ICGHIT

Program Guide Book

International Conference on
Green and Human Information Technology 2023

ICGHIT 2023

Jan.31 – Feb. 02, 2023

Bangkok, Thailand

http://icghit.org/

IEIE

applied sciences
an Open Access Journal by MDPI

sensors
an Open Access Journal by MDPI

GHIT

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

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

Chansol Park
Software Engineering Laboratory
Hongik University
Sejong, Korea
c2193102@g.hongik.ac.kr

Woo Sung Jang
Software Engineering Laboratory
Hongik University
Sejong, Korea
uriel200@hongik.ac.kr

R. Young Chul Kim
Software Engineering Laboratory
Hongik University
Sejong, Korea
bob@hongik.ac.kr

***Abstract*—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 normalized 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.**

Keywords—Software Engineering, Database Normalization, BIM, Structure Maintenance, Augmented Reality

I. INTRODUCTION

According to the recent Road Bridge and Tunnel Status Report 2022 issued by the Ministry of Land, Infrastructure, and Transport, the total number of road bridges in Korea is 37,078, and the total length is 3,795.1km[1]. These bridges shall be subjected to regular safety checks two to three times a year or more, depending on the bridge grade[2]. Field surveys and tests are among the essential tasks of regular safety inspections, which require operators to conduct appearance surveys and some simple material tests on concrete and steel structures on road bridges. However, this method can cause safety problems for workers due to dangerous institutional environments. Also are problems that the method of creating a safety inspection result through paper can contaminate or reduce accuracy. In order to improve this, research on safety inspection through Augmented Reality (AR) and intelligent devices is active.

We are researching to develop a facility interface by grafting a progressive web application-based facility condition evaluation engine to an AR device. For this study, this paper proposes a normalized database (DB) table design to store the pieces of information exposed to AR devices, such as bridge descriptions, bridge designs, and bridge photos. Through this, the cost of bridge safety inspection and bridge information management will reduce, and the report of safety institution reliability will improve.

II. RELATED WORKS

A. Building Information Modeling(BIM)

BIM is the addition of information to the 3D drawing for the structure. BIM in the construction industry digitizes and integrates information throughout the project [3]. The BIM integrates information generated during the design and construction stages and collects and reprocesses information generated during the structure maintenance process. BIM allows structural maintenance tasks to expect benefits such as the efficiency of work, continuity of maintenance information, and proactive maintenance [4].

B. Database Normalization

The database is not only essential to store data, but also to query and compute data. In the case of large amounts and types of data, the performance of the database is even more critical. One way to improve the database's performance is to normalize the table. DB normalization minimizes data capacity by eliminating redundant data properties and ensures data integrity by avoiding anomalies. There is also a way to simplify the data model. A low-quality data model if the properties to integrate are split across multiple entities or vice versa. Complex data models can be simplified in such cases to prevent performance degradation and duplication. In addition, the relationship between the data model and the workflow can be linked to ensure information traceability[5].

III. NORMALIZED DATABASE TABLE DESIGN FOR SAFETY INSPECTION ON BRIDGES THROUGH AUGMENTED REALITY

A. Identify bridge-related data

We identified BIM data on bridges and data necessary to display them through AR as general facility information such as facility names, GPS coordinates, facility 3D and 2D drawings, facility area information, facility type information, facility appearance inspection information, damage information, and photo information.

- ***Facility information*** includes standard bridge data such as the facility's management number, the facility, the name of the facility, the GPS at the facility's starting point and ending point, and the facility's management entity.
- ***Drawing information*** of the facility is stored as a file. 3D design drawings are stored in the form of Industry Foundation Classes (IFC), and 2D design drawings are stored in Drawing (DWG).
- A facility is divided into several ***section***s according to its structure. For example, in the case of a road bridge passing through a river, it can be divided into an entry lamp, a section A, a section B, a section C, and a department lamp of the bridge.
- The ***point type*** information of the facility is information on each point constituting the facility. In

