Simulation to find a Shortest Escaping Route with 3D-GIS Using a GRID testbed in an Ubiquitous System

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Abstract: Underground structures such as underground subway stations and underground shopping centers are very dangerous places in case of fire accident. It can easily develop into a disaster which can make a lot of people die. To prevent this kind of disaster, we made an emergency management ubiquitous system. There we included an ubiquitous system which finds out the shortest escaping route and delivers the information to persons in the underground structure. The system does real time simulation and, for the simulation, uses 2D-GIS and 3D-GIS informations and Seoul Grid Testbed for the real time processing. In this paper, we introduce our system focusing on the simulation using the GIS informations and Seoul Grid Testbed.

Key-Words: Ubiquitous System, Grid, GIS, Ubiquitous Sensor Network, Fire Accident.

1 Introduction

These days the underground structure are common 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 special facilities as well as treatment recipes to prevent an accident such as fire, flooding and structure collapsing from growing a disaster in underground structures.

We have been doing a project that can be a facility and a recipe for it. It is a part of a grand challenge R&D project that constructs an ubiquitous convergence system which can be used for Seoul, the capital city of Korea. A consortium of which consists of more than 10 organizations leads the project [Fig. 1]. The experts from information technology area and geographical information system engineering area 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]

We have used simulation to find out the best escape route in case of fire accident. We use our grid computing technology with the Seoul Grid Testbed to simulate them. If there are large crowds when the fire accident occurs, then the crowd escaping pattern should also be carefully considered. Here in this paper, we introduce our simulation using the Grid Testbed to find out the shortest path to an underground place or to a nearby safe place in underground structures in case of fire, flooding, and structure collapsing.

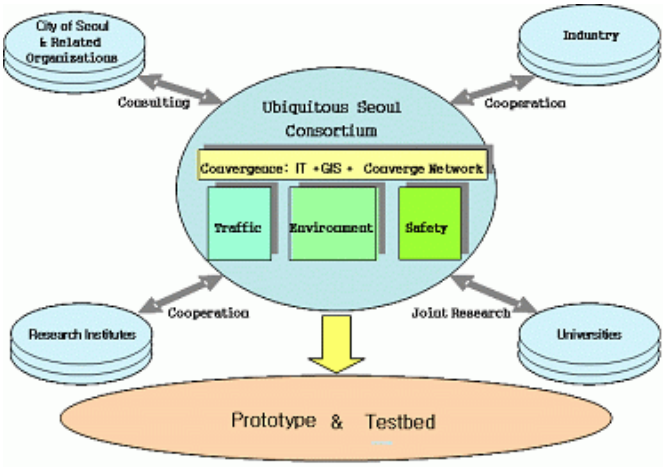
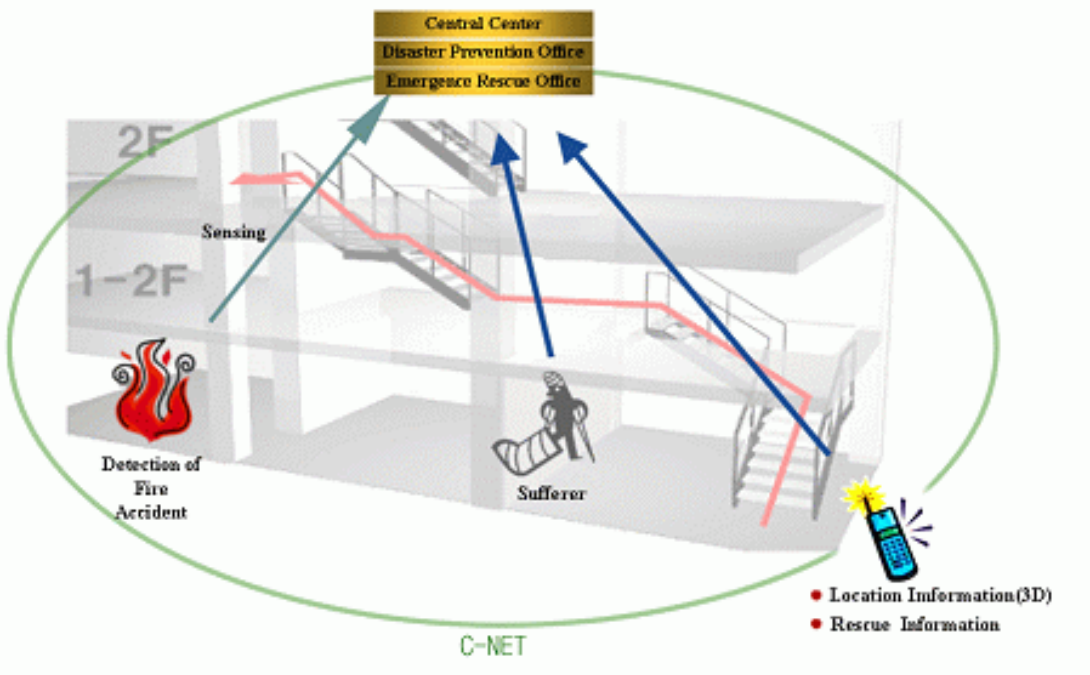


