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Applied practice on Mapping both the Associated 3D Drawing in BIM and Crack with AR Device

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***Abstract*— Currently, we must inspect a huge artificial bridge for regular maintenance. The current safety inspection of the bridge is manually checked and recorded by the inspector [1]. The problem with this method is that he/she is exposed to risks at the dangerous site. To solve this problem, we propose a maintenance inspection method of mapping the BIM 3D drawing and a crack area based on augmented reality technology. Through augmented reality-based safety checks, a manager quickly makes a decision to respond to problems in the damaged area for workers' safety and also records data immediately. With this approach, he/she expects to make maintenance decisions directly on site.**

Keywords*— *Inspection , Augmented Reality, Mapping , BIM 3D

I. INTRODUCTION

Currently, many bridges must make regular inspections and maintenance. In the safety inspection method of the huge bridge, the inspector directly checks the safety through manually inspecting it. This work is exposed to risk, and cannot guarantee the accuracy. In particular, it is difficult for managers to quickly identify problems in the damage field, making it difficult to solve problems immediately. To solve this, we propose a mapping method of the BIM 3D drawings and a crack area with augmented reality devices for crack inspection. We can reduce the risk of workers' work, increase the accuracy. Managers can also quickly identify and respond to problems in the crack field. The inspector makes maintenance decisions immediately with this information. This paper is as follows. Chapter 2 mentions the entire process, the definition of classification codes, the indexing of bridge information, the DB design that stores it, and the method of transmitting and receiving heterogeneous data as related research. Chapter 3 explains the mapping of BIM and a crack with augmented reality. Chapter 4 shows how to implement that. Finally, chapter 5 mentions conclusions and further studies.

II. RELATED WORKS

A. Our whole development process

Figure 1 is the entire process. We generate a classification code by recognizing a QR code on HoloLens 2. We propose a mechanism to simply modify and add the crack information at the location corresponding to the classification code generated in the DB and output it along with the BIM 3D drawing. This increases the safety and accuracy of bridge safety inspections. Our remote maintenance system allows managers to quickly determine whether it is dangerous or not at the inspection site.

