지하구조물에서의 화재사고처리를 위한 유비쿼터스 그리드 시스템

이 용 우* 김 태 영** 김 주 현***

◈ 목 차 ◈

1. Introduction

These days the underground structure becomes more popular and its size grows day by day due to lack of ground space in modern cities. The underground structures often have complex internal structure where many users visit. Therefore fire can cause a catastrophe there.

We had terrible experience of the fire disaster in an underground subway station of Taegu City, the central part of South Korea, where more than one hundred people died in March, 2003. From the disaster, we learned the unforgettable lesson that we needed a special facilities as well as treatment recipe to prevent an accident such as fire, flooding and structure collapsing from growing a disaster in underground structures and the Korean government have sought it many ways.

We have been doing a project that can be a facility and a recipe to do it. It is a part of a grand challenge R&D project that constructs an ubiquitous (smart) convergence system which can be used for Seoul City[Fig.1]. A consortium of which consists of more than 10 organizations leads the project [Fig.2]. The experts from information technology, environment engineering, traffic engineering and geographical information system engineering works together to achieve the goal of the grand challenge. The project started in 2005 and will finish the first phase work in 2010.[1]. In this paper, we introduce our ubiquitous system in fire management in underground structure.

This paper is organized as follows. Section 2 describes our ubiquitous system requirement. Section 3 explains the ubiquitous system architecture. Section 4 presents our ubiquitous sensor network. In section 5, we introduce our 3D-GIS based information processing. Section 6 explains human interface through convergence network. Finally conclusion of this paper is given in section 7.

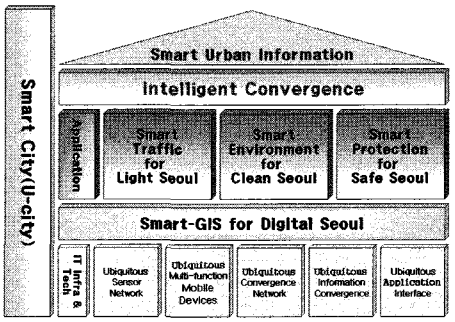

Fig. 1. The Smart Seoul Consortium Project

* 서울시립대학교 전자전기컴퓨터 부교수
** 서울시립대학교 메타 컴퓨팅 연구실
*** 서울시립대학교 대학원 전자전기컴퓨터공학부 석사

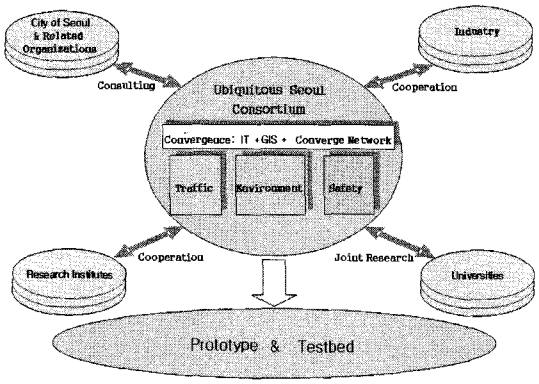

Fig. 2. The Seoul Ubiquitous City Consortium

2. The Characteristics of Ubiquitous Underground Structure

An accident such as fire, flooding and terror in a underground structure can easily grow into a disaster because human beings usually have difficulty in escaping from the underground structure and underground closeness characteristics give human beings difficulty in managing the accident properly.

For example, underground subway stations and underground shopping centers are closed spaces without(except) prepared routes and dark spaces without electrical power. Therefore, people should be guided to escape from an accident spot in an underground structure to outside or to a nearby safe space. We use an ubiquitous system to do it. The rescue guide information given to the rescue team and the sufferers should be realtime information and delivered to them in realtime processing mode because a fire usually grows quickly if it can grow.

