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Poster 3

Room: Sky 2

Chair: Ki Young Lee (Incheon National University, Korea)

Feature Extraction of Electrocardiogram Signal for Healthcare System Application

Jiwon Choi (Yonsei University & College of Medicine, Korea); Oyun Kwon (Yonsei University & Yonsei University College of Medicine, Korea); Junhwan Kwon and Kyeong Teak Oh (Yonsei University College of Medicine, Korea); Hee Cheol Kang (Severance Hospital, Korea); Sun Kook Yoo (Yonsei University College of Medicine, Korea)

The purpose of this paper is to develop an electrocardiogram feature extraction system that can be applied to a small and light healthcare system and to design a system backbone that can diagnose heart diseases. Therefore, 5 models that have already been used and 1 model with Haar Wavelet Transform added to preprocessing are developed, and the performance of each model is compared. All models were developed using matlab on window, and performance was verified in an embedded system of Nvidia Jetson Nano environment. As a result, the best performance model in terms of speed and accuracy is the Haar wavelet bidirectional Long Short-Term Memory model, which makes classification predictions fast with 96.81% accuracy. The advantage of this study is that it fast detects the pqrst, the characteristic region of an electrocardiogram signal, compared to existing healthcare systems that only predict heart rate by calculating features based on signal-based thresholds. Therefore, by applying this study to the healthcare system, cardiovascular diseases can be predicted and monitored. In addition, by constructing and verifying patient data in the future, it will be possible to utilize it in hospitals.

Deep Learning Based Monitoring System for Crowded Situation

Hayoung Kim (Yonsei University & College of Medicine, Korea); Oyun Kwon (Yonsei University & Yonsei University College of Medicine, Korea); Junhwan Kwon, Kyeong Teak Oh and Sun Kook Yoo (Yonsei University College of Medicine, Korea)

Crowded situation can lead to disaster. In a pandemic situation, when people are crowded, infection is easy to occur, and accidents such as suffocation and crushing may occur due to a dense crowd. To solve these problems, a system for monitoring crowd situation is needed. In this paper, we propose a deep learning model that can find face masks to prevent infection and count people to prevent crowding accidents. What we want to detect is divided into three classes: face with masks, without masks, and mask weared incorrect. The detection performance of the face mask model is 78.6%, 73.1%, and 76.6% for Precision, Recall, and mAP50, respectively. By adding the ability to count the number of people, the number of people not wearing a mask, and the number of people wearing a mask incorrectly, you can monitor the crowd size and whether or not you are wearing a mask.

Detection of LPI Radar Signal Using Periodic Autocorrelation Function and LSTM

Do-Hyun Park, Jong-Hyeon Bang and Hyoung-Nam Kim (Pusan National University, Korea)

In an electronic warfare support (ES) system, it is important to detect an opponent's radar signal rapidly and accurately. However, with the advent of low-probability-of-intercept (LPI) radar signals in modern electronic warfare, it is difficult to detect the opponent's radar signals as the power of the LPI radar signal is equal to or lower than the power of noise. Therefore, detecting such a weak LPI radar signal is crucial in the ES system. In this paper, we propose an effective weak signal detection method using the characteristic of LPI radar signals in a periodic autocorrelation function (PACF). We produces the PACF of the intercepted radar signal and captures the features in the PACF using the long short-term memory layer. Through simulation, we analyze the detection performance of our proposed method and show that it can effectively detect LPI radar signals even in a low signal-to-noise ratio environment.

Performance Analysis of UAV-Based Array Antenna Beamformer Considering Spatial Channel Correlation

Soon-Young Kwon, Ji-Hyeon Kim and Hyoung-Nam Kim (Pusan National University, Korea)

UAVs have been used for various missions due to low-cost and flexible deployment. Especially, UAV-based array antenna has the advantage of being able to change the array formation of antennas according to the situation and thus expect good beamforming performance. However, the beamforming performance may be deteriorated by spatial channel correlation. We analyze the performance by applying spatial channel correlations to the signals received by the UAV-based array antenna and show that the performance is degraded when the signals have low channel correlation.