Fig. 1: The Seoul Ubiquitous City Consortium

Accidents 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 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.

Fig. 2: 3D-GIS Based Information Processing

This paper is organized as follows. Section 2 describes our ubiquitous escaping system. Section 3 explains GIS based information processing. Section 4 describes our simulation. In section 5, we explain the used Grid Testbed. Finally conclusion of this paper is given in section 6.

2. The Ubiquitous Escaping System

In most of emergency cases caused by fire, electrical power usually becomes unavailable thus mobile personal devices could be the only way to communicate to the sufferers. Furthermore, the sufferers and the rescue persons are moving, therefore the wireless communication is suitable to communicate them in field.

In order to give ubiquitous services which satisfy the system requirement, that is, the characteristics of

ubiquitous underground structure, our prototype system includes 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 field information including escaping route information through convergence network to the persons' PDA in the accident spot. Figure 2 and figure 3 show the GIS based information processing.

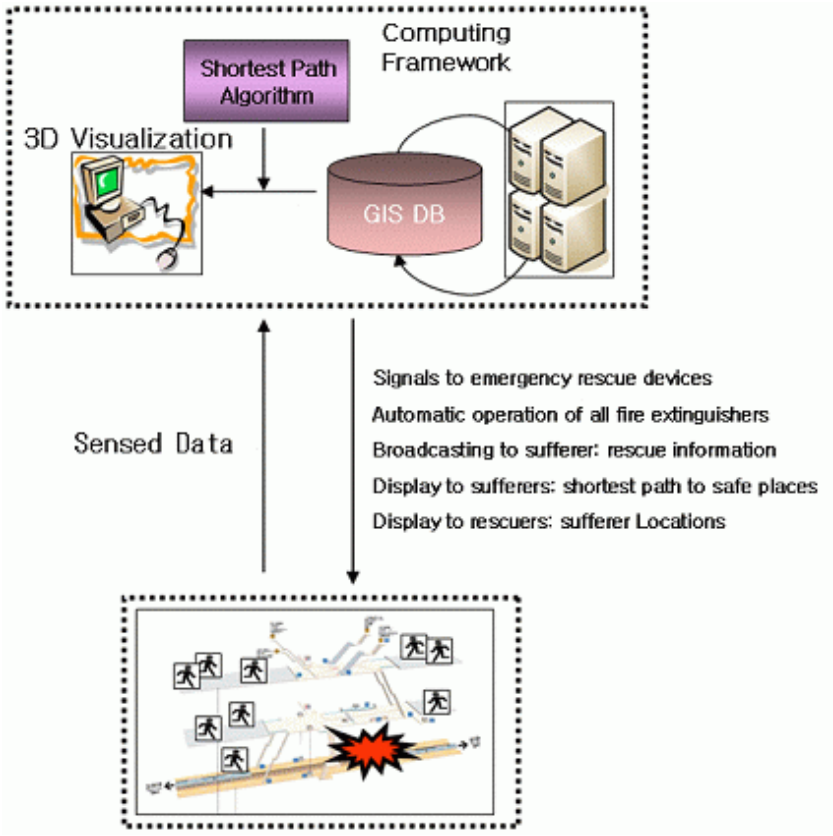


Fig. 3: Overview of the Architecture

In order to find out the best route to outside or a safe place, we do realtime simulation using the computational grid system of Seoul Grid Testbed. The rescue information is delivered to the accident sufferers and each sufferer receives the customized rescue information and can safely escape or can cope with the accident while escaping.

