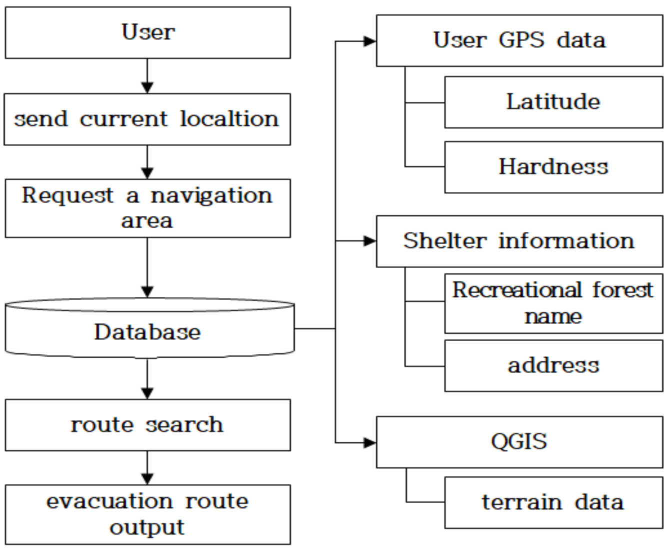


**Fig. 1.** Overall structure

Based on track (link) log (node) data on the recreational forest walk generated by QGIS, a path detection system is proposed using Dijkstraalgorithm, the shortest distance algorithm. GPS is used to identify the current location, and in the event of a flood, an evacuation route is detected to provide the nearest evacuation center and evacuation route. In the event of an unexpected situation, the user's location is searched, risk notifications are provided to users, and routes are detected and provided to users using the shortest distance algorithm, the

Dijkstra algorithm.

**Table 1.** Units for magnetic properties

| | Scenario |
|---|---|
| User detection. | I agree with the location information to the user. |
| Situation detection. | Identifying the location with user GPS data |
| | 1. In the event of a flood |
| | - Exploring the evacuation route. |
| | 2. If there is no flood situation |
| | - Identifying the location with user GPS data. |
| Exploring the evacuation route | Provide the shortest route evacuation route to the nearest evacuation center.<br>In the event of an unexpected situation in the route of movement, the route is rediscovered at the current location and provided. |

## III. RESULTS

The implementation result is shown in Figure 2 below. In order to implement the building and topography created in QGIS in SHP form and display the data on the map, install it through the TMS for korea plugin and visualize the map in the QGIS Tool using the kakao Map API. The result of detecting the shortest path with the Dijkstra algorithm based on the track log GPX data of the visualized map is shown.

**Fig. 2.** Example results for non-dangerous(left) and dangerous(right) situations for moving objects

## IV. DISCUSSION AND CONCLUSIONS

In this study, we propose a path detection system based on the shortest distance algorithm in the event of a flood. Using QGIS and Dijkstra algorithm, we built a system for detecting the shortest route in Python using the topographic data and GPS data collected from mobile devices. In this paper, it works when the system arbitrarily sets the origin and destination, and outputs the route. However, in order to solve these problems, practical data is needed. In order to supplement these problems through future research, based on actual data, a flood occurs unexpectedly even in the process of evacuation. A study to detect a new path by stopping at the current location and searching again is planned as a future study.

## ACKNOWLEDGMENTS

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# Analysis of User's Emotional Responses in Interactive Immersive Display

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## Abstract

This study aimed to see the users' emotional responses during experiencing the interactive immersive display. Specifically, the users' emotional responses during experiencing 3D display using LeapMotion and not used LeapMotion were analyzed by facial expression through FaceReader™ software. FaceReader™ provides a means to analyze emotional responses to stimuli, specifically the type of emotion, valence (positive/negative) and arousal (immersion) via facial expression. Frog and Man contents were used for the experiment, and the experiment was conducted with a total of 4 adults. As a result of our study, it can be seen that the user's positive emotions and immersion level are high when the content is directly manipulated through LeapMotion. In order for the newly developed contents for interactive immersive display to lead high immersion and presence of the users, users' responses of emotion should be reviewed in more various points of view.

**Index Terms**: Emotional Responses, FaceReader, Facial Expression Recognition, Interactive Display, Interaction

## I. INTRODUCTION

As the realistic image display technology develops, such as augmented reality, mixed reality, virtual reality, users have become more actively participated in experiencing these media [1-2]. This spotlights the development of interactive technology for realistic image display media, which focuses on the interaction between the user and the media [3]. A method that reflects the user's thoughts and intentions to trigger reactions with the device is used with the aim of enabling the user to more actively participate and experience a higher degree of immersion and amusement. This has also led to the development of diverse content that is capable of interaction to maximize the effect of the interactive immersive display media.

On the other hand, in terms of interactive immersive display media development, it is very important to understand and measure user's immersion and emotions. Both verbal and nonverbal behaviors can be used as a measure of the emotion of humans. In particular, nonverbal communication includes all forms of communication other languages and consists of physical behaviors commonly referred to as body languages, gestures, and facial

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expressions. Among these, facial expressions are considered to be essential to the expression of emotions because human faces provide useful information about feelings and the inner state of an individual [2].

FaceReader, an automatic facial expression recognition software program, was used to analyze the users' emotions in our study [4]. Using FaceReader software, instant emotions are measured at the moment of experience interactive immersive display. FaceReader provides a means to analyze emotional responses to stimuli, specifically the type of emotion, valence (positive/negative) and arousal (immersion) via facial expression [5].

Against this background, the present study aimed to see the users' emotional responses during experiencing the interactive immersive display. The user's emotional responses were analyzed by facial expressions through FaceReader software.

## II. EXPERIMENTAL PROCEDURE

In order to analyze the emotions of users who watch the immersive display device, the experiment was conducted in the order shown in Fig. 1. Frog and Man images were used for the experiment, and the experiment was conducted with a total of 4 adults. By linking the two contents with LeapMotion, the users can directly manipulate the contents.

