Disaster Information Sharing System Using Pictograms Only

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Abstract- In the case of disasters, people's comprehension of the situation of the surrounding area is an important factor in deciding corresponding actions. In an area overflowing with people and rubble, it is dangerous to act recklessly. In this paper, we propose an information sharing method to ascertain present status and support decision of corresponding actions when a disaster occurs. Users of the system can decide a course of conduct and avoid risks such as injuries by ascertaining the situation of the surrounding area ahead of time. The disaster information collection system currently in operation in Japan is difficult to use for users unfamiliar with machine operation and is not intended for use by non-Japanese. This work aims to support such people during a disaster. This system uses pictograms that express meaning using shape and color instead of language. It expresses information visually and aims to provide easy operation by using mainly maps and pictograms. Moreover, this system adopts a social media model, which was recognized to be effective in the 2011 Tohoku Earthquake. We promote use of the system when a disaster occurs via a means for using the system in non-disaster situations. In this paper, we describe the system's effectiveness and prospects for the future with an evaluation experiment targeting experts on disaster prevention, non-Japanese and general users.

Keywords-Pictogram; Disaster Mitigation; Social Media; Information Sharing;

I. INTRODUCTION

Japan is affected by many disasters; in fact, the country is an area that suffers a concentration of disasters. Although this area is only 0.25% of global landmass, it is the site of 20.5% of all earthquakes of magnitude over 6.0, 7.1% of all active volcanoes, and 16.0% of disaster-related damage costs worldwide [1]. Furthermore, Japan is expected to be affected by a large earthquake such as the Nankai Trough Quake and an earthquake in the Tokyo Metropolitan area within 30 years. For these reasons, interest in seismic countermeasures has increased and the government is beginning to take various measures. However, current disaster risk management is undertaken with local inhabitants, so measures for people unfamiliar with the area, such as tourists, are barely considered.

Meanwhile, Japan is aiming to make the country a global travel destination, which is being treated as important policy in the 21st century [2]. As an example, Kyoto city is visited by one million foreign tourists every year, and foreign visitors across Japan are expected to increase in the future. Paris is a famous model of an internationally competitive sightseeing city, visited by 45 million tourists every year, 60% of whom are from overseas [3]. When a disaster strikes such sightseeing cities, many tourists will suffer from heavy damage. They are unfamiliar with the area, local language, culture and disasters. The safety of foreign tourists is critically important, and actions to protect them are the responsibility of the region and the nation. We focus on the problem of language in this research. Most disaster information systems and services use letters to provide necessary information. When a disaster occurs, foreign tourists will be in a precarious situation because they are not likely to have sufficient ability in the local language, which limits their methods to collect information.

On the other hand, there are many people who are not used to advanced information systems and services. As an ongoing problem, proportion of elderly population is rapidly increasing in Japan. Information collection in a disaster is difficult for the elderly, because many aged people are not proficient at using advanced information technology and services. A new approach is needed to support them collect disaster information by easy-to-use human machine interface.

In this study, in response to these situations, we aim to propose a unified and integrated method to share information for disaster victims who have various different requirements.

In the next section, related work is described. We present outline of proposed system in Section 3, and system architecture in Section 4. Then evaluation experiment is presented in Section 5. Finally, a conclusion and future work are described.

II. RELATED WORK

A. *Universal Design of Disaster Prevention Pictograms*

Kunoki et al. of Ritsumeikan University considered the provision of unified design of disaster prevention pictograms at tourist sites. They conducted an investigation into signs and guide plates at Kiyomizu Temple, a famous tourist attraction, as a target and suggested a method for improvement [4]. The summary of their results is as follows.

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1) Guide plates that display foreign languages or use pictograms are only about one quarter of the total.

2) Methods to express color, shape and content are different depending on the place. There is no sense of unity and this hinders understanding.

From the summary of results, Kunoki et al. advocated the necessity of offering information utilizing universal design to provide efficient evacuation guidance. These problems have been noticed by the Fire and Disaster Management Agency (FDMA) in Japan too. They are considering concretely implementing universal design [5]. Figure 1 shows sample models under consideration by the FDMA.

(a) Tsunami Warning

(b) Tsunami Warning Area

(c) Tsunami Refuge Building

Figure 1. Graphic Symbols for Tsunami Signs

B. *Analysis during the 2011 Tohoku Earthquake*

In the 2011 Tohoku Earthquake, the Tokyo metropolitan area suffered from disaster for the first time after being developed as a modern city, and there were many people who had difficulty returning home. This is relevant to this study, as it is useful to design our system through analysis related to information media.