3. Structure The Ubiquitous System Architecture

In order to give ubiquitous services which satisfy the system requirement, that is, the characteristics of ubiquitous underground structure, our prototype system consists of ubiquitous sensor network, 2D-GIS and 3D-GIS information processing system, convergence network, user interfaces to various kinds of wired devices and personal ubiquitous devices such as ultra mobile personal computer, PDA devices, DMB devices, and information convergence softwares.

In case of fire accident, sensors detect the accident and report the sensed data through ubiquitous sensor network to the central control center and it converges all sensed data and decides its action. If emergency actions are required, then it takes proper actions and sends realtime spot(field) information through convergence network to the disaster prevention center, the emergency rescue center, other necessary offices in order to cooperate to prevent the fire accident from growing into a disaster. Figure 3 and figure 4 show the architecture of our ubiquitous system.

From the sensors, the control center knows the location of human beings and trace them on the 3D-GIS image of the underground structure until the emergency situation ceases. In the accident field, the emergency management teams from various organizations can communicate with each other to cooperate via our ad hoc network.

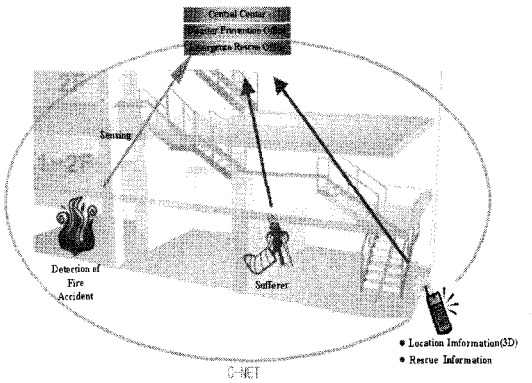

Fig. 3. 3D-GIS Based Information Processing(2)

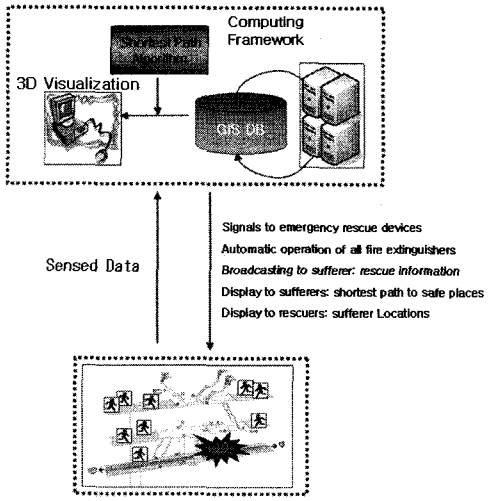

Fig. 4. Overview of the Architecture

4. Ubiquitous Sensor Network

Ubiquitous Sensor Network is used to sense the temperature and smoke in order to detect fire accident. It also detects many kinds of data such as the state of fire wall, that is, whether the fire wall is close or open, the human voice which is used to detect whether there is people or not and video data which is used to detect whether the any part of the underground structure collapsed or did not. Ubiquitous Sensor Network covers all interesting spot of the underground structure enough to make the sensed data useful.

RFID is used to detect whether there is people or not and whether any part of the underground structure did collapse or not as shown in figure 5. [3]

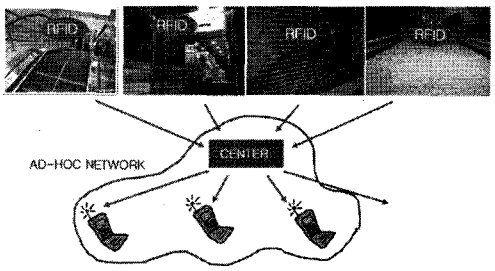

Fig. 5. Location Detection using RFID

In order to detect the fire accident correctly and accurately through USN, we should have good quality of sensors, we have to deploy the sensors well so that we do not miss any necessary sensing point and we should have good topology and protocol of ubiquitous sensor network and good accident detect algorithm. Each sensor covers 10meter (radius). A fault-tolerant routing protocol is used to connect all the sensors. [4]

We have used a simulation method to find out the best escape route in many cases of fire accident and the sufferers' escaping pattern. [5] We use our grid computing technology wth the Seoul Grid Testbed to simulate it. If there are large crowds when the fire accident occurs, then the crowd escaping pattern should also be carefully considered. The simulation result is used to decide the proper positions of the ubiquitous sensors which detect the fire accident and thereafter monitor it.[6]

The USN is also used to control remote fire extinghishing devices, fire wall, forced ventilation, emergency light system. etc..

