# Nonlinguistic Disaster Information Sharing System including Multidimensional Objects: a Proposal

Kakeru Kusano
Graduate School of Information Science and Engineering
Ritsumeikan University
Shiga, Japan
is0013vi@ed.ritsumei.ac.jp

Tomoko Izumi
College of Information Science and Engineering
Ritsumeikan University
Shiga, Japan
izumi-t@fc.ritsumei.ac.jp

Yoshio Nakatani
College of Information Scinence and Enginnering
Ritsumeikan University
Shiga, Japan
nakatani@is.ritsumei.ac.jp

*Abstract*— **This work aims to support disaster victims, including persons who do not understand local language and tourists, via the provision and collection of information when a disaster occurs. This nonlinguistic system, whereby users are able to understand information and the interface intuitively, has been constructed to convert linguistic information to pictograms and maps. As a result of evaluation, it was demonstrated that multidimensional information is also important for victims to share the information about disaster situation. Multidimensional information indicates scope, for example the condition of transport facilities. In this report, we propose a method to process such multidimensional information in our nonlinguistic approach.**

**Keywords— Disaster Mitigation; Information Sharing; Nonlinguistic; Pictogram; Multidimensional Information**

## I. INTRODUCTION

### *A. Background*

At the present time, various measures are in place for disaster mitigation and disaster reduction in Japan, due to the influence of estimations of damage by a Nankai Trough Quake [1]. Moreover, during the Great East Japan Earthquake of 2011, social media played an important role in sharing disaster information among victims. 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. Such utilization of social media during disasters, exemplified by Twitter, is gaining attention. A “Wisdom of Crowds” was constructed from multiple users’ contributions (Tweets), and the effectiveness of this as an information infrastructure to ascertain the damage situation was recognized [2]. 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. Interest in disaster mitigation and disaster reduction that utilizes such information infrastructure is increasing, due to the influence of anticipated major earthquakes and the disasters that have caused serious damage in recent years.

However, the present information systems to support victims when disasters occur target only local residents, who are geographically familiar with the local area. That is, they require understanding of the local language. Tourists, who are likely to be geographically unfamiliar with the area, and non-local language speakers, tend to have difficulty in sharing and understanding information about the disaster, and to have greater damage than residents [3]. Therefore, a framework is required that can support all disaster victims, including persons predisposed to difficulty such as those described above.

### *B. Importance of Universal Disaster Mitigation*

Methods to support disaster victims, including persons who cannot understand the local language and persons geographically unfamiliar with the area, by transmitting information visually and intuitively have been considered.

The Japanese FDMA (Fire and Disaster Management Agency) is creating a universal design for disaster mitigation pictograms using such a method. Pictograms are diagrams that express meaning using color and shape, which can transmit the meaning of information without using language [4]. These pictograms are created in accordance with the principles of graphic symbols stipulated by JIS (Japanese Industrial Standards), and are registered by the ISO (International Organization for Standardization). In this way, universal methods to support disaster victims are starting to be considered in Japan.

In this research, we propose a disaster information sharing system that is able to collect and provide information visually and intuitively using GIS (Geographic Information System) and pictograms. We aim to construct a disaster information sharing system that supports disaster victims’ decision-making, as well as their grasp of the situation in the surrounding area, by implementing an interface that enables disaster victims to post information easily when disasters occur.

In the next section, related work is described. We present outline of proposed system in Section III, and system architecture in Section IV. Then evaluation experiment is presented in Section V. Furthermore, we propose the new

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system that is taken the results of evaluation experiment in Section VI. Finally, a conclusion and future work are described.

## II. Related Works

### A. Disaster Information Sharing Support System

Aoyama et al. proposed an information sharing system using WebGIS. Their system is a communication tool that is targeted at sightseeing spots [5]. Outside of disasters occurrence, businesses engaged in the tourism industry can use the system to provide tourism promotional information; during disasters, each of these businesses becomes a disaster shelter for tourists and local residents and transmits information. Their system assumes a wide range of users, including staff of local governments, residents, business personnel and tourists. A key feature of the system is the capability for users to mutually transmit information, whether during a disaster or in normal periods.

Transmission of information can be executed using the following four steps.

1. A registered user (including business personnel and residents) selects either category of “sightseeing information” and “disaster prevention information”.
2. The user confirms the geographical location for their information update or registration .
3. The user inputs detailed information.
4. The information is registered/updated on the GIS screen.