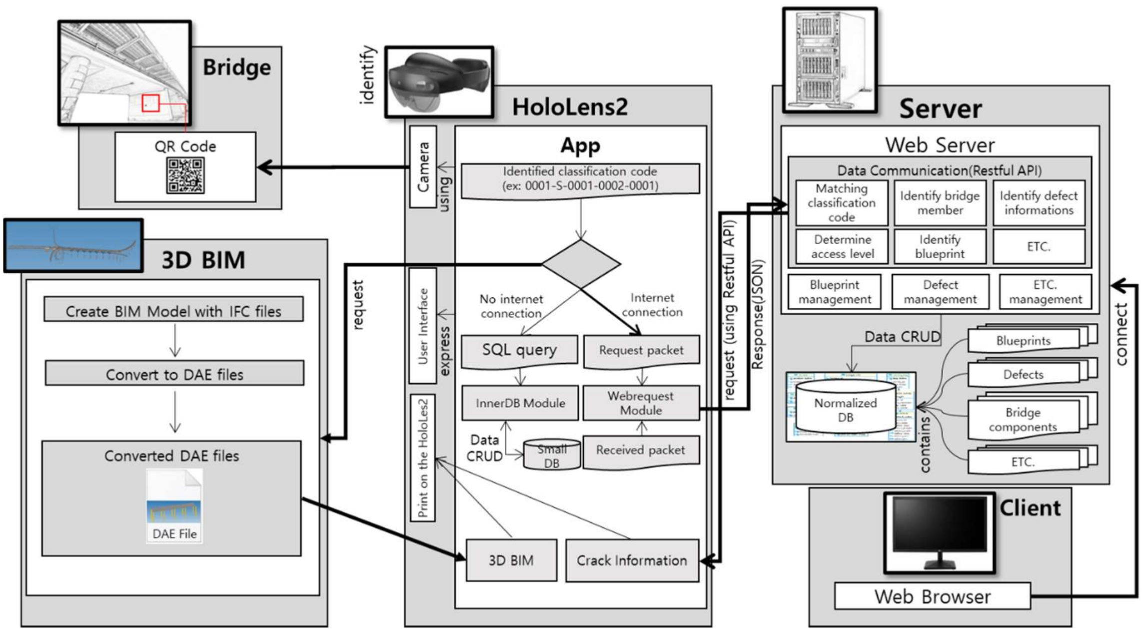

Fig. 1. Our whole Development Process

B. Code Definitions for Bridge classification

TABLE I. CLASSIFICATION CODE FORMAT

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

Table 1 shows how to define the classification code of a bridge. We define Classification codes for each section, spot, and building components. One section contains multiple spots. One spot contains multiple components. The same spot exists in the section. The same components exist in the spot. So we define a unique identification number for each spot and components [2].

C. Database definition and normalization of Code classifications

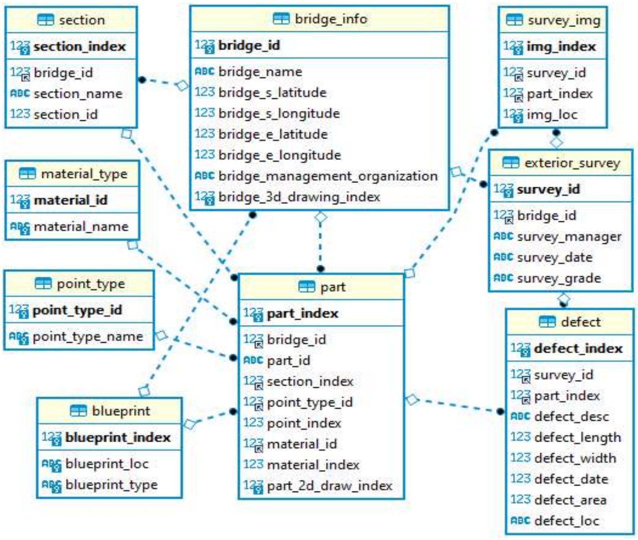

Fig. 2. Normalized DBTable Structure for Bridge information

Figure 2 is a DB table for managing bridge drawings and crack conditions through HoloLens 2. We design the DB and propose the following crack management methods. 1) Index the absence information of the bridge and store it in the DB. 2) HoloLens 2 recognizes indexing information (QR code information) to inquire bridge details of the DB. 3) Add, modify, and delete bridge details in HoloLens 2. 4) The bridge details are CRUD to the DB through the web API. Effective crack management can be achieved through this method [3].

D. Heterogeneous data transmission

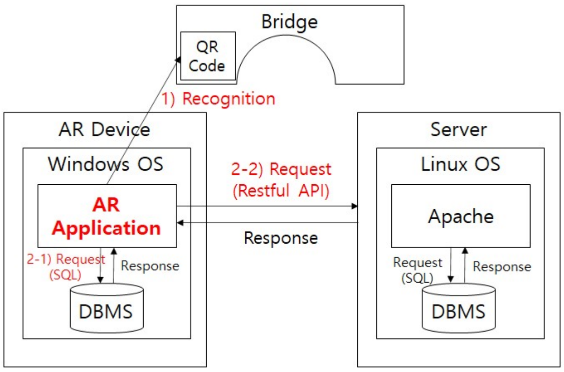

Fig. 3. Request Process of AR Application

Figure 3 shows a heterogeneous data method in which HoloLens 2 queries the internal DB or the external DB depending on the situation. We propose a heterogeneous data transmission/reception scheme as follows. If the Internet is not connected, information on the bridge is obtained through the internal DB. When connecting to the Internet, the information on the bridge is obtained by inquiring the web DB, that is, the external DB, through the Restful API [4].

E. A QR code tracking application

Fig. 4. AR application that tracking QR code on HoloLens2

Figure 4 shows recognizing a QR code through HoloLens 2 and calling the classification code. Using the Webcam function of HoloLens 2, after recognizing the QR code containing the classification code, a marker is created on the QR code, and the classification code is printed on the panel [5].