Prediction of Milk Production Using Statistical and Machine Learning Method

Sooram Kang, Dahyun Kim, Sangkyoon Kim, Myung-Hwan Na, Sora Kang and Wanhyun Cho (Chonnam National University, Korea)

Along with declining milk consumption in Korea, the number of dairy farms and cows is also steadily declining. In contrast, the number of cows raised on one farm has increased. Due to a decrease in milk consumption and an increase in production costs, the profit per cow also decreases, leading to a decrease in the profits of dairy farmers. Therefore, it is necessary to improve the efficiency to increase the income of dairy farmers, which leads to the need to predict the milk production of cows. The purpose of this study is to predict the production of individual cows by using data collected from dairy farms, and to help the farmer make decisions to increase the management efficiency through this. To predict the milk production of cows, data such as feed intake patterns, the number of births, and production days of individual cows were used as explanatory variables. And statistics and machine learning models such as regression, random forest, and SVM were used for prediction.

DB Indexing Mechanism for Building Information Modeling(BIM) Objects

Yedong Yoon (Hongik University, Korea); Kidu Kim (Telecommunications Technology Association, Korea); Robert Youngchul Kim (Hongik University, Korea)

On inspecting bridges for Safety Inspections, some research focuses on adapting an AR-based Device mechanism. With this mechanism, it is necessary to map real damaged data with the original blueprints of Bridges. Building Information Modeling (BIM) is a general framework for creating and managing information on construction costs. Based on mockups and available on cloud platforms, BIM integrates data from structured disciplines to create digital representations of different assets from planning, design to execution, late to operations, and remaining timeframes. Building. Therefore, indexing methods are necessary to identify Bridge's Blueprint Information. We propose an Object Breakdown Structure (OBS)-based indexing method to support management between BIM and blueprint files. We also define how to identify a classification system for each management item and how to use the classification system number as a classification code of bridge design blueprint data. As a result, Design information can be expressed by the design classification code.

Prediction of Rice Yield Using Multi-Spectral UAV Imagery and Deep Learning Algorithm

Sora Kang, Wanhyun Cho, Sangkyoon Kim and Myung-Hwan Na (Chonnam National University, Korea)

Accurately predicting rice production in each country that uses rice as a staple food is not only a major factor in establishing policies that can properly control the supply and demand of rice from the government's point of view, but also they may be able to get a fair price for their labor from the perspective of farmers who produce rice. Therefore, both the government and farmers' organizations are paying much attention to the problem of predicting how much rice can be produced each year. This study proposes a prediction system that can predict rice production in advance using images acquired through multi-spectral sensors and deep learning algorithms. First, rice farms in Gyeongsangnam-do, Korea are selected as samples and multi-spectral images are collected periodically using a camera mounted on the Tron during the rice growing period. Second, based on the collected multispectral images, we build a system that can accurately predict rice yield using three deep learning algorithms: 3D CNN, CNN-LSTEM, and ConvLSTM. Thirdly, an experiment was conducted to compare and verify the predictive performance of three deep learning algorithms using multispectral image data collected from a specific region in Korea. From the experimental results, we can see that the 3D-CNN model has the best predictive power, followed by the CNN-LSTM model and the ConvLSTM model, which are sequentially superior in predictive power. In particular, it was confirmed that the ConvLstem model had much lower predictive power compared to other models. Therefore, it is considered that ConvLSTM age is not suitable for predicting rice yield.

Intelligent Service Representation Mechanism Based on Curriculum and Multimedia Content in Virtual Space

DoHyeun Kim, Atif Rizwan and Anam Nawaz Khan (Jeju National University, Korea); KyungNam Park (Korea Nazarene University, Korea); Rashid Ahmad (Comsat University, Pakistan); HeeDong Park (Nazarne University, Korea); Kyutae Lee (Kongju National University, Korea)

The recommendation of curriculum and content considering knowledge, ability and learning behavior of student is cumbersome task for any institute. The personalized curriculum recommendation always helps the students to achieve their goals according to their ability. In this paper, we present visualization mechanism based on curriculum and multimedia content in internet space. After preprocessing and data preparation, curriculum and content recommendation APIs are designed. The front end for end users is also designed to access and get the recommendations based on their ability.

