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The Development of Real-Time Field Information Warning System for Underground Facility Using Google Cloud Message

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ABSTRACT

A leakage in a waterworks pipe not only does it cause an suspension of water supply but a high cost may be involved in order to restore the leakage and cause other inconveniences. Even if a repairman arrives to restore the leakage, the individual might be unable to find the exact location of the leakage and also experience other problems. In this paper, we designed a real time data push alert transfer module that is both stable and effective through the use of GCM services by Google to make sure that the supervisors at the waterworks pipe accident site are able to respond quickly and receive real time information on the accident. A real time field information warning system has been developed through the use of augmented reality technique for confirming in real time the information of the accident site.

KEYWORDS: Google Cloud Messages, Augmented Reality, Underground Facilities, Waterworks Pipe Networks, Real-time Field Information Warning Systems, SQLite

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1. Introduction

The waterworks pipe, which is a part of the infrastructure, can be damaged and lead to a leakage. It can also take a long time to long time to respond and restore the problem. The estimated damage and the scale of the damage increases as the time of restoration is prolonged and time itself can cause many other inconveniences. In addition, even if a repairman arrives at the scene to fix the leakage, problems

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such as being unable to find the site of the leakage can occur. Therefore, a rapid communication need to occur with the site of the accident and the supervisor in order to locate the exact leakage site in the shortest period of time and restore the site[1, 2].

The development of a variety of applications and the generation of fusion has made the augmented reality techniques to fuse with the mobile devices leading to a production of augmented reality applications. Such fusion techniques has allowed a progressing research to look at the pipe network monitoring applications for managing underground buried pipes and culverts through the use of smart phones[3].

In this paper, the current research aims to graft onto the augmented reality technique and GCM of Google in a cloud environment to make possible rapid response and real time reception of accident related information on the part of the site supervisors in case of accidents or leakages in the underground utilities. Also we proposed and developed a real time sharing system for transferring messages related to the current situation of the site.

2. Related Research

2.1 Leakage Sensing Pipe

It is the exclusive sensing pipe made for leakage detection of RTD-1000(Remote TDR Device-1000) system and sensing cable is inserted around the covering. The inserted sensing cable is wound to the pipe in a spiral way which is easy to be cut by breakage, another pipe passage due to another construction, or wrong connection. The copper wire was used for the sensing cable to have sensing cables shorted out each other easily when leakage occurred. These leakage detecting pipes connect the sensing cables to build the network when connecting sensing pipes when buried under the ground[4].

2.2 Real-Time Monitoring System

There is RTD-1000 system as a leakage detection monitoring system among the underground facility monitoring systems.

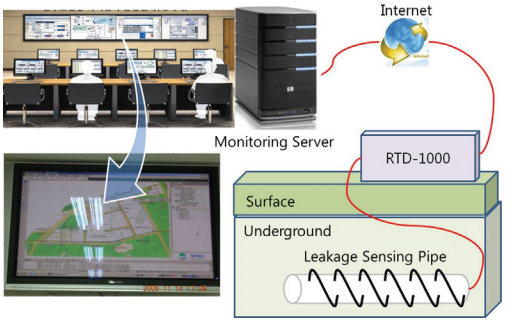

그림 1. RTD-1000 모니터링 시스템의 구성도

Figure 1. Structure of RTD-1000 Monitoring System

<Figure 1> Shows the structure of leakage detection monitoring system using RTD-1000 device. This system is made up of RTD-1000 equipped with TDR, the pulse wave measuring device, and leakage sensing pipe. TDR equipped in the monitoring system is connected to the network and sends the pulse wave to the sensing cable of buried leakage sensing pipe and collects the reflected wave. If there is a problem in the

pipe-network, the sent pulse wave is reflected from the abnormal position and returns. The abnormality of pipes, the pipe with abnormality, and occurrence position can be monitored in real time using the change information of this reflected wave form.

2.3 Google Cloud Message

Google Cloud Message (GCM) is a message cloud system that is provided by Google. All android devices periodically communicate with the Google server and transmit location information and application information. Furthermore, the GCM message push service mechanism is included, which can carry out the remote commands of the Google servers depending on the circumstances[5]. GCM is used to transfer a short messages and hardly ever been used for monitoring field. Currently GCM is being used by some credit card companies for a short message sending when the users pay by card. But, hardly ever been used for monitoring field.

2.4 Augmented Reality

The augmented reality technique is a technique that allows the user's eye to see the imaginary object in the real world as overlapping. This technique is used in games, mobile solution industries, education industries, telemedicine diagnosis, broadcasting, construction planning and in management of manufacturing processes[6].

3. Real-Time Field Information Warning System

There is accident reception method system as a tag and barcode reading method among the underground facility management methods. However, since the fault reception screens for the facility management are complex. And the reception method is difficult, the confusion can increase in the reception.

Also, the monitoring system using already developed RTD-1000 is the real-time system to monitoring using the special pipe called leakage sensing pipe and was developed for the first time in the world and being operated by some self-governing bodies now. The difference from the system suggested by this paper is as <Table 1>. The suggested system is the expanded concept of existing system and aimed to conduct the maintenance in a faster time.

