Development of AR Underground Facility Management System using Map API

Bong-Hyun Kim, Ju-Ri Kim

With the rapid development of IT technology in the modern society, various kinds of information such as smart information age are provided in real time regardless of time and place. Especially, various IT devices and mobile devices using the ubiquitous concept are being widely used in real life and helping to make life convenient. Currently, various ubiquitous services and management schemes are being tried in the government business field. However, commercialization and commercialization are limited to a limited number of businesses. Therefore, this paper proposes an augmented reality based on system implementation and service environment plan for the management of underground facilities (gas, electricity, communication, waterworks, sewerage, heating, oil pipeline etc.). To do this, we used Map API technique. Augmented reality-based underground facilities management system is a system that can locate and modify the location without drawing in the field by communication between tablet and server in relation to underground objects. Especially, it suggested a method to provide and manage the location information of GIS system and the facilities embedded in the underground, and attribute information by replacing the location mark used in existing underground facilities. Through the augmented reality based underground facility management system, it is expected to be effective in terms of practicality, economics, real - time network, information provision and management, and prevention of major accidents. In addition, it will be an effective method for updating and maintaining information related to underground facilities.

Key words: Map API, Underground facility, Web application service, Web communication, Augmented reality, GIS system.

I. INTRODUCTION

Today, the world is rapidly becoming urbanized, and population densities due to rapid urbanization are causing typical urban problems such as traffic congestion and deteriorating ecological environment. As a representative example, difficulties in urban management such as waste disposal, public hygiene, and security problems are increasing. Especially, despite the efforts of the government in the management of underground facilities, there are many damages and inconveniences because the number and types of underground facilities to be managed are large and it is impossible to visually confirm them due to underground burial[1, 2].

Underground facilities refers to certain facilities that develop and utilize underground facilities such as water pipe, drain pipe, power facilities, telecommunication facilities, gas supply facilities, communal areas, underground roads, and subways. The managers of these underground facilities should periodically conduct and report safety checks in accordance with the safety management regulations for underground facilities and surrounding grounds for the area in charge. Underground facilities are buried in the ground. Due to rapid industrialization and urbanization, there are difficulties in management due to inconsistency in design and construction and complexity of underground facilities[3]. In addition, systematic management of underground facilities is very important in that the management becomes poor and unexpected accidents occur, resulting in loss of life or property. In particular, underground facilities rupture in unpredictable conditions, many residents in the area suffer from major inconveniences and repairs are urgently needed. The rupture of underground facilities causes various problems such as various traffic problems, water supply interruption, river pollution, infiltration into other underground facility pipes[4, 5].

Therefore, a convenient and safe underground facilities management system through the combination of advanced information technology and physical environment should be developed and applied. In particular, underground facilities are a key part of the city's core infrastructure, and the need for systematic and efficient management is increasing. Research on related technologies such as GIS, sensor, network, and digital contents is being actively carried out, so that it is necessary to acquire accurate information on facility-related information and to maintain and manage it in a steady state by grasping the location and condition of underground facilities. Recently, many countries are developing systems for managing underground facilities such as smart underground facilities management technique, intelligent underground facilities management network development technology, intelligent water and drain pipes asset management system development and dissemination[6]. Therefore, in this paper, we have developed a systematic management system for underground facilities by applying augmented reality technology. To do this, we used Map API technique. Augmented reality-based underground facilities management system is a system that can locate and modify the location without drawing in the field by communication between tablet and server in relation to underground objects.

Finally, data verification was performed in real time on underground facilities through augmented reality and interworking with the spatial data GIS engine was

Revised Manuscript Received on May 22, 2019.

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performed based on the underground facilities management system. By integrating such development technology, we constructed an underground facilities management system. In the integrated system, we are responsible for the management and operation of underground facilities, and developed a solution applying GIS Interface S / W development and operation method.

II. RELATED WORK

2.1 Augmented Reality

Augmented reality is a hybrid virtual reality technology that combines reality and virtual environment using technology that shows real world three-dimensional virtual objects overlaid. Augmented reality is a technology that superimposes virtual objects on the real world that the user sees. In other words, it is a field of Virtual Reality, which is a computer graphics technique that combines virtual objects or information into a real environment and makes it look like objects in the original environment[7, 8]. The augmented reality is to increase the effect of reality by combining the virtual object on the environment of the real world, unlike the virtual reality which assumes the complete virtual world.

There are augmented reality and virtual reality. Both technologies have a similar format called 3D implementation, but they are clearly distinguished by whether the subject is illusion or reality. Augmented reality is a popular technology that is widely used by the general public. However, virtual reality is generally used only in special environments such as movies and video.

There are several necessary things to realize Augmented Reality. Basically, the like are needed GPS device for analyzing geographic information and location information, a gravity sensor composed of a tilt and an electronic compass. In addition, a location information system in a network connection state in which detailed information according to sensor information is stored is needed. There is a need for an augmented reality application that receives detailed information and displays it on a realistic background, and finally an IT device such as a smart phone or a tablet PC is required for outputting it to a display[9].