A Survey on Prediction and Analysis Models of Repair Cost of AI-Based Bridges

Jae Hyeong Cho, Ye Jin Jin and Robert Youngchul Kim (Hongik University, Korea)

Recently, there are huge bridges and buildings in urbanization. Safety inspectors spend too much time checking damages on them one by one during a lot of time. After that, he/she will make a decision on whether it is repaired or not. Due to the rapid growth of our domestic construction market, there is too much to safely check bridges and buildings. To solve this problem, we need AI diagnosis prediction approach. Therefore, in this paper, we survey some prediction models to identify and predict cracks in bridges.

Best Practices for Inspecting A Large Bridge Facility with an Augmented Reality(AR) Mechanism

Kyeong Chan Moon, Ji Hoon Kong and Robert Youngchul Kim (Hongik University, Korea)

AR is a virtual reality world that mixes the virtual world and the real world. Currently, various kinds of research are being conducted by applying AR in many fields. Design in the current construction industry is complex. Depending on the nature of the facility-based progress, it is in the limelight as a field with high utilization of grafting with AR. Therefore, we introduce the methods and problems that have been used in the inspection method for the maintenance of the bridge construction industry, which is a kind of construction industry.

Deembedding Method of the S-Parameter Extraction of Test Socket with Printed Circuit Board Fixture

Moonjung Kim (Kongju National University, Korea)

In the S-parameter extraction of the test socket, a deembedding method is required to remove the parasitic components of a fixture. The fixture consists of printed circuit boards (PCBs) and a device under test (DUT). Generally, transmission lines such as microstrips are applied on the PCBs to connect a DUT. In this paper, a PCB is designed by applying a coaxial transmission line. The fixture is assembled with the test socket and the PCBs in contact with each other, forming different electrical paths.

Workshop; SACS1

Room: Sky 2

Chair: Byung-Seo Kim (Hongik University, Korea)

Cooperative Transmission with Friendly Jamming to Ensure Secrecy Performance

Yosefine Triwidyastuti and Ridho Hendra Yoga Perdana (Hongik University, Korea); Kyusung Shim (Hankyong National University, Korea); Beongku An (Hongik University, Korea)

This paper exploits the secrecy performance in cooperative relaying system in the presence of an eavesdropper. In order to improve the secrecy performance, friendly jammer radiates the jamming signal to degrade the channel information in eavesdropper. Besides, we study the impact of various jamming scenarios. In the first jamming scenario, the jammer employs all antennas to transmit jamming signal. While, in the second scenario, the jammer employs single selected antenna to maximize the jamming channel gains. Numerical results show that the first jamming scenario provides higher secrecy capacity than the second jamming scenario. Furthermore, the effects of the number of jamming antennas and the distance between jammer and eavesdropper on the secrecy capacity are also evaluated.

Applied Practice on Code Visualization for Guaranteeing the Quality of Augmented Reality Software

Janghwan Kim, So Young Moon and Robert Youngchul Kim (Hongik University, Korea)

Recently, the demand for safety inspection and repair of large facilities such as bridges and buildings has increased nationwide. However, it is difficult for Safety Inspectors to check these large facilities, due to access limitations for safety inspections and long execution times for maintenance and repair. To solve these problems, new technologies such as virtual reality and augmented reality are needed. For virtual reality (AR) software for a safety inspection, we suggest measuring the quality of their software with our code visualization approach.