표 1. 기존 시스템과 제안한 시스템과의 비교

Table 1. Compare Existing System and Proposed System

	Existing System	Proposed System
Map	GEOMania Map	Google Map
PC-Based Monitoring	Yes	Yes
Real-Time Monitoring	Yes	Yes
Augmented Reality (AR)	No	Yes
Accident Location Display	GIS Map	GIS Map + AR Display
Accident Location Search Accuracy	Midium	High
Maintenance Time (Accident)	Midium	High
Portability	Low	High
OS Generality	PC OS	PC OS, Android OS

In this paper, Google's GCM service is linkage

into the existing real-time monitoring system and the maintenance time can be reduced by quickly delivering the accident reception information to the manager of relevant facility maintenance. Also, more exact position information can be provided by using the augmented reality technique.

Cloud server applies the water resource cloud computing technology and allows real time updates and searching through smart phones for all the necessary data needed for pipe network construction and management. The augmented reality applied to the monitoring of the pipe network can display on your smart phone information such as real time site data for the management of the pipe network and the constructed database during the laying stage of the pipe network, resulting in the provision of virtually real information.

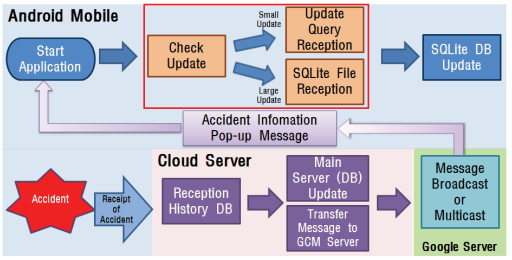

그림 2. 클라우드 서버와 GCM을 이용한 안드로이드 모바일 시스템의 구조

Figure 2. Structure of cloud server and android mobile system using GCM.

The database is extracted from the existing integrated pipe network and the database is made for the optimum performance for monitoring the augmented reality and smart phones. This smart phone database that is temporarily built is called a segment database and it is created for each situation in the whole database[7].

<Figure 2> Shows the structure of the site situation information sharing system using the GCM with Cloud. The Java language completes the GCM server for the transferring of messages.

In case of accidents, the augmented reality screen will consider the necessary level of security for the transferring messages in regards to the accident site and the repair situation. The message is displayed on the smart of the site according to the area of transmission and the level of security. The display in GIS screen and augmented reality screen mode allows confirming of the location and the content information[8].

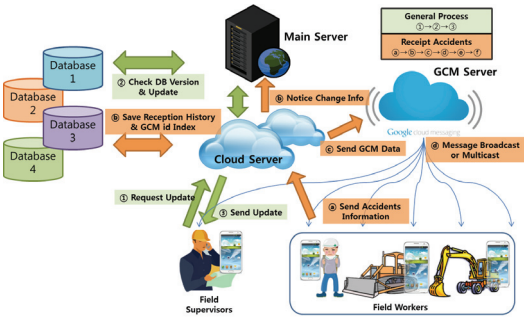

그림 3. GCM을 이용한 실시간 현장 상황 실시간 정보 경보 시스템의 구조

Figure 3. Structure of real-time field situation, real-time field information warning system using GCM.

<Figure 3> show general process and receipt accident process. Server is composed of the server and the Java language and is made up of the TCP/IP server, which has made use of socket communication. The applications on Android mobile devices have also been composed by Java

and therefore make the interactive communication process simple[9,10].

The transmitter will send the messages and the key values of the receiving devices to the Google cloud server, then the GCM server multicasts the messages for the targeted devices. All android devices transmit system information periodically to the Google server, and include a mechanism that can run specific commands of the server. The GCM flag is included in this and if it is transmitted to the Google server, Google will check the message cue and transfer the message to the appropriate device. The client device OS, which has received the GCM message from the Google server will input this into an intent object and broadcast it. The registered activity will be operated for the transmittance of the broadcast in order to handle the message.

There is reduced battery usage and data usage due to the usage of the existing communication mechanism from Google compared to a server that directly composes a message and in addition there is guaranteed safety, trust and speed.

4. Implementation and Simulation

The following are the scenarios for the use of GCM for the message provision services.

1) When the application is run the GCM Key is confirmed by the server during the loading process and then confirms if the applicable mobile device is an authorized device for use. The verification process occurs automatically with the running of the application.

2) If the verification process succeeds, it proceeds to the login screen. If the database version of the applicable mobile device is not up to date, the server will run an update mechanism and the “update query” will be transferred in the case of minor updates but if it is a major update, the majority of the queries can take a longer period of the mobile device and therefore the latest SQLite file itself will be transferred to replace the database file. After the login, the database version information of the mobile is sent to the server to check for any updates.

3) If the update has been completed or there is no need for updates, the database will load as per usual and run the application. <Figure 4> show the screen of real-time field information warning application.