1) Analysis of Victim Behavior

From the summary of a Cabinet Office survey conducted via the Internet, there were 5.15 million persons who had difficulty returning home in the metropolitan area, which includes Tokyo, Kanagawa, Chiba, Saitama and Ibaraki [6]. The results of the survey into how people returned home are shown in Figure 2.

In Figure 2, n = 5,372 persons who were affected by the disaster and responded to the survey. The most common method of returning home was on foot, accounting for 37.0% of the total victims, and the second most common method was by car. The percentages of walking and car are very similar. The reason for these being the most common is that trains ceased operation immediately after the earthquake.

2) Necessary Information for Returning Home

Disaster victims felt that certain information was necessary while returning home, as shown in Figure 3. In descending order, information on their families' safety, investigation of the damage, and time until the trains and subway would resume operation, were the most cited. If we exclude family safety information, we can see that victims need information about items required to return home.

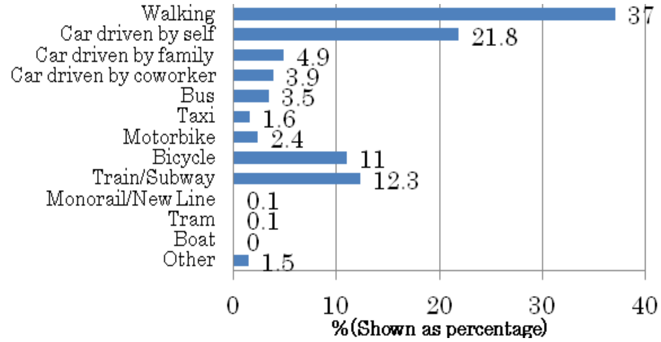

Figure 2. Methods of Returning Home

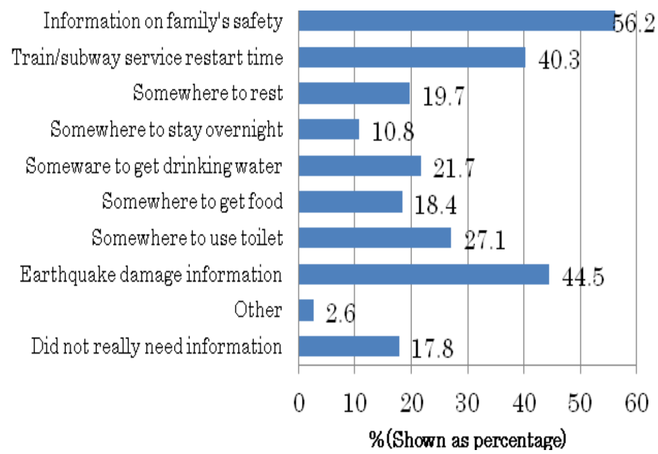

Figure 3. Necessary Information

3) Future Methods of Obtaining Information

Figure 4 shows the results of a survey conducted about future methods of obtaining information hoped for by disaster victims. This survey targeted people who tried retuning home in a disaster. Results are grouped for three conditions related to whether victims were capable of returning home. In particular, the provision of information by TV is strongly hoped for. This reason is considered to be that TV is capable of providing information visually, and that people watching TV can know an overview of the disaster in various places. The number of people who wish to be provided information by cell phone is high, because it is easy to use while on the move. In particular, there is a tendency for this to be desired by people who tried to return home but were prevented. This may be estimated as due to the necessity for information to decide a new course of action after being prevented from returning home.

