A Refuge Location Prediction System for When a Tsunami Has Occurred

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Abstract. During the 2011 Tohoku Earthquake and Tsunami, DMATs (Disaster Medical Assistance Teams) could not rescue victims efficiently with accurate location data, because the local governments had lost refuge location data and resident registers due to damage caused by the tsunami. In this paper, to support DMATs, a refuge prediction system based on the characteristics of disaster, landscape, and victims' psychology is proposed, which can function even if local governments lose information about victims and refuge locations. As an example, this system deals with tsunami. We demonstrate the effectiveness of this system by comparing the data of the 2011 Tohoku Earthquake and Tsunami and our prediction system.

Keywords: Disaster Medical Assistance Team, earthquake, local government.

1 Introduction

All over the world, suffering is caused by various kinds of natural disaster, including typhoons, floods, volcanic eruptions, and earthquakes. Japan is particularly affected by earthquakes, as the country is surrounded by four tectonic plates.According to recent statistics, magnitude 2.0 earthquakes occur in Japan about 10,000 times a year.For that reason, Japan is a country of frequent earthquakes and many earthquakes happen every year[1].

The 2011 Tohoku Earthquake and Tsunami occurred on March 11, 2011, killing more than 15 thousand people. This earthquake'smagnitude was9.0, which ranks fourth highest in global statistics of the past 100 years.

In the 2011 Tohoku Earthquake and Tsunami, many hospitals and medical institutionswere damaged by the tsunami, causing shortages of doctors. To solve this issue, DMATs (Disaster Medical Assistance Teams) supported the disaster area. In spite of the DMATs' early dispatch to the disaster area, they were not able to rescue with accurate location data, due to the fact thattown office administration stopped becausemany coastal town offices suffered from the tsunami. There were no means of contacting victims, as the town offices had lost records of the sufferers' addresses[2].

M. Kurosu (Ed.): Human-Computer Interaction, Part III, HCII 2013, LNCS 8006, pp. 295–300, 2013.

It is predicted that the probability of a Nankai or Tonankai Earthquake occurring in Japan within 30 years is over 60 percent [3].In future, when earthquakesoccur, it is vital to know victims' addresses, conditions and ages in order to make full use of DMATs' abilities.

In this study, we proposea refuge predictionsystem for supporting disaster medicine from the viewpoint of disaster characteristics, regional characteristics and psychological characteristics, which can be used even when local governments are not able to acquire information on victims' addresses and conditions.

2 Related Work

During a disaster, it is important to exchange disaster information. In the 2011 Tohoku Earthquake and Tsunami, DMATswere not able to acquire sufferers' addresses or refuge location information, as the local governments that should have performed this task were too damagedby the tsunami. In order to solve these problems, DMATs must establish who is in need of rescue, where they are, and acquire refuge location data. If information cannot be obtained from sufferers, we need to predict refuge locations in some way. In the 2011 Tohoku Earthquake and Tsunami, such support was not provided.

Over the past few decades, a considerable number of studies have been conducted on predicting refuge locations. In this section, we briefly introduce such research.

In 2009, Asakawaet al. proposed a system that shares the location information of the user by displaying it on a map [4]. This system attaches these data to Google Maps using a mobile phone camera and GPS function. By sharing the data as map information, the system links between Google Maps and the physical world.Thus, Asakawa et al,'s system proposes an environment in which information can be exchanged as a reality.

In 2007, Tanida and Daito proposed a method for specifying victims' locations using IC tags when the telephone network fails in the damaged area, and demonstrated the system's effectiveness by simulation [5]. In their system, a helicopter scatters active type IC tags on the ground, and the system specifiesvictims' locations by trilateration with three fixed IC tags and the location-unknown subject's IC tag.

In 2011, Google constructed the "Google Crisis Response System"in response to the Tohoku Earthquake and Tsunami [6]this system displays refuge locations with markers in Google Maps, and displays the number of evacuees by marker color. In addition, this system can output refuge location data for all forty-seven Japanese prefectures in CSV andKML formats.

In 2011, Iizukaet al. proposed a systemthat collects disaster situation information and showsit on a map when institutions such as universitiesareaffected by disaster[7].

It is thus clear from the above research that it is effective to show disaster information on maps. However, sufferers were forced to take refuge in unexpected places by the Tohoku Earthquake's large tsunami, andrescue attempts by DMATs were hindered because the tsunami destroyed many designated refuge places. Therefore, a system is required that can predict refuge locations in advance, and give this data to DMATs, thus supporting disaster medicine.

3 System Construction

We proposed “The refuge place forecast system for supporting disaster medicine “as previous study stage.

In this study, we proposeda refuge predictionsystem for supporting disaster medicine from the viewpoint of disaster characteristics, regional characteristics and psychological characteristics, which can be used even when local governments are not able to acquire information on victims’ addresses and conditions from huge tsunami [8]. A previous study stage of system output is shown in Figure 1.