The captured video was analyzed for valence and arousal through FaceReader, an emotion analysis tool.

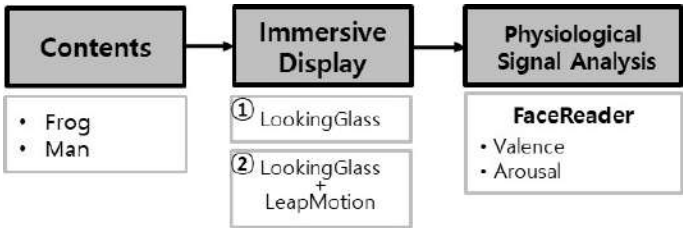


**Fig. 1.** Experimental procedure

## III. RESULTS

Fig. 2 shows the result of analyzing the reaction of the first experimenter through FaceReader. The experimenter's reaction to Frog and Man contents was analyzed through changes in Valence and Arousal. Through the results in Fig. 2, it is possible to confirm the change in the user's Valence and Arousal level who use the immersive media.

Table 1 shows the results of calculating the average value and standard deviation for the analysis results shown in Fig. 2. It can be seen that the range of emotional changes of users who directly manipulate content is large and positive emotions are high.

As a result of the analysis in Fig. 2 and Table 1, it can be seen that the user's positive emotions and immersion level are high when the content is directly manipulated through LeapMotion.

In [6], the range of user's emotional change was examined for one content, but in this paper, the correlation between emotional change and immersion was also analyzed for various content.

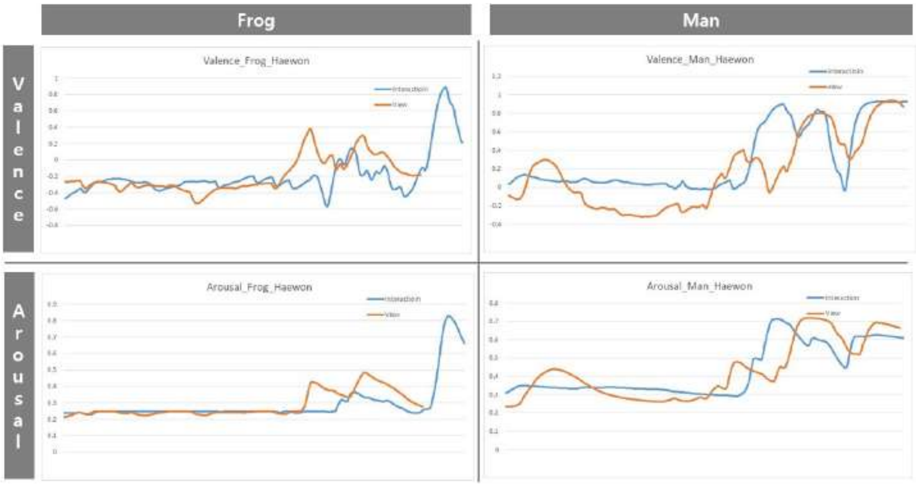


**Fig. 2.** Analysis results

**Table 1.** Analysis results(detailed)

| | | Valence | | Arousal | |
|---|---|---|---|---|---|
| | | Interaction | View | Interaction | View |
| Frog | Min | 0.57171 | -0.53227 | 0.228681 | 0.215341 |
| | Max | 0.888645 | 0.383883 | 0.826846 | 0.486014 |
| | Aver | 0.19039 | 0.19506 | 0.293718 | 0.286794 |
| | Std | 0.265186 | 0.202516 | 0.126509 | 0.074482 |
| Man | Min | 0.03489 | 0.31729 | 0.29255 | 0.233877 |
| | Max | 0.928567 | 0.938885 | 0.71245 | 0.717804 |
| | Aver | 0.308542 | 0.172534 | 0.431111 | 0.428534 |
| | Std | 0.358066 | 0.392394 | 0.138861 | 0.155958 |

## IV. DISCUSSION AND CONCLUSIONS

In this paper, users' emotional responses analyzed by FaceReader showed that some difference appeared between experiencing images using LeapMotion (interaction) and unused LeapMotion images.

In order for the newly developed contents to lead high immersion and presence of the users, users' responses of emotion should be reviewed in more various points of view.

## ACKNOWLEDGMENTS

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# Fall Detection System Applying Parameters Processed by Accelerometer Data to Long-short Term Memory

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## Abstract

In this paper, we introduce a long short-term memory (LSTM)-based fall detection system using TensorFlow that can detect falls occurring in the person in daily living. 3-axis accelerometer data are aggregated for fall detection, and then three types of parameter are calculated. 4 types of activity of daily living (ADL) and 3 types of fall situation patterns are classified. The parameterized data are applied to LSTM. Learning proceeds until the Loss value becomes 0.5 or less. The best accuracy was 99.28% in both of the double parameter $P_{TGD}$ combined with angle and gravity-weight differential sum vector magnitude (GDSVM) and the multiple parameter combined with all parameters so that it is approximately same to that of the previous hidden Markov model (HMM).

**Index Terms**: Tensorflow , Fall detection, The elderly, Long short-term memory(LSTM)

## I. INTRODUCTION

In recent, as Korea's aging population intensifies, the number of falls due to various senile diseases such as knee arthritis, one of the problems with the increase in the elderly population, is increasing. A fall detection system was devised to solve the inconvenience of the elderly due to such a fall problem. The fall detection system using the 3-axis accelerometer were reported [1-3]. One of the best accuracy of the fall detection system is an existing application of 3-axis acceleration sensor data with various parameters to the hidden Markov model (HMM), one of machine learning [1]. With the development of deep learning technology, there is a need to develop a fall detection system applying deep learning.

In this paper, we present a fall detection system using deep learning based on the long short-term memory (LSTM) [4,5] that can learn sequential data patterns. This paper describes the accuracy of each parameter by learning the parameterized data using the 3-axis accelerometer using the LSTM. Sec. II briefly describes the LSTM-based fall detection system. Sec. III compares the learned fall detection results, and Sec. IV presents the conclusion.