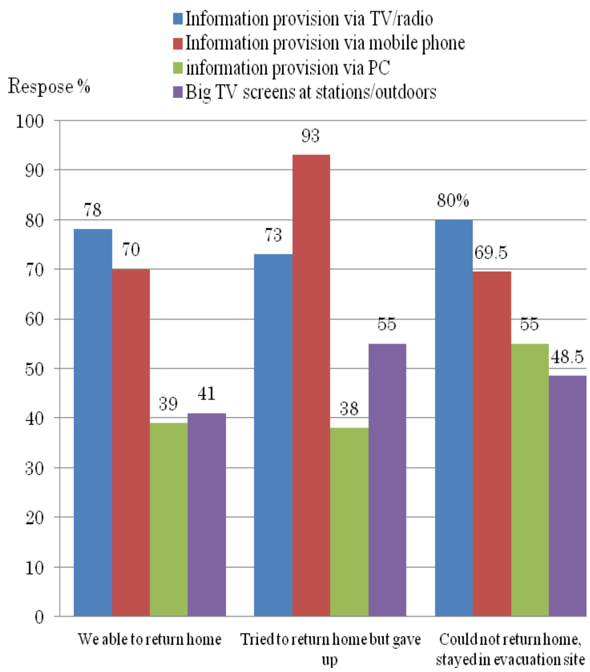

Figure 4. Desired Sources of Information in Future

C. *Social Media*

The effectiveness of social media was recognized during the 2011 Tohoku Earthquake, exemplified by Twitter. The "wisdom of crowds" was constructed from many users' posts (Tweets) [7]. This is revolutionary as being the first system in which victims themselves provided information, in contrast to previous systems in which the victim is only provided information by the system. Official hash tags were provided by Twitter from the day after the disaster occurred. Examples of hash tags include '#j_j_helpme request rescue', '#anpi safety', and more. Various kinds of information was posted on Twitter, such as the appearance of the disaster-hit area, means of transport, available toilets, evacuation sites, places for lodging, and more.

D. *An Information Collection Support System for disaster-affected areas using Mini-blogs*

Yokobe et.al., proposed an information collection system using social medias and mini-blog to collect information when disaster occurs [8]. In this paper, the evaluation results using Twitter are shown. This research assumes the following two conditions:

1) The useful information for victims is sent from disaster-affected areas.

2) The reliability of information is evaluated by people in the area where the information is sent.

Based on these assumptions, the system deletes information which is sent at an area away from the disaster-affected area because the information is decided as unnecessary and unreliable. Specifically, assuming that information with exact location data has high reliability, the reliability of each tweet and user of Twitter is evaluated based on the location data and the responses from people living around a location where the tweet is sent. From the results of the evaluation, it is shown that tweet including a name of the place has high relationship with the disaster-affected area. This fact implies that a name of place is important in deciding the reliability of tweet. However, it is known that most of tweets do not have information of its location data. Thus, the detection of reliability based on location data is not available in many cases.

III. OUTLINE OF PROPOSED SYSTEM

A. *Pictogram*

Pictograms are graphic symbols that express things or general ideas instead of using words. For example, signs such as 'emergency exit' and 'disabled access' are well known. In Japan, pictograms are adopted in places that are heavily used by the general public. Their biggest advantage is to enable communication of information without the restraints of language. In this paper, we devise a solution for problems contained in the present Japanese disaster information gathering and transmission system.

B. *Visual Provision of Information*

When victims need to evacuate or return home during a disaster, they are interested only in their present location and surrounding area. When a victim posts information, this can be expected to be a report of situation of their neighborhood. Recently it is easy to calculate present location by using GPS (Global Posting System) or networks. Also, the GIS (Geographic Information System) service is free of charge and easy to use too. We constructed a framework to show the information of present location and surrounding area using these two services. The system shows information automatically and visually, so it is easy to use. This is a highly important function in a disaster information system.

C. *Overloaded Communication Lines*

Cell phones and smartphones are one of the most frequently used methods to gather information when a disaster occurs. However, the calling function can barely be used, and mail and Internet is delayed significantly by limiting or congestion of communication lines. When we gather information using information infrastructure, the system needs to operate in this kind of situation. With this in mind, we propose a system built as a smartphone application.

D. *Disaster Information to Provide*

In this system, we deal with the kinds of information that were required during the 2011 Tohoku Earthquake. By determining information types beforehand, we can anticipate the degree of increase in comprehension and avoidance of misunderstanding. Furthermore, provision of information is separated into two types: information displayed by default and information displayed by user operation, as shown in Figure 5.

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TABLE I. PROVISION OF INFORMATION

Pictogram	Meaning of Pictogram
	Usable Means of Transport
	Evacuation Site
	Place for Medical Treatment
	Place for Rest

(a) Information Displayed by Default

	Food, Drink
	Available Toilet
	Place for Available Network
	Available Accommodation

(b) Information Displayed by User Operation

In the default settings, we limited the amount of pictograms to be displayed, so that it is easy to obtain information from the pictograms. The system can add pictograms to the display according to the user's needs. In addition, if the user taps a pictogram, the time of the posting and the contributor are displayed as annotations.

E. *Dissemination of System*

At the present time, various measures are in place against disasters. However, their rate of utilization is a low percentage in total telecommunication services. We can consider that this is due to the fact that the service is not known among disaster victims. Information sharing systems cannot demonstrate effectiveness if they are not widely known.

Accordingly, we propose a social media model as a method to raise the rate of utilization. This model is can also be used outside of disaster occurrence, and the users can freely change the genre of information. Disaster information is treated as one genre. During non-disaster times, users can view information pictograms about places (for example, tourist attractions and store information) and read comments posted by other users. In addition, users can post pictograms and comments themselves and add to other users' contributions. This system is different from current social media that mainly use text, because it mainly uses maps and icons made from pictograms. We expect that the amount of information will increase because disaster victims can post information themselves. We aim to design a system to be used by victims when a disaster occurs, by encouraging them to use and familiarize themselves with the system during non-disaster times. This study assumes such a form of utilization for the system.