Federated Learning Based Low Rate DDoS Detection

Muhammad Nadeem Ali (Hongik University, Korea); Muhammad Salah Ud Din (Hongik University, Sejong, Korea); Muhammad Imran (Hongik Unviersity, Korea); Byung-Seo Kim (Hongik University, Korea)

Software-defined network (SDN) is one of the appealing internet architectures that can full fill the future Quality of services requirements of both user and internet deployment organizations. The SDN can guarantee such requirements by logically separating the control and data plane. SDN's centralized control plane, which separates the control and data planes and presents a comprehensive view of the underlying network architecture, encourages effective network resource management. In addition to its inherent advantages, the centralized SDN architecture poses substantial security risks such as spoofing, sniffing, brute force, API exploitation, and denial of service, and must be carefully monitored to ensure network security. Among these security risks, Distributed Denial of Service (DDoS) and its version Low-Rate DDoS (LR-DDoS), provide one of the most difficult detection and defense challenges since harmful traffic is generated at a low rate by the fraudulent user. Machine learning (ML) has demonstrated exceptional performance in identifying and defending such assaults. To identify Low-Rate DDoS (LRDDoS) attacks, we have used Weighted Federated Learning (WFL), based on the neural network (NN), in this research. The proposed work has improved the detection accuracy when compared with the individual training algorithms of the neural network and the proposed scheme that existed in the literature. The simulations are performed on MATLAB and the results corroborated the proposed work is detecting the attacked user efficiently.

Real-Time Object Detection Using Data-Distributed Deep Learning on CCTV

Hassam Tahir and Eun-Sung Jung (Hongik University, Korea)

The development of smart cities with modern technology is increasing day by day. With the development of intelligent cities, pressure on innovative technologies is also directly proportional. Furthermore, CCTV monitoring in a modern city is a crucial parameter. CCTV monitoring using deep learning techniques has been widely adopted. Nevertheless, with population growth and other items, the real-time dataset is enlarged, which affects hardware and output precision. In order to tackle this situation, a modern data-distributed approach is applied to real-time CCTV monitoring in this research. Dataset is distributed on an available number of devices and trained accordingly to decrease computational complexities. The PyTorch data distributed approach is used on Faster-RCNN backboned with Mobilenet-v3. After rigorous training precision of the model is 89%, and FPS is maintained at an average of 29.34. GPU utilization factor with data distributed approach and without data distributed at batch size 128 is 11% and 13%. Moreover, the GPU utilization factor with the data distributed approach and without data distributed at batch size 256 is 6% and 9%. Results reveal the competitiveness of distributed machine learning without loss in precision.

Particle Swarm Optimization-Based Clustering Algorithm to Support QoS Routing Protocol in Flying Ad-Hoc Networks with CF-mMIMO

Yushintia Pramitarini and Ridho Hendra Yoga Perdana (Hongik University, Korea); Kyusung Shim (Hankyong National University, Korea); Beongku An (Hongik University, Korea)

This paper proposes a particle swarm optimization-based clustering (PSO-C) algorithm to support quality of service (QoS) routing in flying ad-hoc networks (FANETs) with cell-free massive multiple-input multiple-output (CF-mMIMO). A dynamic topology is characteristic of FANETs due to the presence of mobile unmanned aerial vehicles (UAV). Moreover, the limited battery resource and mobility of UAV cause unstable routing in the FANET. To solve this problem, we propose a PSO-C protocol to elect the cluster head (CH) and help the self-organized various nodes to form the clusters. In detail, we consider the problem of jointly weight of node degree, cosine similarity, cosine distance and remaining energy of the node to maximize the cost of CH subject

Workshop; SACS2

Room: Sky 2

Chair: Byung-Seo Kim (Hongik University, Korea)

Designing the Normalized Database Table for Storing Information of Safety Inspection on CHEONGDAM Bridges with Augmented Reality

Chansol Park, Woo Sung Jang and Robert Youngchul Kim (Hongik University, Korea)

Currently, in terms of maintenance of facilities, it is required to improve technical capabilities through new technologies and construction methods. Facility maintenance techniques through Augmented Reality (AR) are actively being studied to meet these demands. However, although using these techniques requires large amounts of data to store and process, the design of the database still needs to be well-considered. Poorly designed database causes problems, such as decreasing data processing speed and occurring dummy data like duplicated or incorrect data. These problems reduce the reliability of the data with huge information, blueprints, and images of Bridges. To solve these problems, we propose to design a regularized database table structure for the data required for the safety inspection of bridges through AR. Through this, we can expose efficiently to workers through AR devices. Furthermore, the reliability of the safety inspection will increase.