The augmented reality is characterized by the combination of virtual information spaces that are reproduced by computers in the real space, that virtual information is displayed in coordination with the position and content in the actual space, and that information can be interacted It is processed in real time. In other words, computer graphics technology has been developed to add automobiles and robots that were not in production at the time of editing in the editing process. That is, it is a feature of augmented reality technology that a virtual image can be synthesized and displayed in real time in accordance with the environment of the user, and these virtual objects or information can be manipulated and interacted with each other[10].

In order to realize the augmented reality, it is necessary to recognize the objects that are the background of the augmented reality correctly. In the case of camera tracking, which is generally used, the camera recognizes the mark or surrounding objects and provides the location information to the central database. Another system for acquiring location information is GPS technology, which is used in the augmented reality realization principle that holds information that must be provided by absolute user location. Also, it is a technology for grasping an electronic compass and a tilt by using a gravity sensor. These techniques are used collectively to realize augmented reality[11].

2.2 JSON Communication

An abbreviation for JavaScript Object Notation (JSON), which is an expression used to create an object in JavaScript. This expression is easy for people to understand, machine is easy to understand, and the data capacity is small. For this reason, JSON has been replaced by XML in recent years and is used for storing settings and transmitting data. JSON is a lightweight data-interchange format, which means an expression used to create an object in javascript. JSON expressions are easy to understand for both humans and machines, and because of their small size, JSON has recently replaced XML and used them for data transfer[12, 13]. It does not depend on any particular language, and it provides a library that can handle data in JSON format in most programming languages. These are universal DATA structures. In fact, all modern programming languages support them in any way. It is natural that a compatible DATA format using programming languages is based on these structures. The object, array, value, string, and number formats used in JSON are as follows.

JSON is lightweight text-data interchange format -smaller than XML, and faster and easier to parse JSON is language independent - it uses java script syntax for describing data objects, but indenpended of any language. An API is a specification intended to be used as an interface by software components to communicate with each other[14]. An API is a may include specifications for routines, data structures, object classes and variables can take many forms. International Standard such as POSIX or vendor documentation such as the Microsoft Windows API, or the libraries of a programming language can be language-dependent - only available by using the syntax and elements of a particular language, which makes the API more convenient to use language-independent - written so that it can be called from several programming languages. The practice of publishing APIs has allowed web communities to create an open architecture for sharing content and data between communities and applications. Content that is created in one place can be dynamically posted and updated in multiple locations on the web. User information can be shared from web communities to outside applications, delivering new functionality to the web community[15].

III. SYSTEM MODELING

In this paper, we design an augmented reality facility management system that enables facility managers to check underground facility

data by using map API underground burial facilities such as waterworks and sewer pipes buried underground.

Figure 1 shows the overall system configuration diagram. First, when the underground facilities management program is executed, the checking on the device is performed. Device check checks whether GPS is enabled, network is enabled, and whether Google Play Service is installed.

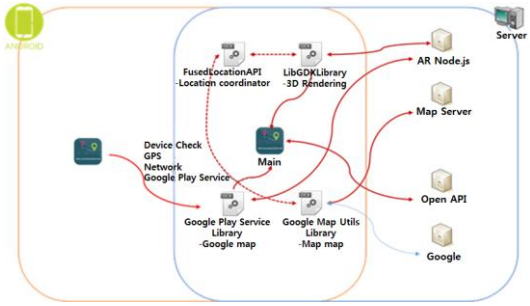

Figure 1 Overall system configuration.

The design for starting AR mode and starting Google Map mode is shown in Figure 2. The system modeling for the start of AR mode starts with facility check and rendering. Then, real time GPS information transmission is performed, and data update is performed through request position calculation and server transmission. Perform 3D rendering of JSON communication and LibGDX library using AR Node.js server. System modeling for starting Google Map mode begins with the Google Play Service Library. Thereafter, the user location transmission, the request location calculation and the server transmission are performed, and the data update proceeds.

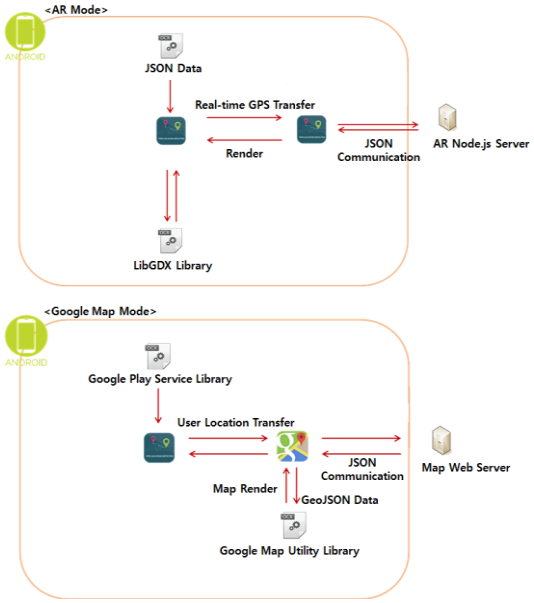

Figure 2 AR mode and Google map mode

The manual position correction is performed in the same manner in the AR mode and the MAP mode. Manual position correction requests GIS data for the specified position from Google Map to Map Web server through Google Map Utility Library. The Map Web server transmits facility coordinates and attribute-value parameter through JSON and generates markers and lines through Map Render.