## II. FALL DETECTION SYSTEM

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Unlike a simple artificial neural network model, LSTM has a cyclic structure in which past events can affect future results, so it is used in various fields such as translation, speech recognition, and stock price prediction.

Figure 1 shows the fall detection algorithm. First, the data in real time from the 3-axis acceleration sensor attached to the body of peoples are aggregated, and then parameters, angle ($\theta$), sum vector magnitude (*SVM*), differential *SVM* (*DSVM*), gravity-weight *SVM* (*GSVM*), and gravity-weight *DSVM* (*GDSVM*) are calculated [1]. The parameters are applied to the LSTM for learning process. When the conditions are satisfied, several parameters are inferred by applying them to LSTM to classify a fall. For learning process of LSTM, the max-min data normalization process [4] and L2 loss function normalization [5] for optimal normalizations are applied and the optimal lambda values for regularization are found in advance.

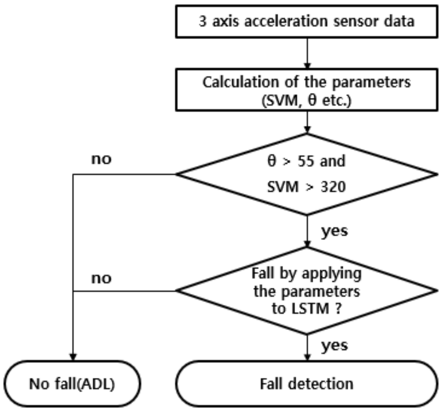


**Fig. 1.** Fall detection algorithm using LSTM

## III. INFERENCE RESULTS

Seven behavioral patterns (4 types of daily life: walking, lying, running, jumping, and 3 types of falls: fall forward, fall sideways, and fall backward) were investigated. The experiment consisted of 6 healthy volunteers (4 males and 2 females) [1]. The age is 20~50 years old, the height is 160~180 cm, and the weight is 50~85 kg. A 20 cm thick mattress was used for the fall experiment. For the experimental data, a total of 140 data were used, 15 for each of the 7 patterns of 2 males in their 20s and 2 females in their 20s, and 10 for each pattern of the remaining 2 males in their 40s and 50s. Performance of fall detection are tested with Accuracy, Sensitivity, and Specificity [1].

Table 2 shows the inference results by each parameter. Each single parameter was trained. Each double parameter was combined as follows:

1. Double parameters: $P_{TS}$ means the double parameter combined with $\theta$ and *SVM*, $P_{TD}$ means one combined with $\theta$ and *DSVM*, $P_{TG}$ means one combined with $\theta$ and *GSVM*, and $P_{TGD}$ means one combined with $\theta$ and *GDSVM*.
2. Multiple parameter: $P_{ALL}$ means the multiple parameter combined with all parameters.

Highest accuracy was 99.28% in both cases of $P_{TGD}$ and $P_{ALL}$, highest sensitivity was 100% in case of *SVM*, and highest specificity was 99.1% in case of *GDSVM*.

**Table. 1.** Confusion matrix of inference results by parameters

| type | parameter | accuracy | sensitivity | specificity |
|---|---|---|---|---|
| single | $\theta$ | 96.9% | 99.37% | 93.1% |
| | *SVM* | 98.75% | 100% | 97% |
| | *DSVM* | 97.5% | 98.75% | 95.8% |
| | *GSVM* | 98.57% | 99.68% | 97.0% |
| | *GDSVM* | 99.1% | 99.0% | 99.1% |
| double | $P_{TS}$ | 98.75% | 99.0% | 98.3% |
| | $P_{TD}$ | 98.75% | 99.0% | 98.3% |
| | $P_{TG}$ | 93.39% | 98.43% | 86.6% |
| | $P_{TGD}$ | 99.28% | 99.6% | 98.75% |
| multiple | $P_{ALL}$ | 99.28% | 99.6% | 98.75% |

## IV. Conclusions

LSTM was applied using the parameters processed from the raw data of 3-axis acceleration sensor attached to the body of the elderly. The more several parameters were combined, the better the results tended to appear. The best accuracy was 99.28% in both of the double parameter $P_{TGD}$ combined with angle and *GDSVM* and the multiple parameter combined with all parameters, so that it is approximately same to that of the previous hidden Markov model (HMM).

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# Various Positions of Optical Phase Conjugator in Dispersion-managed Optical Link for WDM Transmission

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## Abstract

The dispersion-managed (DM) link combined with optical phase conjugation for wavelength division multiplexed signals is proposed and discussed. In proposed DM link, the position of optical phase conjugator (OPC) is various including midway of total transmission length. This various OPC position will be contribute to expand the flexibility of DM link design and implementation.

**Index Terms**: Various position of optical phase conjugator, Dispersion-managed link, WDM transmission, Flexibility of link configuration, Residual dispersion per span.

## I. INTRODUCTION

It is required to compensate for the optical signal distortion due to group velocity dispersion (GVD) and Kerr nonlinear effects, such as self-phase modulation (SPM), cross-phase modulation (XPM), and four-wave mixing (FWM) [1, 2], especially the wavelength division multiplexed (WDM) transmission system. Dispersion-managed (DM) optical link combined with optical phase conjugation is one of the candidate technology for compensating the WDM signal impairments. Authors also had reported 40 Gb/s × 24 channels WDM transmission system with good receive performance was implemented by applying the combined DM and OPC into optical links through the previous work [3-5].

In this paper shows another attempt to expand the flexibility of DM link combined optical phase conjugation. Optical phase conjugator (OPC) in the proposed link has to be placed at the various position as well as midway of total transmission length.