Prediction of People's Behavior in Future Disasters with NLP

Ghulam Musa Raza, Ihsan Ullah and Muhammad Imran (Hongik Unviersity, Korea); Byung-Seo Kim (Hongik University, Korea)

Natural disasters cause horrible damage in daily life. Human beings have experienced huge disasters like rains, floods, tsunamis, and covid-19. Every time, disasters abrupt society in a pathetic way. Every pandemic has affected our society badly like covid-19. It has been a subject of discussion since 2019 due to the increased prevalence of social media and its extensive use, and it has been a source of tension, fear, and disappointment for people all over the world. In the fox century, we can predict the future behavior of people with the help of artificial intelligence. The ability to predict the occurrence of a disaster accurately depends on the use of an appropriate disaster decision model. In this paper, we proposed the NLP-based and deep learning model to predict the future behavior of people based on past practice and run time opinion. This research can help the administrations of different regions take wise and suitable steps for controlling the spread of any outgoing and upcoming disaster.

SDiT: Self Knowledge Distillation Vision Transformer for Distributed Learning

Jinwook Choi and Eun-Sung Jung (Hongik University, Korea)

In recent years, the use of Edge Devices with limited computing resources has increased along with large-scale cloud environments, which has increased the importance of the individual data privacy problem the use of edge devices has increased. Therefore, we study AI model training applying data distributed learning instead of Data Central learning, reflecting the importance of data privacy in AI learning, and apply it to Vision Transformer (ViT) models that have recently achieved state-of-the-art (SOTA) in the Computer Vision domain. However, the Transformer based model proposes a 'Self-Knowledge Distillation Vision Transformer (SDiT)' model for data distribution by applying the Self-Knowledge Distillation technique to overcome the disadvantage of requiring learning using a lot of data, which is solved by applying it to the Pothole classification domain.

Cuckoo Optimization-Based Routing Protocol to Enhance QoS in Mobile Ad-Hoc Networks

Amalia Amalia and Yushintia Pramitarini (Hongik University, Korea); Kyusung Shim (Hankyong National University, Korea); Beongku An (Hongik University, Korea)

Mobile ad-hoc networks (MANETs) face with the challenge of reliable data transmission because of the random mobility that results in a rapid change in the network topology. Frequent link failures harm Quality of Service (QoS) performance. Especially, in the case of high-speed node movement, it is essential to develop a MANETs routing protocol that can adapt to changes in network topology. In this paper, we propose a cuckoo optimization-based routing protocol (CORP) to support QoS in MANETs. Cuckoo optimization is a metaheuristic algorithm that is based on the odd breeding strategy of cuckoo bird. It is used to find a minimum fitness function by optimizing the remaining energy of the node, distance, and hop count. The simulation results show that the proposed CORP obtains good scalability with a high packet delivery ratio (PDR), low routing delay, and low control overhead.

A Study on Generation of Heterogeneous Request Codes from QR Codes in Bridge Facilities Based on Metamodel

Woo Sung Jang (Hongik University, Korea); Young-Soo Kim (National IT Industry Promotion Agency, Korea); Hee-Do Heo (TMAX OS, Korea); Sam-Hyun Chun (Soongsil University, Korea); Hyun Tae Kim and Robert Youngchul Kim (Hongik University, Korea)

Bridge facilities are social indirect assets that require constant maintenance. Our AR-based bridge facility maintenance system uses QR codes to effectively maintain bridge facilities. However, AR devices have limited memory and computation speed. Therefore, maintenance data must be received through communication with heterogeneous internal/external SW. We propose a maintenance method of heterogeneous AR data request packets using a metamodel. This method can add and modify heterogeneous data request packets without modifying the source code of the AR application.