3. 3D-GIS Based Information Processing

The collected data from the ubiquitous sensor network are combined with GIS database and are graphically displayed on 3D GIS screen. The combined data are also used for 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 an fire accident from growing into a disaster [Figure 3]. 3D-GIS is essential to locate the sufferers in underground structures [2][3]. 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. [4][5] [Figure 5]

4. Simulation

Our ubiquitous system does real time simulation to find out the best escape route in case of fire accident. We use our grid computing technology and the Seoul Grid Testbed [6] to do simulation in realtime mode. The escaping route information made through real time simulation is broadcasted to personal devices as shown in figure 6. If there are large crowds when the fire accident occurs, then the crowd escaping pattern should also be carefully considered. [7] Fire can cause partial collapse of the underground structure and some prepared routes might be blocked. Toxic smoke from fire which is fatal to human beings can spread quickly through some prepared routes. These should be considered in guiding the best escape route to a sufferer and guiding the best rescue route to a rescue person. Situation information is necessary to both the rescuers and sufferers.

Fig. 6: The Escaping route information delivered to a person.

5. The Grid Testbed

Seoul GRID Center has been building a large scale GRID Testbed, namely Seoul GRID Testbed, which covers whole metropolitan area of Seoul, the Capital City of Korea. Seoul GRID Center at the University of Seoul designed and built a high performance SuperCluster system with 256 nodes, which are 2.0GHz Intel Pentium IV processors. The SuperCluster is a part of Seoul GRID Testbed. Seoul Grid Center has also been building the P2P Grid testbed which integrates the personal computers. [6,7] We use the Seoul Grid Testbed for the real time processing of the simulation.

Fig. 4: Selective presentation through 2D-GIS and 3D-GIS with GIS DB

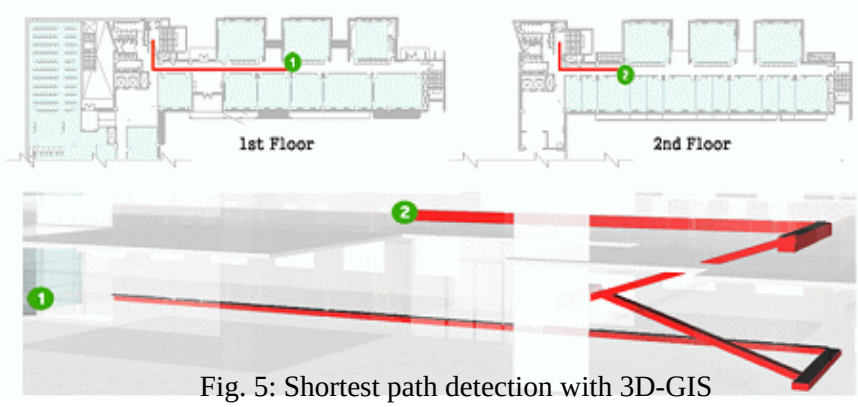
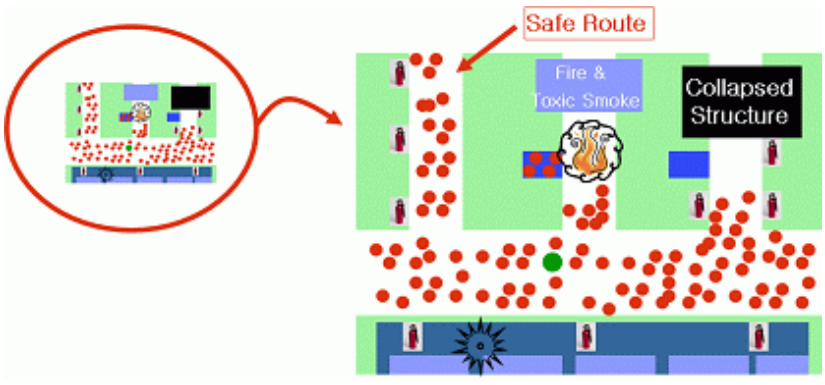


Fig. 5: Shortest path detection with 3D-GIS



6. Conclusions

In this paper, we introduced our ubiquitous system which find out the shortest escaping route in case of fire accident in an underground structure. For it, we do simulation. For the real time simulation, we use 2D-GIS and 3D-GIS informations and Seoul Grid Testbed. 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 center of Seoul City, the Capital City of South Korea. 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 beings, the most precious thing in the world.

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