## II. MODELLING OF DM LINK WITH OPC

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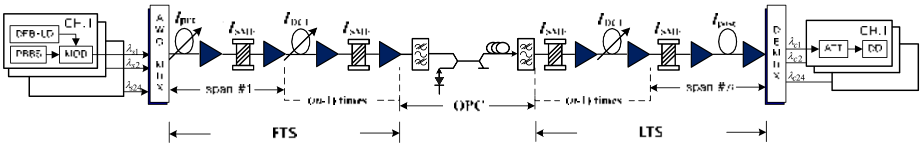

**Fig. 1.** Configuration of optical links and WDM transmission system

Fig. 1 shows DM link embedded with OPC for WDM transmission of 24 channels x 40 Gb/s. The total transmission link consists of 80 fiber spans, i.e., $m+n = 80$ in Fig. 1. Number of the former transmission section (FTS) and the latter transmission section (LTS) are $m = n = 40$ in the midway OPC link. The main object in this research is to investigate the compensation in DM link with various OPC position. Besides the midway OPC, the various non-midway OPC positions are represented as 'FTS versus LTS', such as 1vs9 ($m = 8$ and $n = 72$ in Fig 1), 2vs8, 3vs7, 4vs6, 6vs4, 7vs3, 8vs2, and 9vs1.

The length of the SMF in every configuration, $l_{SMF}$, is assumed to be 80 km. Furthermore, the SMF is characterized by attenuation coefficient $\alpha_{SMF} = 0.2$ dB/km, dispersion coefficient $D_{SMF} = 17$ ps/nm/km, and nonlinear coefficient $\gamma_{SMF} = 1.35 W^{-1}km^{-1}$ at 1,550 nm. On the other hand, the DCF of every fiber span is characterized by dispersion coefficient $D_{DCF} = -100$ ps/nm/km, attenuation coefficient $\alpha_{DCF} = 0.6$ dB/km, and nonlinear coefficient $\gamma_{DCF} = 5.06\ W^{-1}km^{-1}$ at 1,550 nm.

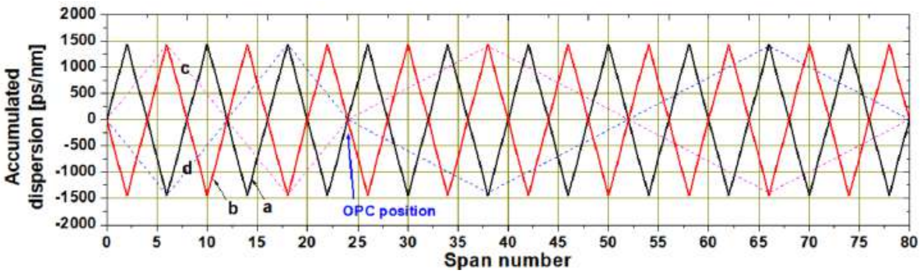

**Fig. 2.** Dispersion maps in 3vs7 configuration

We also investigate the effect of dispersion map on the compensation of WDM channels. Two specific schemes are considered for this; first is called as 'uniform period type,' in which the residual dispersion per span (RDPS) of each fiber span is decide to repeat the shape of dispersion profile every 8 fiber spans, shown in "a" and "b" marked in Fig. 2. The "a" scheme is formed with positive triangular-wave shape precede inverse triangular-wave shape, this is marked as "PN-TW" shape, on the other hand, the "b" scheme is antitypical with "a," this is marked as "NP-TW" shape. The other is called as 'only one cycle type,' in which only one of positive triangular-wave profile and inverse triangular-wave profile is presented for each transmission section, shown in "c" and "d" marked in Fig. 2. The "c" scheme marked as "PN-TW" shape, and the "b" scheme is marked as "NP-TW" shape.

The RDPSs of every fiber spans are assumed to be ±720 ps/nm in 'uniform period type.' The maximum accumulated dispersion is 1440 ps/nm, for this reason, the RDPS of each fiber span is decided to be the value required for the maximum dispersion to be 1440 ps/nm in each transmission section in 'only one cycle type.'

It is needed to control NRD of each half section by using the arbitrary span to obtain the optimal value for the good compensation. DCF length of the first fiber span i.e., $l_{pre}$ is used to determine NRD of former half section, on the other hand, DCF length of the last fiber span i.e., $l_{post}$ is fixed for completed-compensation of latter half section, i.e., NRD = 0 ps/nm in latter half section.

And the configurations and parameters of 24-channels WDM transmitter and receiver, and OPC illustrated in Fig. 1 is assumed to be the same with those in Ref. [5-7] of our previous research.

## III. RESULTS AND DISCUSSION

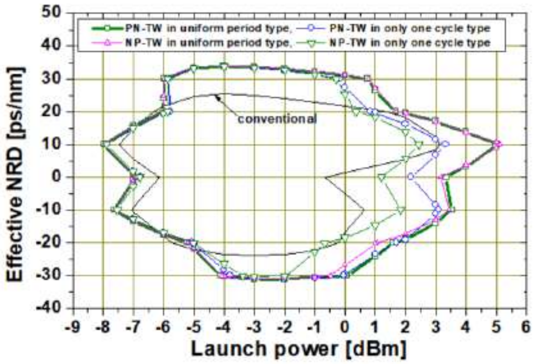


**Fig. 3.** The effective NRD range contours in 5vs5 configuration

Fig. 3 illustrates the effective net residual dispersion (NRD) range of the worst channel among 24 WDM channels as a function of the channel launch power in 5vs5 configuration. It is confirmed that the proposed 4 DM schemes are more effect to compensate for the distorted WDM channels than conventional DM link. The conventional DM link is configured by uniform RDPS of 0 ps/nm in every fiber spans.