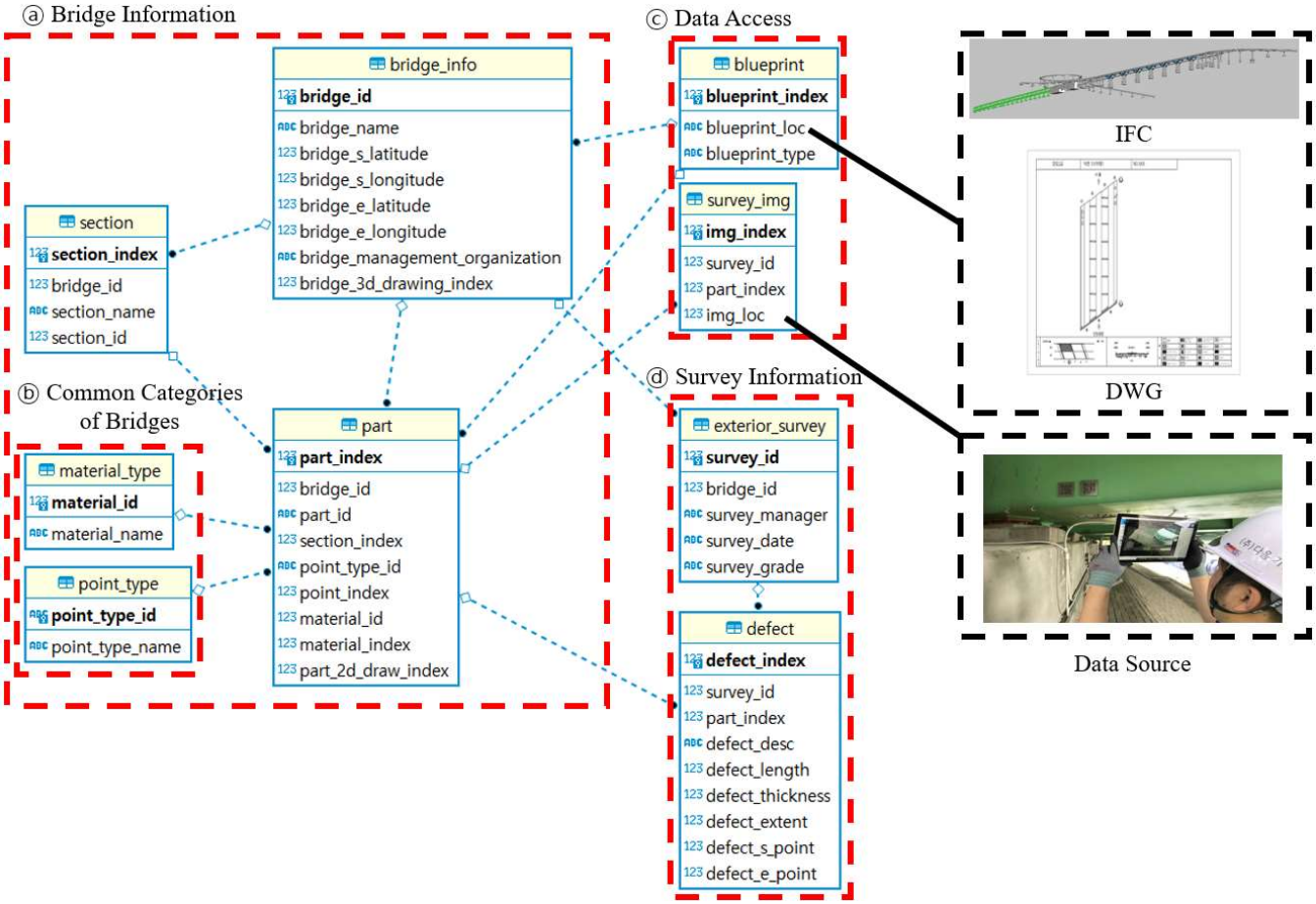

Fig 1. Normalized Database Table Structure for BIM Data

the case of bridges, piers support the bridge vertically, abutments support the bridge horizontally, and intervals connect the piers/bridges.

- The ***member type*** information of the facility is information on the unit material forming the components of the frame. The types of members of the bridge include floorboards, girders, horizontal beams, vertical beams, and abutments.
- The facility's ***appearance inspection*** information is investigated through appearance inspection during the safety inspection process. The appearance inspection information includes information such as the identification number of the appearance inspection, the person in charge of the investigation, the date of the investigation, and the evaluated safety grade.
- The ***defect*** information of the facility is information on the defect observed as a result of the appearance inspection. The facility's defect information includes the identification number of the appearance investigation, the identification number of the defect site, the defect point, the defect content, the length of the defect, the width of the defect, the area of the defect, the starting and ending point of the defect.
- The ***appearance inspection photo information*** is information on a photo taken as a result of an appearance inspection. It has the storage location (URL) of the image file, the identification number of the photographed appearance investigation, and the serial number of the photographed member as attributes.
- Facilities are managed on a member basis. We named it ***part***. Each member is distinguished by a serial number consisting of an interval identification defense, a point type identification symbol, an order at the point, a member's identification number, and an order at the member. Each member also has a 2D design drawing.

B. Normalized DB Table Structure Design

Figure 1 is a normalized DB table structure that stores previously identified data elements. In order to focus on the structure of the design, we omitted several vital attributes.

Part ⓐ of Figure 1 is a group of tables for storing information on bridges. The group includes a table for storing general information about bridges, a table for sections of the bridge, and a table for members of the bridge. A part ⓑ is a group of tables for storing categories common to all bridges. The group includes a point category and a member category table. Also, the group ⓐ contains the group ⓑ. A part ⓒ is a group of tables for storing information on files accessed by the BIM system: a drawing and photo information table. A part ⓓ is a group of tables that store appearance inspection information, including an appearance inspection information table and a defect table.

