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A Hazard Information Management Integrated Personal Hazard Alert System

Ming-Jen Wang, Chien-Hao Tseng, Cherng-Yeu Shen and Ren-Jieh Shih

National Center for High-Performance Computing, Taiwan

Abstract. Due to the advances of Internet and mobile technologies, mobile phones with Internet connection and computation capabilities are widely used now a day. The purpose of this paper is to examine the proposed hazard warning mechanism using the Location Based Service technology and a hazard information management system to rapidly distribute warning message in a short time while hazard sites are near the system users. The hazard information management system provides several hazard data management functions for system supervisors. The system not only can accept the hazard warning alerts from hazard monitoring devices, such as water-level meters, deployed in the fields, but also the hazard information that are manually added by a supervisor of the proposed system. Once the new hazard data is added into the system database, the system will dispatch the newly added warning message to those who are too close to the hazard area, provided that they had carried mobile phones with the hazard warning application installed. A pilot test was conducted to understand the performance of the system. The result shown that the system can reliably sending alert messages to users who are traveling at different speeds toward a potential hazard site before those users reached the hazard site.

Keywords: Environment, hazard warning, wireless communication, Location Based Service

1. Introduction

In August 2009, typhoon Morakot, which passed over the Philippines, Taiwan, and China, brought enormous damage due to strong winds, flooding, and landslides. In Taiwan, the total rain fall reached the new record of 100 inches on this island. Due to the heavy rain fall, there are total 1688 landslides and 769 people dead during the Morakot typhoon [1]. Because natural disasters are difficult to prevent from happening, many researches have focused on how to use current technology to reduce the loss and impacts brought by natural disasters.

According to the report from Nation Communication Commission, Taiwan, the mobile phone penetration rate in Taiwan has reached 120% and the wireless internet service penetration rate also has reached 70% [2]. A mobile phone device should be a very suitable medium for broadcasting disaster warning message, because of the high penetration rate and widespread wireless internet service. Currently, sirens, radio, or telephone are still used in delivering warning message when a disaster is about to occur. With all the development and progress made in Information and Communication Technology (ICT), a new opportunity emerged by using ICT to help people and to reduce the loss of lives brought by the natural disasters.

Within the current ICT, the Location Based Service (LBS) is getting more and more attention because of the popularizing of Global navigation satellite system (GNSS), wireless internet service, and cheap smart phones. A keyword search using “location based service” on Google could return around 554 million of results. However, even with lots of attention on the LBS technology, the applications of LBS on disaster management is relatively scant comparing with entertainment or leisure uses.

In this paper, we proposed a LBS disaster early warning mechanism with hazard data management system. The early warning system will send out a warning message and information when the user equipped with a mobile device is near any potential disaster site. With the information provided by the LBS warning system, users could raise their caution and pay more attention on the environment and avoid potential damages that might happen to them.

2. Literature review

A location-based service is an information or entertainment service, accessible with mobile devices through the mobile network and utilizing the ability to make use of the geographical position of the mobile device [3]. Brimicombe pointed out three most important technologies of LBS, which are GIS, mobile devices, and Internet service [4].

Because the penetration rate of smart phone and GNSS, and data transmission rate via mobile wireless network were not high enough in year 2002, the LBS related applications were not widely used at that time. However, after all those years of advances in ICT, those limitations are mostly removed. First, the penetration rate of smart phone is getting higher and higher. The cost of an entry-level smart phone is nearly affordable for many people in the developed countries. The computing power of an entry-level smart phone is getting higher through the years. Secondly, the popularization of Wi-Fi and 3G services is allowing mobile phone more tightly connected to the Internet information and services. Third, mobile users are able to conveniently and accurately acquire their positions with the help of inexpensive GNSS devices and many GIS services such as Google map. Because of the mature of the hardware and software environment, many people are able to get in touch with many practical and useful LBS applications such as Yelp, Pocket Journey, Wikitude, BreadCrumbz, etc. Because most of the above mentioned LBS applications are entertainment or leisure related, we would like to know if the LBS can be used for lives saving purpose and explore the potential of LBS on disaster mitigation purpose. Some of the researchers have tried to use LBS on Crisis Response System (CRS) or Disaster and Emergency Management (DEM) [5], [6], [7], [8].

In Yufei's study [7], he pointed out that mobile communication is an efficient and effective manner for disaster related information communication. Tobias also indicated that a mobile phone is the only one technology to have the potential to fulfill the requirements of all the six main tasks in CRS when comparing with warning sirens and radio [6]. The disaster warning system proposed by Tobias has proposed many solutions when building a mobile phone based LBS warning system. However in this system, when and where the users of the system will receive a warning when a disaster occurred is not further explored.