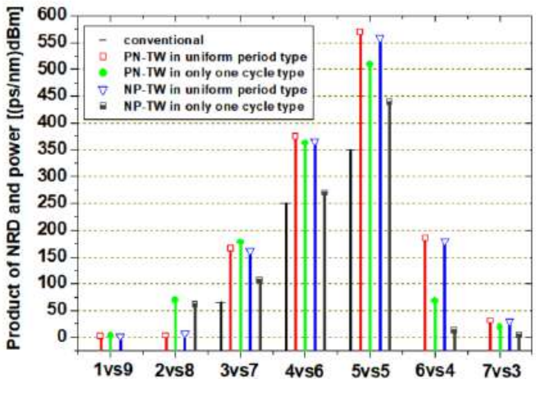


**Fig. 4.** The product of NRD and launch power.

Fig. 4 shows the product of NRD and launch power, which is obtained from the result of the effective NRD contour such as Fig. 3. The results of 8vs2 configuration and 9vs1 configuration are not presented in Fig. 4, since these products are not obtained. It is first confirmed that the proposed DM schemes are effective to compensate for the distorted

WDM signals, irrelevant with OPC positions. And, in viewpoint of dispersion map profile, it is also shown that uniform period type is better than only one cycle type.

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# Indoor Position Learning Technique for Smartphone Environments based on Fuzzy Logic and Wireless Raw Signals

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## Abstract

Accurate indoor positioning with wireless signal has been a great challenge for decades. A variety of techniques proposed to advance the positioning accuracy by means of the convergence of existing technologies. Signal fingerprint is the most common approach for building environments due to its significantly low device cost over the other techniques. In this study, we propose fuzzy logic-based indoor position learning technique using fuzzy c-means clustering and fuzzy decision tree for smartphone environment. Among the available signals from smartphone, we mainly use raw RNSS signals from satellite and Wi-Fi beacon signals from telecommunication providers as feature to develop the learning model. Position learning consists of two elements; building fuzzy decision tree and classify fuzzy and less-fuzzy data. Firstly, it builds Fuzzy Decision Tree based on the preceding FCM clustering result. Next, it recursively repeats the process on its subtrees until they are not classified as more than one class. The method has a great generality owing to the following two reasons; it can exploit all the available wireless signals for smartphone, and it differently establishes the learning structure depending on the data.

**Index Terms**: Fuzzy Decision Tree, Indoor Positioning, Localization, Signal Fingerprint

## I. INTRODUCTION

According to the beginning of the era of hyper-connectivity, lots of human-made stuff has been linked into one with Information and Communication Technologies (ICT). In recent, extended Reality (xR) technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (MR) show marked improvement. Despite that these kinds of xR reality that create new space via the blending of virtual space and real space is at the make-or-break moment, indoor positioning technology is still in challenging period. Contrary to the outdoor positioning technology that can exploit global positioning system (GPS) to measure outdoor location with high accuracy and high precision, indoor location technology is extremely difficult to exploit the GPS signals since trilateration technique, or the main method to measure the position, generally needs more than three stable signals for accurate measurement.

Signal fingerprint [1] is one of the most active research fields of indoor positioning. The technology typically consists of the following two steps; (i) to deduce learning model, it collects the unique signal characteristics in each grid-divided subspace for hours, and (ii) it estimates the current location from the signal collected now based on the learning model in (i). Depending on what technology aims for, the learning modeling method varies [1-4].

In the study, we propose a method for indoor position learning in smartphone environment. The method exploits fuzzy c-means (FCM) clustering [5] and fuzzy decision tree (FDT) [6] to generate the learning model. In addition, it exploits all the raw radionavigation satellite service (RNSS) signals [7] available in smartphone environments as well as Wi-Fi RSS and wideband code division multiple access (WCDMA).

## II. SYSTEM MODEL AND METHODS

The proposed method is aimed to derive more accurate GPS coordinates than pure GPS system by exploiting weak GNSS signals, and Wi-Fi beacon. The system consists of the following three steps: (i) signal collection, (ii) position learning, and (iii) measurement.

### A. Available RNSS Signals in Smartphone Environments

In the proposed method, all the raw GPS signals, and the recently measured GPS coordinate are used. Moreover, in the Android Developer Community, GNSS logger [8] that can collect and visualize the raw GPS signals such as GPS, global navigation satellite system (GLONASS), Quasi-Zenith Satellite System (QZSS), etc., including Cabinet Office.

Provided GPS coordination shows large error as the measurer lies deeper inside since the number of RSS decreases due to the obstacles. In our testbed environment, as the smartphone moves towards the inside of the building, the number of the observed satellites decreases by 2.5 per meter in average.

### B. Signal Collection Method

Our signal collection application is made based on RNSS logger; it consists of scan manager, plot manager, and collection manager. Scan manager controls to collect Wi-Fi and RNSS signal strength, plot manager visualizes the collected RSS, and collection manager transmits the collected data to the collection platform through REST API. The data collection is conducted in a building located in Silla University, Busan, Republic of Korea. The building has the size of 100m of width, 20m of length, and 20m of height.

### C. Indoor Position Learning

The learning method consists of the following two steps. Firstly, the collected data are classified by FCM clustering algorithm, and FDT is generated based on the membership derived by FCM clustering. Secondly, the method recursively repeats the first process with the subtrees until the data is no longer classified.

# III. RESULTS

## A. Data Sets and Classification Methods

To evaluate the performance of the proposed method, we use the two types of data sets as following: (i) SET1 – only Wi-Fi, and (ii) SET2 – Wi-Fi and RNSS signals. Moreover, both only FCM, and FDT-based FCM are used for the evaluation.

## B. Classification Result

Table 1 shows the F1 score of the classification result of the two algorithms. In the case of only FCM, none of Aisle-to-Aisle Inside data is classified. Even when we intentionally increase the number of clusters from 18 to 720, the result remained as NaN. On the other hand, FDT-based FCM partially succeeded to classify the indoor locations.

