Development of a smartphone application for disaster response

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***Abstract*— The Japanese National Police Agency report confirmed 15,883 deaths, 6,145 injured, and 2,667 people missing by 2011 Tohoku earthquake tsunami. Even though Japan had a well-prepared tsunami warning system, unpredictable size of wave and short evacuation time (the first tsunami arrival time was only 25 minutes) brought many casualties. So, information system for emergency response has been a great concern of policy makers to reduce damages from tsunami. Meanwhile, a smartphone is useful for disaster response because of its mobility and information communicability. Evacuees can receive real–time disaster information which helps to make an evacuation judgment. Especially, over 30 million are using smartphones in South Korea, so it is necessary to use a smartphone as a disaster information delivering device. In this study, a smartphone application (app) is developed to reduce damage of human life from tsunami.**

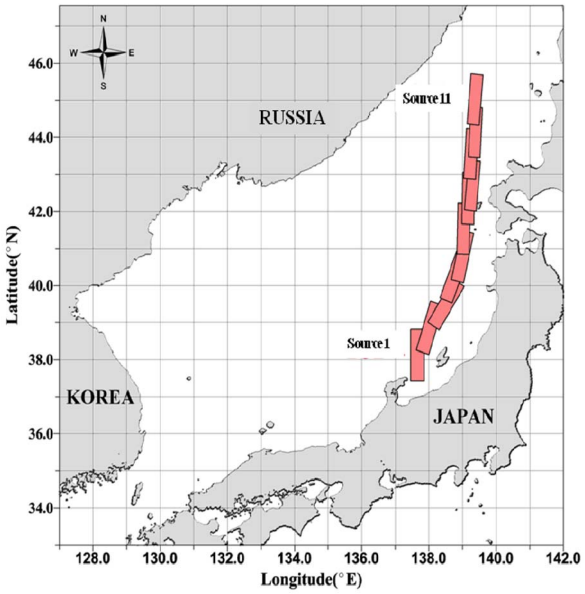
Keywords— disaster management; smartphone application

I. INTRODUCTION

Tsunami is a series of long water waves caused by underwater earthquakes, underwater volcanic eruptions, drastic tectonics like faults, landslide, glacier carvings or nuclear experiments. The waves we see on a beach that come from far sea to break on the shoreline are movements of sea surface by winds, but tsunami is an up-and-down motion of the total water body. Accordingly, tsunami has destructive power incomparable with general waves and strikes the shore at as much as 60 km/h ,so nobody can make his way out from the gush of water . The height of wave gets radically tall when it hits the shoreline and it's different on the topographic characteristics including the shape of the shorelines and the contour of the underwater slopes.

The Japanese government and the measurements performed before the 2011 Great East Japan Earthquake had estimated tsunamis and earthquakes that were highly likely to occur in the past and in the near future. However, the Great East Japan Earthquake and tsunami was a huge disaster that exceeded the existing estimated size. It was difficult to prepare for a massive tsunami that occurs so infrequently with only coastal structures, but it is possible to observe effects such as water level reduction, delay of arrival time, and maintenance of the coastline. Meanwhile, the "Basic Policy for the Great East Japan Earthquake and Tsunami Reconstruction Efforts" was established by the Japanese government, and the Central Disaster Prevention Conference established the "Professional Social Action on Earthquake and Tsunami Measures After the Northeast Pacific Earthquake" and verified it (September,

Fig. 1. Virtual tsunami source



2011). Henceforth, the primary tsunami measures will basically assume a two-stage tsunami by considering its frequency and scale. However, in the first stage an estimation is devised of a relatively high-frequency tsunami (occurrence cycle: tens to hundreds of years), human life protection with coastal structures, property protection, stabilization of regional economic activity, and securing an effective production base. In the second stage, non-structural measures are comprehensively established and promoted. This includes creating a structural measure and a Hazard Map for coastal structures by considering "reduction" with the objective of

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Fig. 2. Main page of app(tsunami alert)

Fig. 3. Find a nearest shelter

damage minimization and estimating a maximum tsunami that has low frequency (occurrence cycle: hundreds to thousands of years) but can induce massive damage.

In Korea, tsunami have been considered safe because of their topography and location(far from Pacific tsunami disasters). But it is never safe because there's a long underwater earthquake belt along the Japanese west coast in the East Sea(Fig.1). Actually, five tsunamis were observed in Korea including 1741 Kanpo tsunami, 1940 Shankotan tsunami, 1964 Niigata tsunami, 1983 the central East Sea tsunami, 1993 Hokkaido southwestern tsunami among which the 1983 and 1993 ones cost casualties and property damages in the east coast including Kangwondo province. Presently, Korea has the tsunami forecast and warning system in the Korea Meteorological Administration, but it is difficult to predict exact flooding by the region because the system only shows the arrival time and the condition of wave of the tsunami. Therefore, it is difficult to establish tsunami disaster prevention such as shelter designation or evacuation plan as well as to respond promptly and systematically. Furthermore, the tsunami inundation risk maps prepared by some local governments of Kangwon-do and Gyeongsang-do only analyze the past history, so it is difficult for the central disaster prevention authority to use their data for the consistent management. Therefore, it is necessary to establish tsunami response system that provide the information for the disaster response.

In these days, a smartphone is a very important tool that people use on a daily basis and over 30 million are using smartphones in South Korea. So it could be a very useful tool to reduce damage of human life from tsunami. The “tsunami disaster response Application(App.)” receives the latest earthquake information which includes tsunami warning message, inundation height, and arrival time. It provides evacuation information such as the nearest evacuation shelter, evacuation tips. Also, the App. can be used for public disaster consciousness education in ordinary times.