IV. SYSTEM DEVELOPMENT

The underground facilities management system developed in this paper processes and processes the data by using the markerless method depending on the absolute coordinates of the device. Therefore, the accuracy of the data due to the GPS error did not meet the expectations. In order to secure these problems, the way of expressing the ground facilities was changed to the marker type. In addition, the facility that can be visually identified is changed by a marker method so that the device camera can confirm the information of the facility when the facility is moved into the screen. Also, the underground facility renders a line of a desired radius by using GIS coordinate information and changes the view point to move using the GPS and the sensor of the device. Therefore, it will be possible to develop an engine that can check and use the data in a precise error range when developing the engine through the marker method and the actual mapping.

Figure 3 shows the user interface function.

1. Update GPS coordinates
2. Activate MINI MAP VIEW
3. Activate the supported functions in that mode
4. Index the displayed information on the screen
5. Switch AR / MAP mode
6. Select and display underground objects

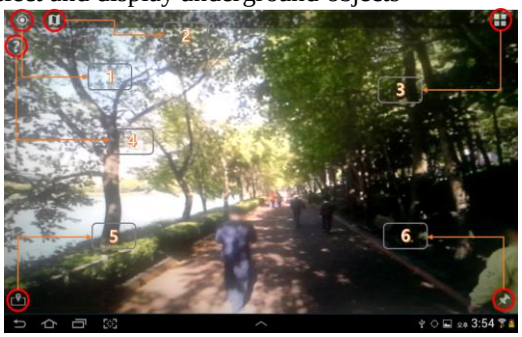

Figure 3 User interface mode

Figure 4 shows the facility indexing function. The color and shape of the facility can be checked.

- Facility History Management: Register facility history.
- Facility history: You can check the facility history.
- Refresh current location: Refresh all data by current location.
- Map data update: Sets and applies the display radius of facility information.
- Address search and move: Update location and data using old address and new address.
- Manual Position Correction: Fix position using map.

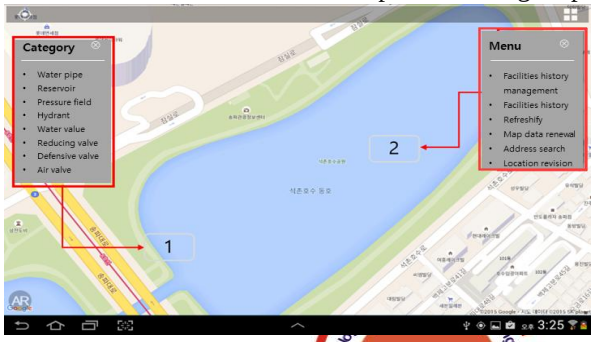

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Fig. 4 Facility indexing function

The underground facility management system procedure is as follows. First, the smart device network connection and DB server connection checking are performed. If both conditions are met, the current position is taken. Move the map to set and confirm the correction for the initial coordinates. When checking, store the index of the position specified in the device memory. You can select either AR mode or Google Map mode to select the entry mode and change the mode after entry.

In the selection mode screen, select the rendering category, and in summary, identify the facilities in the augmented reality mode through the color and shape of the graphic.

- Facility history: You can check the history list of facilities.

- Facility history registration: You can register history of facilities.

- Manual position compensation: The applied position can be compensated.

V. CONCLUSIONS AND FUTURE WORK

In this paper, we have developed a systematic management system for underground facilities by applying augmented reality technology. To do this, we used Map API and JSON communication technique. Augmented reality-based underground facilities management system is a system that can locate and modify the location without drawing in the field by communication between tablet and server in relation to underground objects. The augmented reality engine of underground facility management system implemented in this paper is LibGDX sub desktop or mobile platform game engine. We confirmed the limitations of the data base and GIS program due to limitations of the LibGDX engine. In order to reduce the constraints on scalability and data mapping, research and development of proprietary augmented reality engines is required instead of existing open source engines.

Finally, it is possible to precisely measure underground facility survey and condition for existing buried pipe or new public pipe by applying augmented reality based underground facility management system. In addition, it is possible to derive accurate prediction data for underground facilities by performing pipeline information digitization and detailing, and database information of property information to perform information inquiry, editing, and attribute information management.

VI. ACKNOWLEDGMENT

This paper was supported by wonkwang University in 2019.

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