**Table 1.** F1 Score of Classification Result

| Algorithm | Window-to-Window (20m) | | Aisle-to-Aisle Inside (100m) | | Between-Stairs (20m) | |
|---|---|---|---|---|---|---|
| | SET1 | SET2 | SET1 | SET2 | SET1 | SET2 |
| Only FCM | 99.96 | 97.19 | NaN | NaN | 100 | 66.41 |
| FDT-bsed FCM | 99.81 | 99.22 | 78.71 | 51.12 | 100 | 94.27 |

We must consider the characteristic of Aisle-to-Aisle Inside. There does not exist any obstacles in the aisle being different from Window-to-Window and Between-Stairs. That is, no factor causes the steep decline of the signal strength. Thus, several clusters have extremely high similarity.

**Table 2.** Precision of Data Set Failed for Classification

| Data Set | Position in Aisle-to-Asile Inside (x 6m scale) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| SET1 | 49.88 | 49.75 | 61.41 | 60.90 | 61.66 | 88.47 | 41.95 | 80.89 | NaN | NaN | 32.78 | 94.13 | 34.02 | NaN | 53.79 | 81.89 | 83.28 | 69.95 |
| SET2 | 51.82 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | 15.93 | NaN | NaN | NaN | 22.78 | NaN | NaN | 15.48 |

Table 2 shows the precision of the classification by only FCM algorithm. In detail, the positions with NaN value of precision are indeed classified as non-NaN valued neighbor class. For example, position 9 and 10 of SET1 are mostly classified as position 11. Thus, the precision of 11 dramatically decreases, and 9 and 10 have zero precision. This result indicates that a part of the clusters does not have sufficient distance to be classified as different class.

## IV. DISCUSSION AND CONCLUSIONS

In this paper, we proposed a basic indoor position learning method with GNSS signal and Wi-Fi beacons. Our unsupervised learning method exploits FCM clustering and FDT algorithm recursively. Our proposed method outperforms the typical FCM clustering algorithm. However, against our expectation, the dataset with GNSS signals shows the worse classification performance than the dataset with only Wi-Fi beacon strength.

According to the classification result, SET1, or only Wi-Fi beacon, is sufficient for indoor localization to get a good performance. The shortage of the dataset, however, can never automatically be mapped to common global mapping system; supervisor input the GPS coordinates of each indoor position manually so that the measuring device can recognize the position in the real world. Therefore, our future work include the following two goals; (i) improvement of positioning accuracy with RNSS signal, and (ii) automatic mapping method to common GPS coordinate.

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# Q-learning Based MAC Protocol for CR Networks

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## Abstract

Ad-hoc CR (cognitive radio) network is a network technology that can overcome the shortage of frequency resources due to the increase of radio services. In an ad-hoc CR network, there is a need for a medium access control technology that can access a channel while minimizing interference to the primary user. In this paper, we designed an ad-hoc CR MAC protocol that can significantly improve transmission efficiency using Q-learning, which is one of the recently actively studied reinforcement learning, and compared and analyzed its performance through simulation. Through reinforcement learning, it was possible to increase the throughput and improve the transmission efficiency by attempting channel sensing and access for channels with a high possibility of being idle.

**Index Terms**: Cognitive Radio, Medium Access Control, Channel Sensing, Ad-hoc networks, Multi-channel

## I. INTRODUCTION

In a cognitive radio network, a spectrum hole should be allocated to the SU(secondary user) to prevent interference to the primary user. In addition, when the secondary user recognizes the appearance of the primary user, it must immediately switch to another spectrum band. As such, studies on the medium access control method for cognitive radio networks are being actively conducted [1]-[2]. Various opportunistic channel access techniques have been proposed in a multi-channel environment but system complexity greatly increases in recognizing the traffic characteristics and channel environments of the primary user and selecting an idle channel [3]. In ad-hoc cognitive radio network, since there is no centralized network, adaptive response to the rapidly changing network environment becomes a bigger technical problem. In order to solve this problem, various studies are being conducted to apply reinforcement learning to the media access protocol. Reinforcement learning makes it possible to derive the optimal performance of a system according to network changes by adaptively and rapidly analyzing multidimensional input data through learning according to a given algorithm [4]-[5]. In this paper, using Q-learning, we designed a MAC protocol that has the ability of terminals to learn from past environments and behaviors. Through this, we derive a channel sensing and channel

* Corresponding author

selection technique that can minimize interference to primary users and increase transmission efficiency in a distributed network.

## II. Q-learning based CR MAC protocol

In this paper, Q-learning base CR MAC selects the optimal idle channel according to the traffic characteristics of the primary user, and the amount of computation can be reduced by using stateless Q-learning. Stateless Q-learning method that does not consider the state space and given by

$$Q_{t+1}(m) = (1-\alpha)Q_t(m) + \alpha r_{t+1}(m) \tag{1}$$

In this case, action $m$ means selection of a spectral channel, and $Q(m)$ represents the Q value of the selected channel $m$, and $\alpha$ is learning rate. Accordingly, all SUs store the Q value for each channel. In this paper, the reward value $r$ returns –1 for transmission failure and 1 for successful data transmission.

In ad-hoc CR networks, there is no base station that controls the network, so the terminal itself must select a channel and decide data transmission. For a distributed network, an out-of-band common control channel (CCC) for exchanging RTS/CTS control signals is used as shown in Figure 1. Figure 1 shows the proposed CR MAC protocol. The figure shows an example of data transfer from A SU to B SU. As shown in this figure, the transmitting node acquires the common control channel CCC and transmits the RTS packet. At this time, the transmitting node selects $n$ candidate channels, and transmits the corresponding channel number and its Q value together to the receiving node through RTS. The receiving node averages the Q values for the $N$ candidate channels using its own Q table, re-prioritizes the channels according to the average Q values, and transmits them to the transmitting node through CTS. That is, the candidate channel set is included in the CTS according to the order of the average Q values.