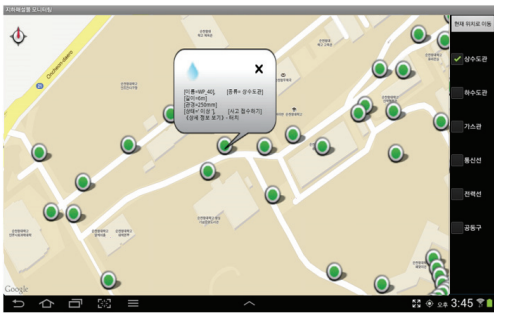

그림 4. 실시간 현장 정보 경보 어플리케이션

Figure 4. Real-time field information warning application.

The following scenarios will occur in the case of accidents.

1) In the case of an accident or modifications from maintenance, the application will select the appropriate pipe from the screen and move to the accident reception screen.

2) After the selection of the accident, maintenance, completion and reception types and

the current status from the screen, the clicking of the reception will lead to the transmittance of the reception information including the id of the receiver to the server.

3) The cloud server, which has received the accident information will record this data on a separate MySQL database and update the database through the modified specifications of the central server, thus analyzing the contents of the received information.

4) The necessary user information segments will be extracted from the MySQL database for emergency message alerts through the coordinates of the appropriate pipe from the received data and then the key coordinates of the extracted users and the accident information will be transmitted to the server. The GCM server will extract the key coordinates of the user's GCM from the payload of the received data and multicast this message to the appropriate devices.

The recipients are separated according to the security levels at the time of the information transfer of the site situation. In order to achieve this, the currently being research segment database will be applied to decide on the area of transfer and also selectively sets level of transfer for people that only need the information according to the security levels.

5) The message is sent as push warnings in real time to the users through the GCM mechanism and the devices receiving the information will have a pop-up of the accident information, then the application is run when this is confirmed. <Figure 5> show cloud warning message that is sent to smart pad device. Press the run button to see a leakage point that is running augmented reality mode.

그림 5. 증강 현실 모드에서 수신 받은 클라우드 경보 메시지

Figure 5. Cloud warning message received on augmented reality mode.

5. Conclusion

In this paper proposed system to the following conclusions. The proposed system is based on cloud and the accident information is transferred according to the security level by the sender in the case of an accident at a site. The database of the proposed system uses the basic technologies in the database used by PC-based monitoring systems and has a background of the exact location information of the pipe network at the user's construction site, thus providing any information of faults to the user. In addition, the construction data input/maintenance program has made up for the problems with the method of recording at a real construction site, and therefore systematically organizes the data for easier use of the information. It is also predicted that standards will be proposed for the effective construction of utilities. In the future, the limitations of the

database that can occur in a smart phone environment of the cloud environment will be resolved and a construction situation information monitoring system that uses a 3D modeling technique will be developed in the future.

References

[1] B.-M. Kang, and I.-S. Hong, *A study on a remote leakage sensing system in waterworks network*, Journal of The Korea Information Processing Society Transactions : Part D, Vol. 11-D, No. 6, pp. 1311-1318, 2004.

[2] J.-T. Park, and I.-S. Hong, *A study on underground facility monitoring application using smart phone based on android*, Proceedings of The Korea Multimedia Society Conference, Vol. 13, No. 2, pp. 261-264, 2010.

[3] B.-H. Lee, *Management of water distribution systems using optimization model*, Journal of The Korean Geophysical Society, Vol. 7, No. 1, pp. 51-60, 2004.

[4] B.-M. Kang, and I.-S. Hong, *A study on a leakage sensing pipe and monitoring system using TDR in GIS*, Korea Multimedia Society, Vol. 7, No. 4, pp. 567-578, 2004.

[5] Google APIs console, https://code.google .com/apis/console/

[6] Augmented Planet, http://www.augmented planet.com/tag/android

[7] B.-M. Kang, B.-C. Chan, and I.-S. Hong, *The development of augmented reality facility database for water works pipe networks management*, Journal of The Korea Knowledge Information Technology Society. Vol. 8, No. 2. pp. 1-8, 2013.

[8] W.-Y. Song, M.-G. Doo, S.-W. Ha, and D.-W. Jeong, *Design of android-based sensor registry system for semantic processing of sensor information*, Journal of The Korea Information Science Society, Vol. 37, No. 1, pp. 58-61, 2010.

[9] Android SDK, http://developer.android.com /sdk/index.html

[10] R. Meier, *Professional android 2 appication development,* Wrox, 2010.

구글 클라우드 메시지를 이용한 지하매설물의 실시간 현장정보 경보시스템의 개발

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요 약

상수도관의 누수가 발생하면 단수뿐만 아니라 복구까지 걸리는 시간에 따라서 막대한 비용과 불편한 문제들이 발생한다. 그리고 복구를 위해서 사고현장에 도착해도 사고지점을 정확히 알 수도 없는 문제들이 많이 발생한다.

본 논문에서는 지하 매설물에 사고가 발생 시 현장 관리자들이 사고접수 정보에 대한 실시간 수신 및 빠른 대처가 가능하도록 Google의 GCM서비스를 이용하여 실시간 데이터의 안정적이고 효율적인 푸시 메시지 전송 모듈을 설계하였다. 그리고 증강현실 기술을 이용하여 실시간으로 사고 현장 정보를 확인할 수 있는 현장상황(Real-Time Field) 실시간 경보 시스템을 개발하였다.

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