IV. SYSTEM ARCHITECTURE

A. *System Description*

This system uses a client-sever model in which the client is a smartphone application and the server is a web application utilizing a database and PHP programs. The database stores the pictogram type, location (latitude and longitude), contributed time, contributor and pictogram ID inputted by the user. PHP programs respond to requests by the client, acquire information from the database, then send the client information registered in server about their current surroundings.

B. *Disaster Data Collection*

The system's initial screen is showed in Figure 5. The user can collect information on their current surroundings via map information and icons on this screen. The functions of each button are described.

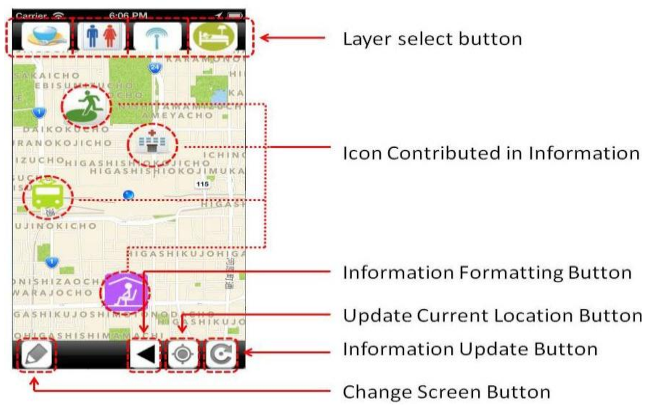

Figure 5. Information Collection Screen

The following is a description of the system flow during information collection.

1) *Acquire latitude and longitude of current position from GPS and network.*
2) *Using current position information, acquire information on the surrounding area up to a 3km radius from the database.*
3) *Display map information for the surrounding area up to a 3km radius and place the pictograms in designated positions on the screen.*

By tapping an icon, the users can find out the contributor and posted time, which can aid in judging the situation, as showed in Figure 6.

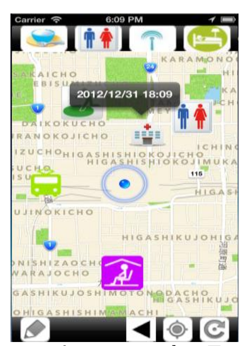

Figure 6. Annotation when Tapping an Icon

When the user changes the information genre to information about disasters, the system displays only

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important information. Other information can be seen by tapping the Layer Select Button.

There are two methods to update information. The 'Information Update Button' updates information. The 'Information Formatting Button' updates information and also changes the information genre to default. Both actions update the user's current location and center the map on the user.

In this way, this system expresses information using shape and color without words, by which the user is able to collect information on their surrounding area.

C. Contributing Disaster Information

During disasters, the time and operations required to contribute information should be minimal. In this system, users can contribute with three steps, as shown in Figure 7.

1) *Change to "Contribute" screen*
2) *Select the pictograms corresponding to the information the user wants to contribute from the icons at the bottom of screen*
3) *Tap "Contribute" Button*

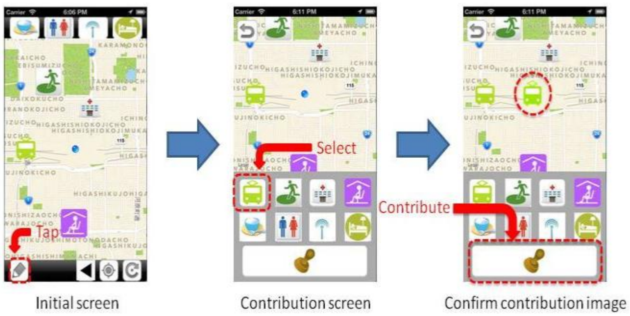

Figure 7. Contributing Information

Via this operation, the client-system sends the server information that includes the current position (latitude and longitude), pictogram name, time of contribution and pictogram ID determining whether to display the default display or layer selection. This information is obtained from the system automatically, with the exception of the pictogram name, so the system saves the user's time. In non-disaster situations, users can post comments and photos in the system, but if the information genre is changed to disaster, these functions are automatically suspended and text-based communication is prohibited. This reduces the amount of communication.

V. SYSTEM EVALUATION

A. Evaluation Method

To verify the effectiveness of the system, we conducted an evaluation experiment separated into two patterns: for experts and for normal users.