IV. Application Case

As an application example of the normalized DB table structure design proposed in this paper, we implement a RESTful API for communication with a safety check application installed in an AR device. Table 1 is an API

specification for the implemented RESTful API. A method of obtaining basic information on a bridge for safety inspection and providing information on a corresponding area through indexing information is implemented.

Table 1. RESTful API Specification

Method	*URI*	*Query Parameter*
GET	/bridge/{bridge_id}	
GET	/bridge/{bridge_id}/part	part_id: String


```
{
    "bridge_name": "청담대교",
    "bridge_s_latitude": 37.53032,
    "bridge_s_longtitude": 127.06599,
    "bridge_e_latitude": 37.522694,
    "bridge_e_longtitude": 127.062954,
    "bridge_management_organization": "서울 시설 공단",
    "draw_loc": "www.example.com/api/blueprint/ifc?bid=1",
    "draw_type": "ifc"
}
```


Fig 2. Response Result of URI '/bridge/{bridge_id}'

Figure 2 shows the API response to */bridge/{bridge_id}*. The inspecting bridge ID should be entering in *{bridge_id}*. In that case, it provides the bridge's name, the starting/ending point of the bridge (latitude and longitude), the management entity, and the storage location of a 3D drawing with the IFC form.


```
[
    "point_index": 1,
    "material_index": 1,
    "draw_loc": "www.example.com/api/blueprint/dwg?bid=1&sid=7&sin=1&mid=11&min=1",
    "draw_type": "dwg",
    "section_name": "Ramp1",
    "point_type_name": "교각",
    "material_name": "교각",
    "exterior_survey": [
        {
            "survey_id": 1,
            "survey_manager": "John Doe",
            "survey_date": "2022-12-01",
            "survey_grade": "A",
            "defect": [
                {
                    "defect_desc": "균열",
                    "defect_length": 10.0,
                    "defect_thickness": 1.0,
                    "defect_extent": 10.0,
                    "defect_s_point": "1a",
                    "defect_e_point": "10a"
                }
            ],
            "exterior_photo": "www.example.com/api/survey/image?sid=1&pid=1"
        }
    ]
]
```


Fig 3. Response Result of URI '/bridge/{bridge_id}/part'

Figure 3 shows the API's response to */bridge/{bridge_id}/part*. API provides information on the part when the inspecting part's serial number is transmitted as a value for the *part_id* Key. Providing information is the order at the point of the bridge, the order at the member, the name of the section, the name of the point, the name of the member, and the location of the 2D drawing file with the DWG form. In addition to the basic information on the inspecting member, the results of the appearance inspection through existing safety checks and the defect information inspecting member are provided.

V. CONCLUSION

This paper proposes a normalized DB table design for the safety inspection of road bridges through AR. Through this, it is possible to efficiently inquire about bridge information, drawings, and photo information to be exposed by the AR device during the safety inspection work. In addition, it is possible to prevent data contamination and inaccurate data recording by inputting appearance inspection work information into the DB through an intelligence device. Through this study, we expect the safety inspection workers to efficiently expose the information they need when working to the front of their eyes to increase work efficiency and the reliability of the safety inspection results. Future research will be conducted to predict defects in bridges by learning safety inspection information collected through DB.

ACKNOWLEDGMENT

This work was supported by the Ministry of Education and the Korea Research Foundation (F21YY8102068) and a grant (RS-2022-00155579) of Disaster-Safety Industry Technology Commercialization R&D Program, funded by Ministry of Interior and Safety (MOIS, Korea) and the government (Ministry of Education) with the support of the Korea Research Foundation (No. 2021R1I1A3050407, No. 2021R1I1A1A01044060) in 2022.

REFERENCES

[1] Korea Institute of Construction Technology, "Road Bridge and Tunnel Status Report, 2022", Sejong: Ministry of Land, Infrastructure and Transport, 2022.

[2] Korea Institute of Construction Technology, "Detailed Guidelines for Safety and Maintenance of Facilities: Safety Inspection and Diagnosis", Sejong: Ministry of Land, Infrastructure and Transport, 2021.

[3] Eastman, Charles M., et al. "BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors." John Wiley & Sons, 2011.

[4] Kim, Jeong-Hwan. "BIM-based maintenance technology trends." Construction Engineering and Management 13.6, 2012, pp. 33-35.

[5] LEE, Jong-Seok; LEE, Chang-Ho. "Modeling on Data Performance for Very Large Database. In: Proceedings of the Safety Management and Science Conference." Korea Safety Management & Science, 2012, pp. 383-391

International Conference on
Green and Human Information Technology 2023

ICGHIT 2023

Sponsored by_

ISSN : 2466-121X