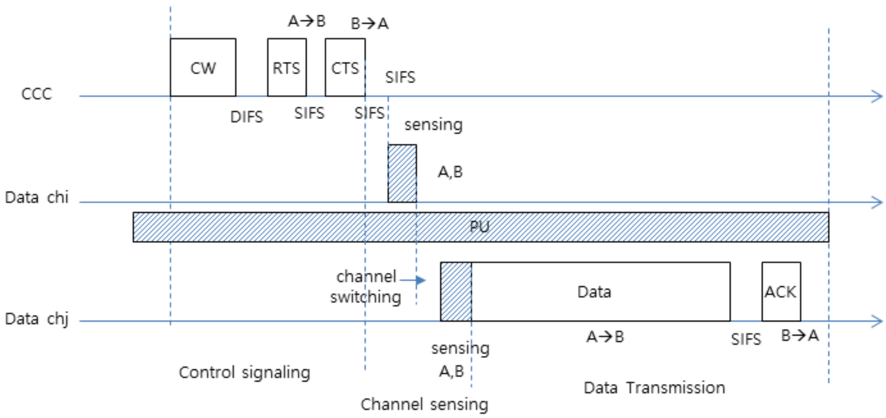


**Fig. 1.** Q-learning based ad-hoc CR MAC

The transmitting node and the receiving node share the priorities of $N$ candidate channels by RTS-CTS exchange and sequentially perform channel sensing according to the priorities, and when the channel is idle, data is transmitted. If the channel is busy, the transmitting node and the receiving node switch to the next predetermined channel and attempt channel sensing and data transmission again. That is, by sequentially sensing channels with a high probability of being idle instead of sensing all channels, the time delay for channel sensing can be minimized.

## III. RESULTS AND CONCLUSTIONS

The bandwidth of each channel was assumed to be 1.2Mbps, and it was assumed that the active and idle time duration of traffic had an exponential distribution, and the traffic characteristics of the primary user for each channel were set differently. The main parameters for the simulation with reference to [6].

Figure 2 shows the average throughput according to the arrival rate of the primary user. As the arrival rate of the primary user increases, the available frequency resources decrease, so it can be seen that the throughput of both the conventional periodic sensing and the Q-learning based MAC decreases. In addition, it can be seen that the MAC protocol based on reinforcement learning increases the throughput by about 5-10% compared to the existing method.

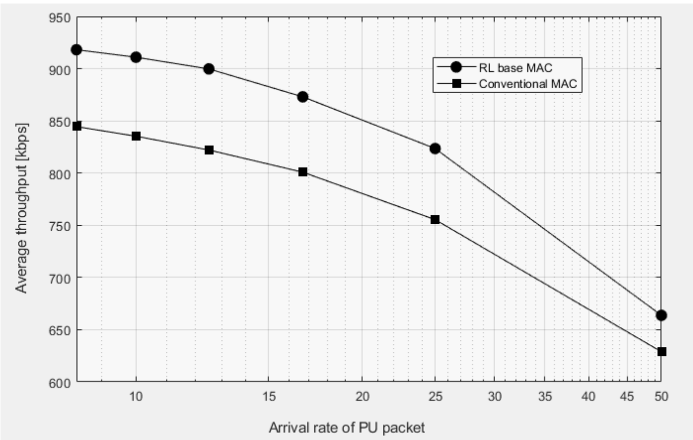


**Fig. 2.** Power depletion rate according to energy harvesting rate

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# A Study on Big Data Analysis Related to 'Digital literacy' Using Newspaper Media in South Korea

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## Abstract

As a result of analyzing newspaper articles related to digital literacy, it was found that the number of related articles exploded in 2021. Classification of digital literacy articles shows that there is a close relationship with digital technologies such as AI and big data, banks and IT companies, government agencies such as the Ministry of Education and the Ministry of Science and ICT, and information-vulnerable groups such as the disabled and rural and fishing villagers. Digital literacy is continuously required not only by elementary, middle and high school students, but also by college students and general adults. In particular, since it is becoming a knowledge that all people should have, education for sustainable development should be conducted in the dimension of lifelong education.

**Index Terms**: Digital literacy, Big Data Analysis, Keyword Analysis, Technology, Newspaper in South Korea

## I. INTRODUCTION

In the general outline of the 2022 revised curriculum for elementary, middle, and high school students announced in November, it was emphasized that strengthening 'digital literacy' to understand and utilize digital technology as a core competency of future generations[1]. This means that beyond the three basic literacy known for reading, writing, and counting, 'digital literacy', which is the basis for learning multiple subjects, is added as basic literacy.

In addition, last December, according to the 'World Competitiveness Yearbook'[2] of the International Institute for Management Development (IMD) in Switzerland, the ranking of Korea's national competitiveness has risen, but of educational competitiveness has declined.

In other words, it can be analyzed that Korea's competitiveness in university education has not kept up with the level of national competitiveness. Meanwhile, on the same day, South Korea's government announced that it would promote a talent nurturing program that greatly strengthened digital education to create quality jobs for young people[3].

In other words, in order to respond to the era of the 4th industrial revolution and the era of great digital transformation, changes in the curriculum and educational institutions that operate it from elementary, middle, high school and university are inevitable[4]. Rather, everyone agrees that actively accepting changes and not lagging behind in strengthening digital capabilities is effective in enhancing national competitiveness in the future. Therefore, it is necessary to predict the future or make decisions based on past and present data in order to establish a new educational direction with a focus on strengthening ‘digital litreracy’ from elementary, middle, and high school, to university. Big data analysis is used in this case. Unstructured data used in big data analysis is increasing exponentially due to the development of information and communication technology, and these topics are covered through various media. It is known to be very effective in analyzing trends over a long period of time[5]. Therefore, this study aims to analyze the trend of ‘digital competency’ by collecting big data related to ‘digital competency’, which is emphasized at home and abroad, through newspaper articles and analyzing it focusing on topics.

## II. METHODS

The data used in this study are newspaper articles from 1999 to 2021, when articles related to ‘digital literacy’ first appeared. A total of 21 newspapers were included in this study. To collect newspaper articles related to ‘digital literacy’, Big Kinds[6], a news search site of the Korea Press Foundation, was used. ‘Digital literacy’ was a search term in Big Kinds, and a total of 267 cases were collected. Of these, 249 articles were analyzed, excluding 18 duplicate articles.