Three persons belong to Kyoto's Disaster and Crisis Management Section and twelve persons belong to Konan Fire Department participated in the experiment as experts, performed simulated operation of the system and answered a questionnaire survey after we explained about the system.

Two students from China and six students from Japan participated in the experiment as normal users, and answered the same survey without hearing an explanation of how to use this system. Three of the students had not used social media or smartphones before. The items of the survey are listed below.

1) *Do you think comprehension of the situation during a disaster would increase by using this system?*
2) *Were the sizes and designs of pictogram appropriate?*
3) *Was the system sufficiently easy to use?*
4) *Are the types of information provided sufficient?*
5) *Do you have other points of feedback or improvement?*

B. Expert Evaluation

The following is a summary of the evaluation by the experts.

1) *Response to Question 1*
   a) *There are big advantages for evacuating to shelters and obtaining information for returning home*
   b) *Information is available quickly, as it is expressed using easy-to-understand pictograms*
   c) *Users can be psychologically reassured, as they can gather information on their surrounding area*
   d) *Comprehension of the situation can be increased, as information about the destination is easy to understand*
2) *Response to Question 2*
   a) *Pictograms were appropriate (13 out of 15 experts)*
   b) *Users should be able to change the size of the pictograms (2 out of 15 experts)*
3) *Response to Question 3*
   a) *If users already have smartphones, the system could be operated without problems*
   b) *Limiting the amount of provided information leads to ease of use*
   c) *Mental barriers to using this system are higher for elderly people*
4) *Response to Question 4*
   a) *Information about unavailable facilities, not only available facilities, is necessary*
   b) *Information about means of transport (operation status and area) is necessary*
5) *Response to Question 5*
   a) *Need accurate and safe user-contributed information*
   b) *Setting display periods for pictograms would improve management of information*
   c) *Wish to utilize Wi-Fi spots during disaster situations, for example bus stops*

C. Non-Japanese User Evaluation

The following is a summary of the evaluation by non-Japanese users (Chinese).

1) *The provided types of information and size of pictogram are appropriate.*

2) *It is easy to ascertain the situation in the surrounding area via the combination of GIS and pictograms.*
3) *If we have experience of this system as social media during non-disaster times, we can use it when a disaster occurs.*
4) *We could not understand the difference between 'Evacuation Site' and 'Place for Rest' only from the pictogram.*

D. General User Evaluation

The following is a summary of the evaluation by general users.

1) *The provided information types, size of pictograms and denotation are suitable on the whole.*
2) *It is easy to use this system because it only uses pictograms.*
3) *If we have operated this system once, we can use when a disaster occurs.*
4) *Because the display is based on maps, we could ascertain both the geography and situation of our surroundings simultaneously.*
5) *We could understand the meaning of the information quickly, as there was no need to read text.*
6) *The pictograms for 'Evacuation Site', 'Place for Rest' and 'Available Accommodation' are too similar to distinguish. They should be revised or guidelines should be made.*

E. Consideration

The results of our evaluation experiment are as follows. Although some deficiencies in the provided information and comprehension problems for some of the pictograms were pointed out, we were able to confirm that this system can be used as an easy-to-operate disaster information sharing system through evaluation from experts, non-Japanese and general Japanese users.

Advantages and disadvantages are shown below.

1) *Advantages*
   a) *Contributing and sharing the information is easy*
   b) *Various people can use the system*
   c) *The disaster situation can be grasped intuitively*
2) *Disadvantages*
   a) *The system cannot transmit details of the provided information*
   b) *There is no guarantee of accuracy of user-contributed information*

Perceptions of color and shape vary between countries and cultures, because differences in sensitivities derive from the environment in which a person is raised. In this evaluation experiment there were only two non-Japanese evaluators, so we were unable to verify such differences. In future, we will pursue additional evaluations targeting more non-Japanese of multiple nationalities.

VI. CONCLUSION

In this paper, we focused on the importance of supporting persons who are affected heavily during disasters, such as those who are unaccustomed to using information-processing equipment, those who cannot read or speak the local language, elderly people, and foreign tourists. We designed a system whereby disaster victims can share information using pictograms instead of language, and correlate their current position on a digital map. The numbers of foreign tourists in Japan will increase more and more. Moreover, the proportion of elderly persons will increase in Japan's aging society. Therefore, this system aims to support such people, and we are convinced that this support will be required in future.

In future work, we will conduct further evaluation experiments and conduct questionnaires with large numbers of non-Japanese and persons unaccustomed to using information devices as targets, and improve the system accordingly. Additionally on the server side, we will also implement system functions that reflect the results of the experts' assessment, and clarify their effectiveness via further experiments.

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