By dealing with information that is appropriate to the situation, Aoyama et al.’s system is grasped to play a role in ascertaining the local damage situation during the occurrence of a disaster. On the other hand, since it is necessary for users to input the location and details of the registered information in order to send such information, we can assume that the operation of the registration may be complicated for the victims because they must operate the information provision in times of emergency - i.e. the occurrence of a disaster - even if a wide range of users is assumed. Furthermore, understanding of the local language is a prerequisite of using Aoyama et al.’s system, so people who cannot understand the local language will have difficulty not only when contributing information, but also when understanding the contributed information. Accordingly, in our research we aim to resolve such problems by simplifying the system and providing information that have high visibility by using an intuitive interface.

### B. Information Collection Support System for Disaster-affected Areas using Mini-blogs

Yokobe and Nakatani proposed an information collection system using social media and mini-blogs to collect information when disasters occur [6]. In this system, unnecessary and unreliable information is deleted in accordance with the following two assumptions:

1. 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, Yokobe and Nakatani’s system deletes information which is sent from areas geographically separated from the disaster affected area. Specifically, they assume that information with exact location data has high reliability, and the reliability of each Tweet and Twitter user is evaluated based on the location data and responses from people living around the location where the Tweet is sent. From the results of their evaluation, it was demonstrated that Tweets that included geographical names had a strong relationship with the disaster-affected area. This fact implies that geographical names are important in deciding the reliability of Tweets.

However, most Tweets do not contain location data, and there is no such service in Twitter itself. Thus, the ascertainment of reliability based on location data is not available in many cases. Moreover, a problem inherent in Twitter is that when Tweets are sent by a huge number of users in a short time, all these Tweets are displayed on the Time Line, making it difficult for the user to comprehend all the information. As a vast amount of the latest information is displayed during the time taken by a user to read a single Tweet, there is a risk that information valuable to the user may be missed.

In October 2012, disaster prevention training utilizing social media was conducted in Japan [7]. In this training, disaster victims identified evacuation shelters that were posted on social media, and traveled to those evacuation shelters in reality. During the training, there was a major information gap in proportion to the level of comprehension when using an information system, due to problems such as users who were not familiar with dealing with social media being unable to understand where the evacuation shelter information was posted on social media, and users who could not understand how to use social media itself. In this way, the difficulty of using social media effectively during disaster situations was confirmed. It is thus necessary to make innovations such as providing an easily understandable interface to users in which large amounts of information are condensed before displaying. To resolve such problems, we attempt to utilize pictograms and GIS for input and output of information in this research.

## III. Outline Of Proposed System

### A. Basic Policy

In this research, we aim to construct a system that performs both information collection and information provision when disasters occur, with all disaster victims as a target [8]. This system will enable sharing of disaster information among disaster victims via implementation of an interface that allows information to be collected and provided visually and intuitively, even if users do not know how to operate the system.

### *B. Disaster Information to be Provided*

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 TABLE 1.

TABLE I. TWO TYPES OF PROVISDED INFORMATION

| |
|---|
| 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.

### *C. Visual Interface of Disaster Information Sharing*

In this work, we consider that provision of information is biased towards support of local residents in the event of a natural disaster, and accordingly we propose an information sharing method whereby users are able to understand the interface intuitively and visually. By allocating pictograms on GIS, information about the disaster situation at specific locations is expressed visually. Additionally, this system enables the user to execute information provision intuitively by incorporating pictograms and gesture operation using a touchscreen display when users operate the system. Furthermore, the following functions are constructed utilizing network and GPS (Global Positioning System).

- The screen on GIS is displayed. In the screen, the current position of the user getting from network and GPS is the center.
- Disaster information to be contributed by users is collected in the server.

By providing the above functions, we constructed a system for showing information surrounding the user and sharing disaster information among disaster victims.

## IV. SYSTEM ARCHITECTURE AND FUNCTIONS

### *A. System Structure and Development Enviroment*

This system uses a client-server model and is constructed as an iOS application and a Web application consisting of PHP programs and a database as a prototype. The reasons for utilizing an iOS device application on the client side are as follows.

1. iOS devices are portable devices that can be carried easily when disasters occur.
2. Intuitive operation is possible using the touchscreen display.
3. It is possible to save information such as image of pictograms in the devices before disasters occur, and thus, the load on communication channels is small.

We used the Objective-C language for the client application, and PHP and MySQL as the development environment for the server application, to construct a client-server model using an iOS application. The client-application transmits data including the type of pictogram, present location, date and time of the contribution, and name of the contributor. The server-system inserts and updates the received information to the DB passed PHP programs. Thus, disaster victims are able to acquire and/or contribute information when they are affected by disasters.