The study was conducted in four stages: data collection, data preprocessing, keyword analysis, and result interpretation as Fig. 2.

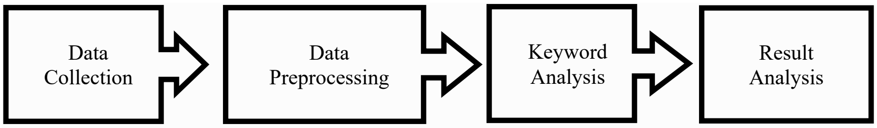


**Fig. 1.** The research procedure consisted of 4 steps

Frequency analysis can effectively indicate which topics are treated as important, but there is a limit to showing issues in various fields only with the frequency of words[7]. Therefore, it was analyzed using the topic rank algorithm or through association and weighting through network analysis.

## III. RESULTS

As shown in Fig. 2, the change in the number of newspaper articles by year is shown as a graph. Since the first related article appeared in 1999, it has steadily increased since 2018, and then increased sharply in 2021.

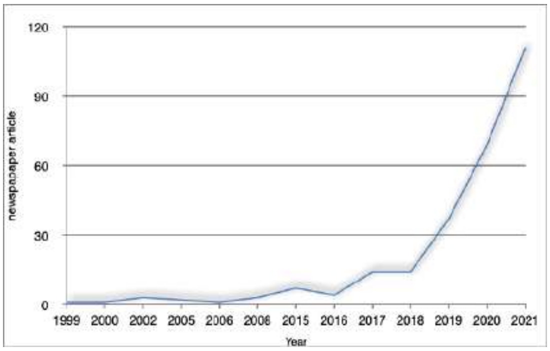


**Fig. 2**. Change in the Number of newspapers articles by year

The top 30 keywords with high keyword frequency are AI, COVID-19, non-face-to-face, Technology, Kwangju Bank, ICT, small industry, big data, RPA, the disabled, and CIB and so on. Fig. 3 shows this in word cloud. This was used because the word cloud has the advantage of being visually displayed by varying the size or color according to the importance and frequency of the word [8].


**Fig. 3**. As a result of keyword analysis, the top 20 keywords were displayed in word cloud

Keywords are related mainly to banks, IT-based companies, government agencies. When we classified keywords, they were related to digital technology, bank and IT_based company, information-vulnerable class, and government agencies. In particular, keywords related to digital technologies were ICT, bigdata, chatbot, and RPA (Robotic Process Automation) and government agency were Ministry of Education and Ministry of Science and ICT.

In other words, it can be seen that there is a relationship between the department dealing with digital technology and the department that educates digital technology. It can also be confirmed that banks and IT companies are inextricably linked with digital literacy.

Fig. 4 is a network visualization of the connections between keywords extracted from data collected from newspaper articles in 2021 with the highest number of newspaper articles.

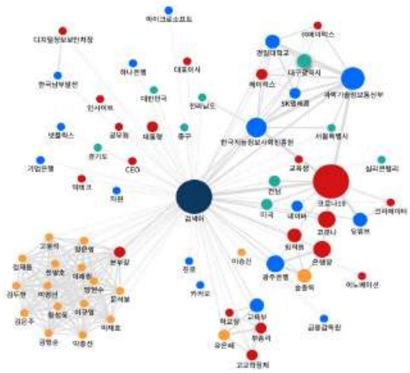

**Fig. 4**. The relationship between the keywords in 2021 was visualized as a network

As a result of analyzing the weights output based on the topic rank algorithm, AI, MOU, COVID-19, Ministry of science and ICT, ICT, technology, Kwangju Bank, NIA, Daegu, and workers appeared as keywords with high weight as Fig. 5.

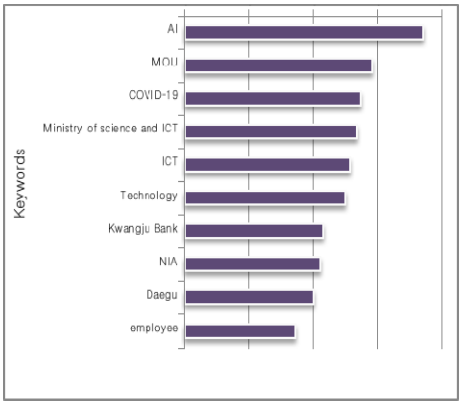


**Fig. 5.** The frequency of keywords was visualized by calculating the weights of keywords in newspaper articles in 2021

It can be analyzed that Kwangju Bank and Daegu and NIA have recently increased their related weights as education related to digital literacy reinforcement has been activated.

## IV. CONCLUSIONS

As a result of analyzing newspaper articles related to 'digital literacy', it was found that the number of related articles increased gradually from 2017. In particular, it increased exponentially in 2021. Keywords related to 'digital literacy' could be classified into digital technology, companies, and government agencies. While companies were continuing their efforts to develop their employees' competencies, it was confirmed that government agencies were making great demands on efforts to nurture young people.

What is noteworthy about keywords related to government agencies is that they focus on cultivating digital literacy for the underprivileged. Many policies were being implemented for the information-vulnerable class such as the disabled and residents of rural and fishing villages. While the number of articles related to digital literacy is increasing for employees of each company, young people preparing for employment, and adults with little access to digital technology, I would like to focus on keywords centered on the Ministry of Education. Although the frequency or weight of keywords was small, the importance of digital literacy for elementary, middle, and high school students was also increasing, centering on the Ministry of Education. It is noteworthy that the curriculum that is to be revised, called the 2022 revised curriculum, is emphasizing digital literacy cultivation and changing the curriculum.

Therefore, digital literacy is continuously required not only by elementary, middle, and high school students, but also by college students and general adults. In other words, as digital literacy is becoming a knowledge that everyone should have, education for sustainable development should be emphasized and carried out in the dimension of lifelong education centering on the government.

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