Thursday, February 2 9:00 am - 12:00 pm

Birds of a Feather

Room: Sky 1, Sky 2

DB Indexing mechanism for Building Information Modeling(BIM) Objects

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***Abstract*— On inspecting bridges for Safety Inspections, some research focuses on adapting an AR-based Device mechanism. With this mechanism, it is necessary to map real damaged data with the original blueprints of Bridges. Building Information Modeling (BIM) is a general framework for creating and managing information on construction costs. Based on mockups and available on cloud platforms, BIM integrates data from structured disciplines to create digital representations of different assets from planning, design to execution, late to operations, and remaining timeframes. Building. Therefore, indexing methods are necessary to identify Bridge's Blueprint Information. We propose an Object Breakdown Structure (OBS)-based indexing method to support management between BIM and blueprint files. We also define how to identify a classification system for each management item and how to use the classification system number as a classification code of bridge design blueprint data. As a result, Design information can be expressed by the design classification code.**

Keywords—BIM. OBS, DB, Indexing

I. INTRODUCTION

Research is underway to develop a system for inspecting bridges that join with tablets into an AR-based system. Software for safety diagnosis and maintenance of construction projects is becoming more complex. Therefore, the use and importance of Building Information Modeling (BIM) are increasing. However, BIM is characterized by continuous expansion and increasing items. On the other hand, Data Base(DB) costs a lot to change when table items are added. BIM classification systems and methods suitable for the database are necessary to solve this mismatch. This paper selects the BIM to be used in the AR-based system to fit the OBS item, defines the classification system for each management item accordingly, and defines the method of using the classification system number as the classification code for the design data. As a result, Design information can be expressed by the design classification code. The following information is collected and defined for the definition of the classification system for each management item. In order to establish a classification system for the composition of members by facility, all types of members constituting the facility are defined, and unique numbers and codes are defined for each section, point, and member type. In addition, classification code classification rules are defined to define the classification code of the drawing from unique numbers and codes. This provides a criterion for the building material information to be configured under clear principles. This paper describes as follows. Chapter 2 mentions the relevant research and explains the proposed method in Chapter 3. Chapter 4 shows the resulting table. Chapter 5 refers to discussions and conclusions.

II. RELATE WORKS

A. Building Information Modeling

It refers to a digital transformation system that integrates all information generated during the life cycle of a facility into a three-dimensional model to link construction information and procedures in a standardized manner and enables digital collaboration[1].

B. Object Breakdown Stucture

OBS refers to a hierarchical structure of space-facility-part units from an object perspective to efficiently manage BIM objects, not work units[2]. In order to utilize BIM for various tasks, OBS systematically classified the entire facility by separating or combining object units from the perspective of the construction information classification system. It is a classification of attributes for each object to construct attributes on a facility object, including characteristics such as identification, shape, material, and code. OBS is a classification system that defines the minimum part of the BIM model that constitutes the Work Classification System, and is insufficient to cover all areas of the construction industry.

III. DB INDEXING MECHANISM FOR BIM OBJECTS

The proposed bridge classification system identifies the components of sections, spots, and building components. A section includes some spots. Each spot includes building components.

Fig. 1. Bridge Design

Fig.1. shows Bridge Design. The green part is a Section. Each section can have multiple spots. And each spot can contain variable building components.

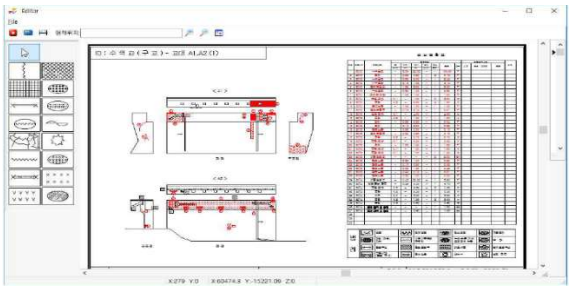

Fig. 2. DWG import UI design

Fig.2. shows UI design of the software. It shows the design of bridge, location of damage, and damage type.