3. The Hazard Management and LBS Based Warning System

The system we proposed is designed to be used in Taiwan. However, the system could still be used in many other countries whenever it is applicable. Taiwan is an island which located between Eurasian Plate and Philippine Sea Plate. The area of slope land of Taiwan is over 73%. Because of this characteristic, heavy rainfall often brings a lot of landslide or flood related disasters during the rainy season. According to the Natural disaster hotspots report [9], there are more than 88% of the total population in Taiwan are at risk of two or more hazards. The purpose of the system is to increase the users' awareness when nearby environment is hazardous. The full warning system is the combination of various disaster monitoring devices, mobile phone (message receiving device), GPS service, and a central data server that automatically send out warning message or environment information to the system users according to the received hazard data. The LBS based disaster warning system structure is shown in Fig. 1.

3.1. Warning Message Resources

Landslide and flood are the most happened disasters during the rainy season in Taiwan, due to the mountainous landform. Because of this reason, the warning system only includes these two heavy rain related disasters at this stage. Due to limited budget on deploying monitoring devices on all over Taiwan, we utilized two methods to receive hazard data.

First, the system is designed to be able to receive external hazard data. Taiwan government has

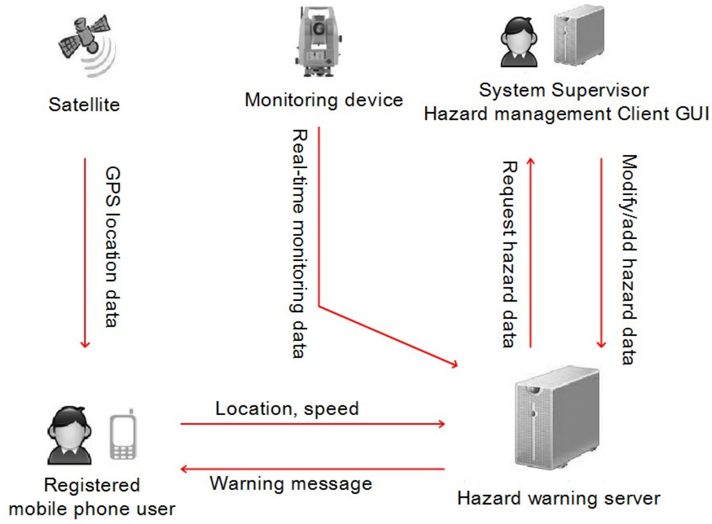

Fig. 1: The Hazard Management and LBS Based Warning System structure.

monitored 1552 rivers that might cause a landslide due to heavy rainfall. Every river has its own set of data, such as rainfall limit that could trigger a landslide, history rainfall records, surrounding geographic information, population that could affected by the landslide, etc. Based on those data of the monitored rivers and many other real time data, such as total rainfall information, real time water level, etc., disaster control center could decide whether or not to issue a disaster warning message to people who lives around the monitored area. The landslide monitoring system based on the monitoring of rainfall, water level, and/or other remote monitor methods, such as the method used in Ming-Chih's research are called the non-contact method [10]. This monitoring method is also adapted in Japan, the United States, and Austria.

Second, we developed a hazard database monitoring and management interface, which gives system supervisor the ability to manage all the hazard information stored in the database. The supervisor could use the management interface to manually input hazard data once the hazard information is reported from other channels, such as telephone, Internet, television, radio, etc. The supervisor interface is shown in Fig. 2.

In the proposed system, once the central server received hazard data from relative authorities' data servers or system supervisor, the warning message will be dispatched according to the metadata of the hazards.

3.2. Warning Messages Dispatching Mechanism

To be able to receive warning messages, the users must carry mobile phones with Internet connection and GPS functions. Also, a hazard warning application that we developed must be installed on the phones.

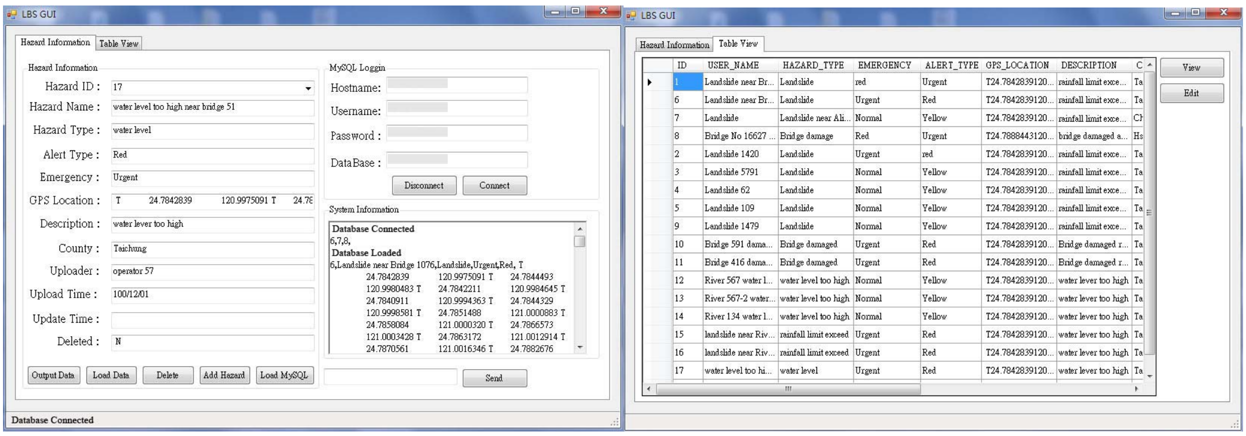

Fig. 2: Left figure, hazard data management interface; Right figure, hazard data viewing interface.