II. MATERIALS AND METHODS

A. National disaster warning system in Korea

The Ministry of Public Safety and Security(MPSS) has the “30 minute evacuation plan against natural disaster(E-30)” to minimize damage of tsunami. This is the plan to establish the evacuation system to complete the evacuation in 30 minutes to minimize damages by preparing for large scale natural disasters and to protect the life and properties of the nation. The point of this evacuation plan is that status propagation and resident evacuation begins in 5 minutes and completes in 30 minutes after the breaking news issued by the Korea Meteorological Administration(KMA) when an earthquake breaks out near the Korean Peninsula.

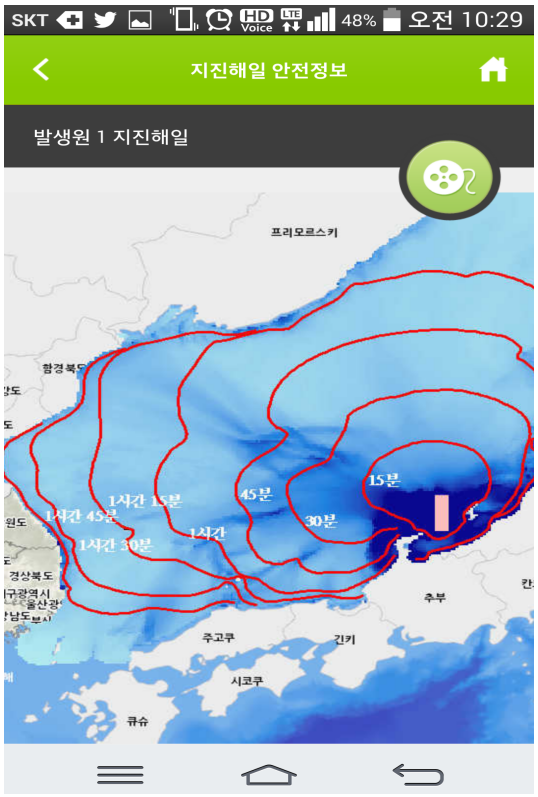
To reduce the risk of disaster, Korean government operates multiple disaster warning system.

- CBS (Cell Broadcasting Service) Disaster Notification Message Broadcasting System - disaster message transmission to nation-wide or specific area resident users simultaneously at once. It's a text messaging information of disaster, and restrict to max. 230 characters per transmission. It also occurs transmission cost.

- Automatic Verbal(Text) Notification System - real time propagation of message of disaster situation with "Automatic Verbal Notification Equipment" located at central and regional disaster and safety countermeasures headquarters, when flood, typhoon or any disaster occurs or are expected.
- Disaster Notification Board System - preparing of immediate response system toward disaster by notifying and broadcasting rapidly the disaster situation through blowing siren and board messaging, at the normal times, performing national propagation of awareness toward disaster, etc. The system install in hazardous areas such as beaches, public parks around lower river.
- TV Disaster Warning Broadcasting System - broadcasting the urgent disaster situation in the form of screen, sound, or screen messages by forcibly automatic turning on TV or changing to disaster warn channel with volume-up through the Broadcasting station's casting-equipment when out breaking of urgent disaster information that could not be easy to transmit this situation at such as deep night, etc.
- RDS-Radio Disaster Warning Broadcasting System - automatic radio turning-on/off for activating the agora's amplifying speaker systems

Limits of existing disaster waning system are unidirectional broadcasting and narrow transmission channel bandwidth. For efficient disaster response, warning message should be sent to anyone, anytime, anywhere.

Fig. 4. Maximum tsunami wave height and propagation map



B. Smartphone application development

The warning system may not function during and immediately following a disaster due to a destructive activity. Alternatively, the mobile apps can assist in an emergency situation and make a personnel disaster prepared-ness. The Android app has developed for the tsunami response which provides information of where the tsunami shelters are along the east coast of Korea and help develop and plan people's own evacuation. It can help warning of undersea earthquakes that could trigger a tsunami, and help better handle them when they happen. ut near the Korean Peninsula.

It provides useful information to tsunami response for resident or tourist of east coast of Korea.

- Earthquake alert – when an earthquake occurs, earthquake information(time, location, magnitude) is provided as an open data API by KMA. (Fig.2.)
- Location of shelter – find the nearest evacuation shelter and list of evacuation shelter along the east coast of Korea(inundation map is not provided because of potential infringement of property rights) (Fig.3.)
- Tsunami propagation information – travel time, propagation movie, max. wave height map(pre-processing data using virtual scenario) (Fig.4.)
- General tsunami information and evacuation tips – characters of tsunami, location of virtual earthquake fault, tsunami evacuation route and shelter sign(Fig.5.)

Fig. 5. General tsunami information and evacuation tips

III. CONCLUSIONS

In case of the 2011 Tohoku earthquake, cellular communication was jammed across much of Japan due to a surge of network activity, but internet services were largely unaffected in areas where basic infrastructure remained, despite the earthquake having damaged portions of several undersea cable systems landing in the affected regions. It means when disaster strikes, smartphone should be a powerful device to survive. As smartphone users increasing, the availability of the smartphones and apps has been a big change for disaster response.

Now, if tsunami is coming to east coast of Korea, people can receive an alert with their smartphone, find out where the shelter is, and can access a evacuate information from their smartphones. It provides earthquake alert(time, location, magnitude), tsunami propagation information(travel time, propagation movie, max. wave height map), general tsunami information and evacuation tips(characters of tsunami, location of virtual earthquake fault, tsunami evacuation route and shelter sign) for resident or tourist of east coast of Korea. It can be used as an educational material for disaster prevention. Especially, in disaster-prone areas, people will be asked to install an mobile app for their safety.

Finally, expansion of alarm area(south coast and specific islands of Korea), using augmented reality technologies for finding nearest shelter, user-friendly interface are planning to upgrade.

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