A. Unique number for each section of bridge facilities

TABLE I. UNIQUE NUMBER FOR EACH SECTION

Section	Unique Number	Section	Unique Number
B	1	Ramp1	7
C	2	Ramp2	8
D	3	Ramp3	9
E	4	Ramp4	10
F	5	Ramp5	11
H	6		

Table I. show Unique number for each section. Unique numbers were defined in the sections B to H and Ramp1 to Ramp5 of Cheong-Dam Bridge. Unique numbers consist of 1 to n numbers. If a new section is added, data can be added without changing the table by adding a unique number.

B. Unique number by spot

TABLE II. CODE FOR EACH SPOT

Spot name	Code
Span	S
Pier	P
Abutment	A

Table II. shows code for each spot. It is a unique code for all spot constituting the bridge facility. The unique code consists of alphabets. It is defined as Span as 'S', Pier as 'P', and Abutment as 'A'. If a new point is added, add a new code for the point.

C. Unique number for each building components

TABLE III. BUILDING COMPONENTS TYPE I

Building components type	Unique Number	Building components type	Unique Number
Bottom plate	1	Bridge bearing	15
Bottom plate (Upper)	2	Expansion joint	16
Bottom plate (lower)	3	Paved bridge surface	17
Girder	4	Drainage facility	18
Girder (internal)	5	Handrail	19
Girder (external)	6	Kerb	20
Secondary structural member	7	Soundproof wall	21
Horizontal beam	8	Protective wall	22
Vertical beam	9	Median strip	23
Abutment	10	Bridge box (internal)	24
Pier	11	Bridge box (external)	25
Foundation Of Pylon	12	Horizontal bridge box (internal)	26
Pylon	13	Horizontal bridge box (external)	27
Side pylon	14	Bracing	28

Table III. shows the unique number for each building components type. The unique number consists of numbers from 1 to n. If a new member is added, add a unique number.

D. Classification code format

TABLE IV. CLASSIFICATION CODE FORMAT

Classification Code Format
[Section Number]-[Spot code]-[Spot classification Number]-[Building components type unique Number]-[Building components type classification Number]

Table IV. shows the format of the classification code. A section number is a unique number for each section. Spot unique code is unique code for each sight. Spot classification number is a number to distinguish spots that have the same name. For example, if two Span spot exists in the same section, then S-0001, S-0002. The building component unique number is the number for each building component. Building component classification number is a classification number for distinguishing building components that have the same section number, spot unique code, spot classification number, and building component unique number. Each classification Number is defined as four-digit number. For example, if the spot number is 4, it is defined as 0004. The alphabet is used without a limit on the number.

IV. APPLIED CASES

TABLE V. CLASSIFICATION CODE AND DESIGN MAPPED TABLE

Classification code	Section	Design name	File path
0001-S-0001-0002-0001	B	Bottom plate (Upper) bar 1	01. B spot\1. B spot Bottom plate upper \Bspot Bottom plate upper bar 1.dwg
0001-S-0002-0002-0001	B	Bottom plate (Upper) bar 2	01. B spot\1. B spot Bottom plate upper \Bspot Bottom plate upper bar 2.dwg
0001-S-0003-0002-0001	B	Bottom plate (Upper) bar 3	01. B spot\1. B spot Bottom plate upper \Bspot Bottom plate upper bar 3.dwg
…	..	…	…

Table V. shows a portion of the design classification code list. The list includes a classification code, a spot represented by the designs, an actual design name, and an actual file path. In the classification code, "0001-S-0001-0002-0001" represents "B section-span-span identification number-bottom plate (Upper)-bottom plate (Upper) identification number". One design classification code is assigned per design, cannot be duplicated, and information on the drawing may be expressed only by the code.

V. CONCLUSION

Through the proposed classification code, information in the drawing can be expressed only by code, and even if new points, intervals, and missing items are added, there is no need to change the schema of the DB. BIM's information has the characteristics of continuing to be detailed and complex as needed. Research is needed on the area and implementation of how to organize the classification system when items not included in sections, spots, and building components are added.

ACKNOWLEDGMENT

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[2] Ministry of Land, Infrastructure and Transport, Implementation Guidelines for BIM in Construction Industry, 2022.

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