5. 3D-GIS Based Information Processing

The collected data from USN are combined with GIS database and are graphically displayed on 3D GIS screen as shown in figure 5. The combined data are used during simulation to find out the best escape route. The emergency management algorithm uses them to find out what we have to do in order to prevent a disaster from growing into a disaster [Fig. 6]. 3D-GIS is essential to locating the sufferers in underground structures [7][8]. With our 3D-GIS model, we can consider collapse of the underground structure and isolation of a space when we simulate the best escape route. [9][10][Fig. 7]

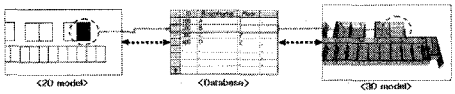

Fig. 6. Selective presentation through 2D-GIS and 3D-GIS with GIS DB

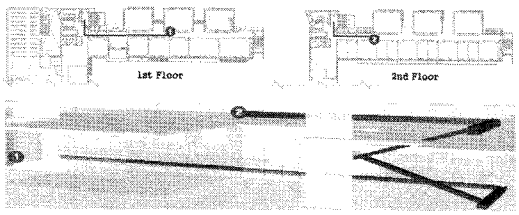

Fig. 7. Shortest path detection with 3D-GIS

6. Conclusions

In this paper, we introduced our ubiquitous system which detects a fire accident and does emergency tasks to prevent the fire accident from growing a disaster in a underground structure. We use 2D-GIS, 3D-GIS, Convergence Network, Ubiquitous network, information merging, grid computing, user interfaces both to wired personal computing devices and wireless personal devices.

We constructed the prototype system and the R&D will be continued for next four years. During next 4 years, the prototype system will be installed in Cheonggyecheon Gwanggyo area, a city center of SeoulCity,theCapitalCityofSouthKorea.

This ubiquitous emergency management system in a underground structure will be tested in many ways including stress tests, because its first task is to rescue human being, one of the most precious things in the world.

Acknowledgments

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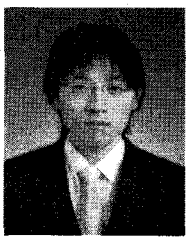
◐ 저 자 소 개 ◑

이 용 우 (YongWoo Lee)

1981년 서울대학교 전기&컴퓨터 졸업(학사)
1990년 영국, Univ. of Edinburg(석사)
1997년 영국, Univ. of Edinburgh(박사)
1999년~ 현재 서울시립대학교 전자전기컴퓨터 부교수
관심분야 : 그리드, 유비쿼터스 컴퓨팅
E-mail: ywlee@uos.ac.kr



김 태 영 (TaeYoung Kim)

2006년 서울시립대 전자전기컴퓨터공학부(학사)
2006년 ~ 현재 서울시립대학교 메타 컴퓨팅 연구실
관심분야 : 그리드, U-city, 유비쿼터스 컴퓨팅
E-mail: silentbrain@uos.ac.kr

김 주 현 (JooHyun Kim)

2006년 서울시립대학교 전자전기컴퓨터공학부 학사 졸업
2006년 서울시립대학교 대학원 전자전기컴퓨터공학부 석사 입학
2006년~현재 서울시립대학교 대학원 전자전기컴퓨터공학부 석사 2학기 재학중
관심분야: 유비쿼터스 컴퓨팅
E-mail: ngkjh@uos.ac.kr