III. MAPPING OF BIM SYSTEM AND AR DEVICE

A. Importing crack information from DataBase through QR tracking

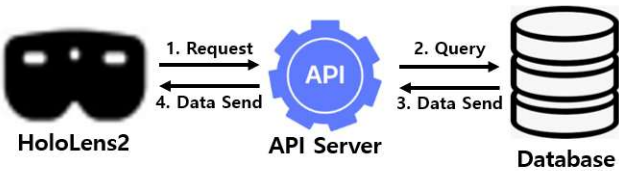

Fig. 5. Relationship between HoloLens2 and DB

Figure 5 shows the relationship between HoloLens 2 and DB. A bridge safety inspection application was developed through two related works. The mechanism is as follows. 1) It recognizes the QR code and sends a request to the web API server through the classification code. 2) The API server sends a query to the DB to receive the location and crack information corresponding to the classification code. 3) The received information is transmitted to the HoloLens 2.

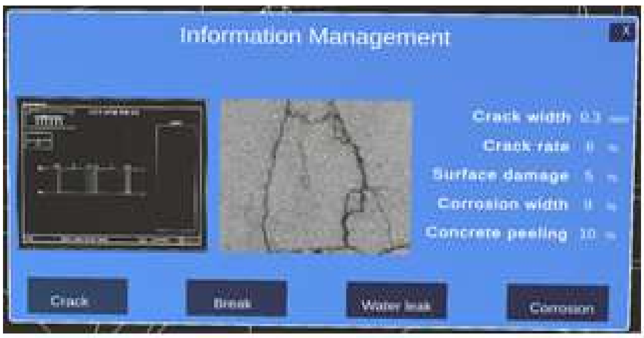

Fig. 6. Crack information panel

Fig. 7. Crack information edit panel

Figures 6 and 7 are output panels that output the called location and crack information on HoloLens 2 and crack information modification panels that can modify the information. Crack information called from DB can be output and shown and can be easily modified and added.

B. Converting Industry Foundation Classes(IFC) to Digital Asset Exchange(DAE)

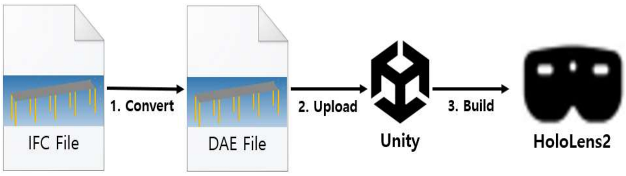

Fig. 8. Industry Foundation Classes(IFC) to Digital Asset Exchange(DAE) Process

Figure 8 is a diagram showing how to upload IFC files, the standard format of the BIM model, to HoloLens 2. Unity, which is linked to HoloLens 2, cannot import and output IFC files. Therefore, Unity converts it into a compatible DAE format file. You can upload the converted DAE file and output it to HoloLens 2.

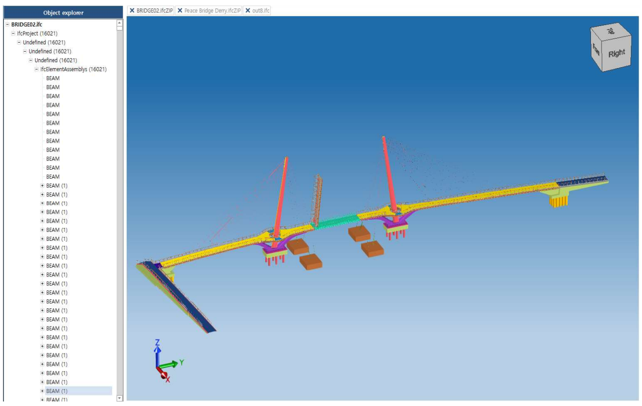

Fig. 9. IFC file before conversion

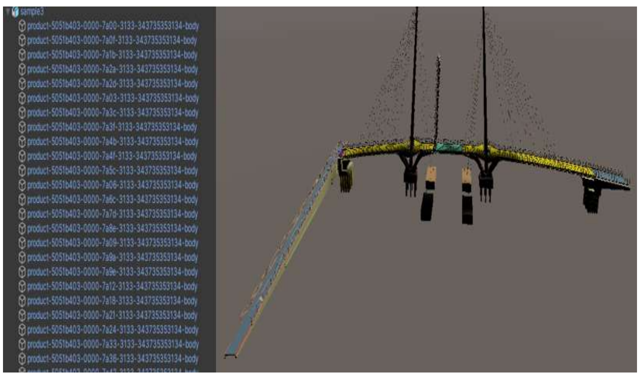

Fig. 10. Model information and photos after conversion to DAE file on Unity

Figure 9 shows IFC file before conversion to DAE. Figure 10 shows that the BIM converted to DAE was uploaded to Unity. Even if it is converted into a DAE file and uploaded, the components and information of BIM are not damaged and can be modified and added in Unity.