Once all the requirements are satisfied, the phones will be within our warning network. The warning message sending procedure is explained as the following. The mobile phone will send out its GPS coordination to the central hazard data server.

The first thing that the server will do is to compare the received user location to all the active hazards' data stored in the database. This process will return all the hazard data that are close to the user. Those hazard data will be transmitted to the user's mobile phone. The hazard data is generally divided into two types, urgent and non-urgent information. Any user who is getting too close to a hazard zone with urgent property, the warning application will issue an alert window to the user immediately. On the other hand, it the hazard is non-urgent type, the user will only see the hazard border drawn on the map. The mobile phone alert system is shown in Fig. 3.

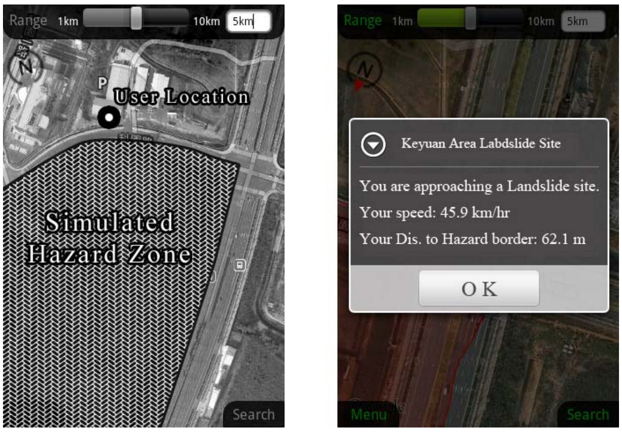

Fig. 3: Left figure, warning system screen that reveal geographical relationship between user and hazard site; Right figure, an issued warning message.

To avoid unnecessary warning messages that could annoy users. The application installed on the mobile phone takes two important parameters into consideration to determine whether or not to issue an alert window, if the user is approaching a hazard zone with urgent property. The two parameters are distance to hazard site and user's moving speed. In terms of distance, any user who is too close to or within a hazard site will receive an alert, regardless of the user's moving speed. Regarding user moving speed, if a user is outside of a hazard site and will reach the hazard site within certain amount of time, an alert will also be triggered to prevent the user from entering the warning area. That is to say, if a user is moving toward a hazard site with higher speed, the user will receive the warning message further away from the hazard site. This mechanism allows users with different traveling speed to have roughly the same amount of responding time before entering the hazard site.

3.3. Awareness of the Hazardous Level of Surrounding Environment

People who get into hazardous environment are usually because they did not know that the surrounding environment is dangerous. The government has set up many monitoring devices to detect the hazardous level of environment. However, the environment information, such as water level of a river, is often not accessible by public at any time. This paper proposed a system that could automatically display those hazard related information to the public through mobile devices. Other than the warning message, the system provides the geographical relationship between a user and the potential surrounding hazards visually as shown in Fig. 3. By doing so, some users might raise their caution while passing through these areas and avoid potential danger. For example, when a user is about to cross an old bridge at night, the warning system reminds the user about the water lever in the river is too high. The user might want to check the water level by him/her own eyes and to decide whether or not to cross the old bridge or to choose another newer bridge which is further away from here to cross.

4. Conclusion and Future Study

In this paper, we proposed a hazard information management integrated hazard warning system for personal use. The purpose of integrating hazard information management function is to compensate the deficiency of using only hazard monitoring devices to detect hazards. By adding hazard information management function to the warning system, the system supervisor can manually add, modify, or update the hazard information according to other hazard information resources, such as radio, telephone, television, etc.

From a user's perspective, the warning system not only may provide lifesaving message in time, but also can depict user's geographical relationship with the potential surrounding hazards. Hence, the mobile phone with the proposed system can be regarded as an extra sensor of its users, by which they can increase their awareness of the hazardous level of environment and choose appropriate actions to avoid possible dangers.

We have conducted a pilot test, in which the participants with our system equipped tried to approach a simulated hazard zone. The warning message always popped up before the participant got too close to the hazard zone. Even though the recorded distances to the hazard border are slightly varied due to the limitation of the GPS sampling rate, the system still shows fairly reliable performance on reminding the user before he could enter the disaster site.

Also, the system can also provide environmental hazard warning messages to its users by feeding various types of sensors' data, such as data from water or air pollution sensors, into the hazard database. The various sensor data stored in the system extends our awareness of surrounding environment. In this paper, we have demonstrated a way, by which the LBS technology was integrated to enhance our relationship with environment. The hazard warning system is just one of many possible applications that could bring humanity and Earth more tightly together. In the future, more researches could be explored to increase our awareness on our environment and environmental changes.

5. Acknowledgements

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6. References

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