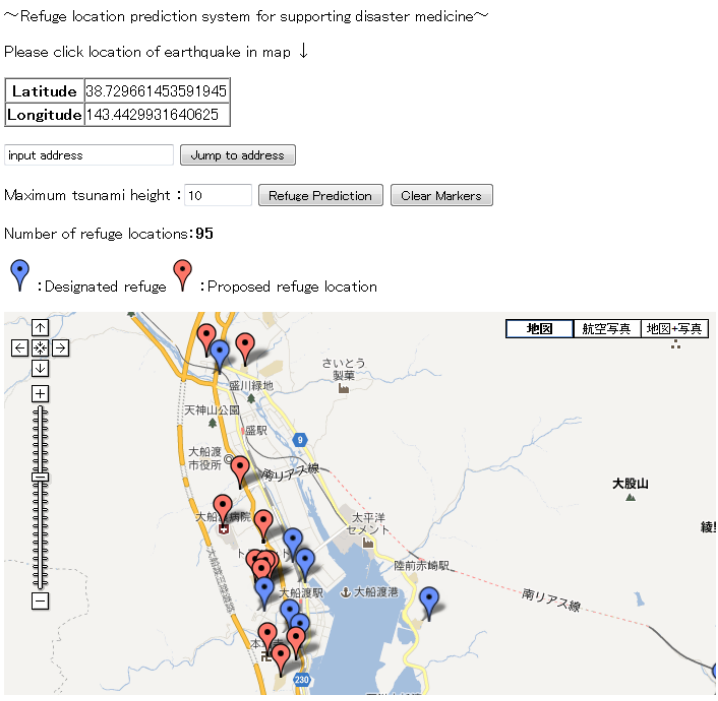

Fig. 1. Output example

In this previousstudy, the user inputs expected maximum tsunami height, refuge place are not displayed if tsunami height is higher than the refuge location’s altitude, sothis system shows refuge location names and the number of evacuees by comparison between regional population and refuge locationpredictionresultif a marker is clicked, as shown in Figure 2.

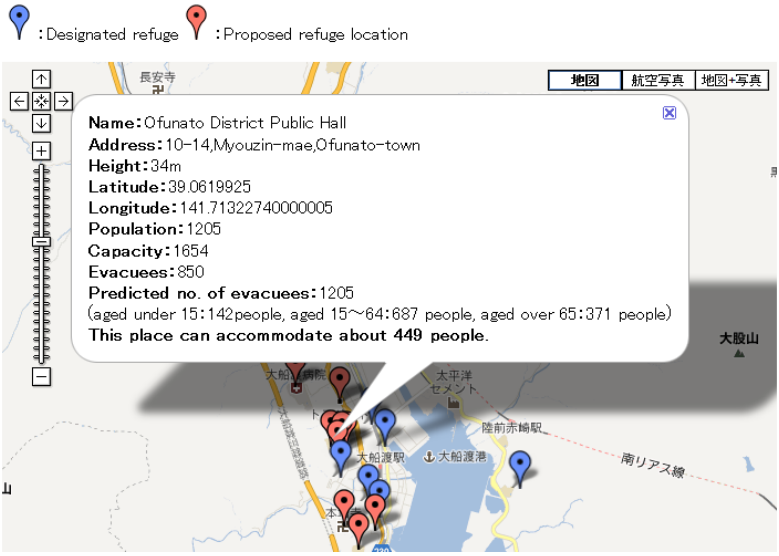

Fig. 2. Output example: marker detail

According to the results of the system's evaluation by Konan Fire Department and Kyoto City Fire Department, it would be useful in future to predict the number of victims, their locations and ages when DMATs are dispatched for early rescue in disaster medicine, however refuge location prediction isn't precise about absence of sufferers' addresses or refuge location information area because this system treats past disaster sufferers' addresses or refuge location information, and this system treats only national census population and age ratio for refuge location prediction.Therefore, in this paper try to accurate predict about the area hadn't occurred disaster.

In this paper, we propose system based on previous study problem not only accurate predict about the area hadn't occurred disaster, but also assume aboutNankai,Tonankaiearthquake will occur. After, we aim to build a platform in which local residents can mutually register the information. For example, local residents could register refuge locations and places where in the past ground liquefaction had occurred, and we propose that system predict refuge place based on registered information when earthquake occur. In Tohoku Earthquake, many evacuees took refuge unexpected place. For example, a skating rink, a private house, a shrine, consequently, DMATs needs get the information that local residents input unexpected place [9]. Also, local residents again realized each other to register unexpected place. For example, local residents think "We didn't know there places", "We can take refuge this place". This system can add choice of refuge location based on refuge location information if tsunami occurred.

4 System Proposal

4.1 About Prototype System

About prototype system register information, local residents input information by smart phone, and prototype system manage database. Local residents register information with text. Register information are time, name, capacity, also this prototype system can upload photo of before disaster refuge place for rescuing if DMATs have visited disaster area first time. This system shows stamp variety of attribute to register refuge place, and can display refuge locations information in map by these stamp.An image of prototype system is shown in Figure 3.

Fig.3. An image of prototype system

4.2 System Flow

In this research is composed of local residents, disaster countermeasures office to pass date. The process of the system consists of the following web application tasks.

① Local residents inputs information about refuge location, and register information for database.
② This system abstracts refuge location information (capacity, evacuees)from database.

③ This system compares abstracted data and predictive refuge location of previous study, and modifiesits data with real-world circumstances so that DMATs can get accurate information.
④ This system sends modified data to disaster countermeasures office.
⑤ DMATs start rescuing based on modified data.

It is thus that this system can support DMAT because input data of local residents and disaster countermeasures office cooperate. To support DMAT is Disaster medicines make revitalize, finally be able to rescue.

5 Endnotes

In this paper, we proposed a system that predicts refuge locations in times of disaster so that DMATs can rescue effectively based on this information. In large-scale natural disasters such as the 2011 Tohoku Earthquake and Tsunami, DMATs were unable toobtain victims' locations and refuge location information because local governments that held such information had suffered extensive damage from the tsunami. The purpose of this research is to support disaster medicine.

According to problem of previous study,we propose system based on previous study problem not only accurate predict about the area hadn't occurred disaster, but also assume about Nankai,Tonankai earthquake will occur. In future, we would like to strengthen the alliance betweenlocal residents, disaster countermeasures office to feedback based on information of local residents input.

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