C. Mapping of BIM 3D model and Augmented Realty application

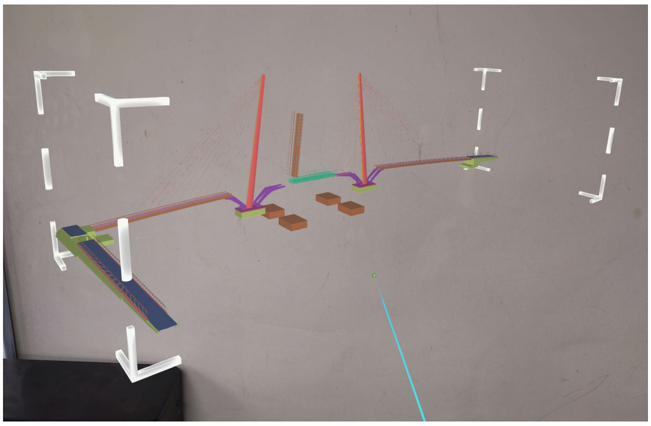

Fig. 11. BIM 3D Model loaded with QR code on HoloLens2

Figure 11 shows a BIM 3D model in which components and information are not damaged through HoloLens 2. Map the mechanism of the Related Works and the BIM 3D model. Through this, QR code recognition can recall the BIM 3D model and the crack information contained in the DB.

IV. CASE STUDY

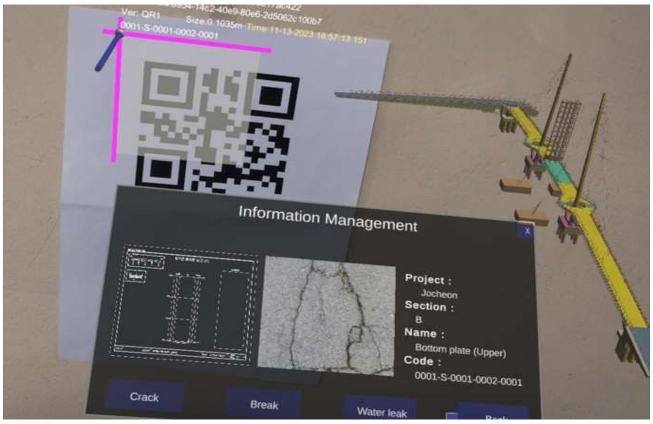

Fig. 12. BIM 3D Model and Bridge information loaded with QR code on HoloLens2

Figure 12 shows how Crack information and the BIM 3D model are mapped and outputted through QR recognition on HoloLens 2. It outputs the information of the Crack and the BIM 3D model taken from the DB. Through this, location information such as the section, point, and absence of the bridge indicated by the classification code contained in the QR code can be found, and information can be simply modified and added. A safe and accurate real-time remote inspection environment can be expected at the bridge safety inspection site.

V. CONCLUSION AND FUTURE RESEARCH

We propose the mapping of augmented reality devices and BIM 3D drawings for the safety inspection of artificial facilities. An operator can inquire about crack information through an augmented reality device and simply modify and add it to the DB. In addition, information can be inquired more accurately by printing BIM 3D drawings. Through this, the information of the bridge can be safely and accurately checked with the augmented reality device in the field and maintenance decisions can be made immediately by the work determiner through the comparison of cracks with the 3D drawing of the bridge. In the future, meta-modeling will allow it to be linked to several augmented reality devices, including HoloLens 2.

It is expected that the safety inspection site will be able to conduct safety inspection and maintenance by selecting augmented reality devices according to the field situation.

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