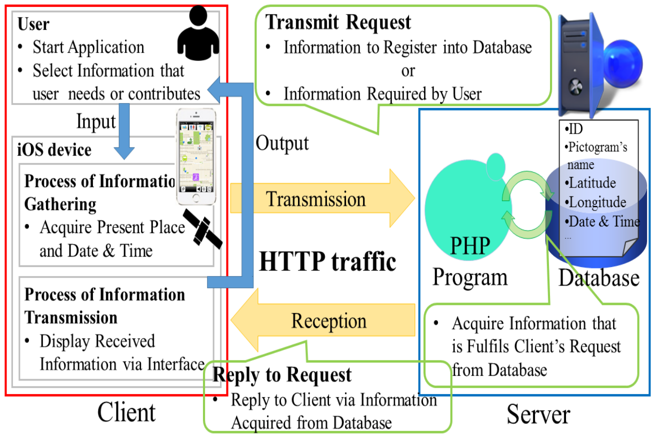



Fig. 1. System Structure Chart.

### *B. Information Collection and Provision*

The system's initial screen is showed in Figure 2. The user can collect information on their current surroundings via map information and pictograms on this screen. The following describes the process of this system when users acquire disaster-related information.

1. The system acquires the present location via GPS.
2. The client-application sends the present location to the server-system, and information which is registered within a radius of three kilometers (centered on the present position) is acquired from the DB.
3. The client-application displays this information on GIS.

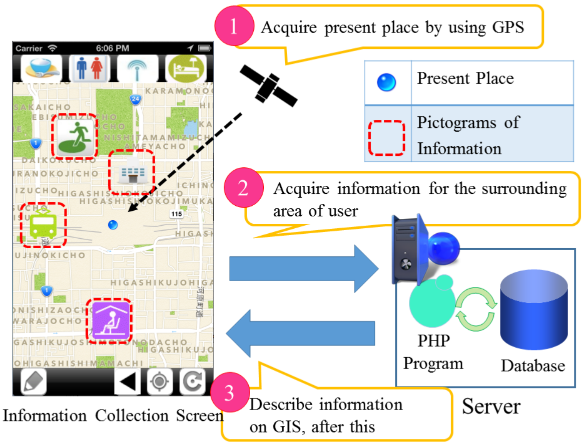



Fig. 2. Flow of System Screen for the Information Collection.

The following describes the flow of this system when disaster victims contribute their own information (Fig.3).

1. The system transitions from the Information Collection screen to the Information Contribution screen.
2. The client selects pictograms that represent the contributed information.
3. The client confirms the image of the contributed information and finalizes the contribution.

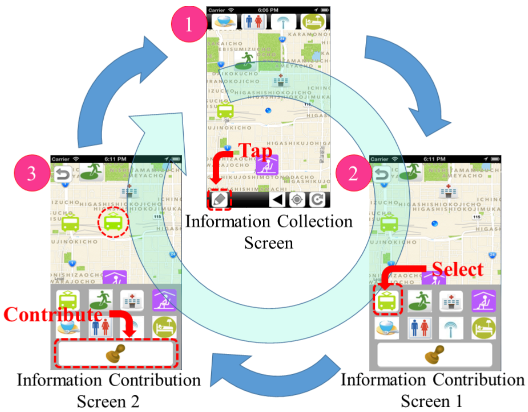



Fig. 3. Flow of System Screen for the Contribution.

The client-application transmits data including the type of pictogram, present location, date and time of the contribution, and name of the contributor. To reduce the operation procedure, the position and submission time to transmit are acquired by the client system automatically. The server-system inserts the received information to the DB. Thus, disaster victims are able to acquire and/or contribute information when they are affected by disasters.

## V. System Evaluation

In the evaluation experiment, we conducted two separate trials: for disaster mitigation experts and for normal users. The expert group consisted of three persons from the Disaster Management Office of Kyoto City and twelve persons from Konan Regional Fire Administrative Organization, Shiga Prefecture.

### A. *Expert Evaluation*

We performed simulated operation of the system and answered a questionnaire survey after we explained about the system. The results of the evaluation experiment conducted with these subjects are summarized below.

- It is highly beneficial for disaster victims to obtain information during their evacuation or going back their home.
- Victims are able to obtain information immediately, because information is simply expressed by using Pictograms and GIS.
- Because victims are able to know the situation the surrounding area, they psychologically calm down.

On the other hand, the subjects gave the following suggestions for improving disaster information using the system.

- The system should provide not only facilities which are not available, but also available ones.
- In the case of providing transportation information, the traffic section needs for disaster victims, not limited to travelling condition.

### B. *General User Evaluation*

Moreover, we conducted an evaluation experiment with a group of normal users, consisting of two Chinese exchange students and six Japanese students. The methods of this experiment were to use the system without any explanation of the method of operation and answered a questionnaire survey. As a result, the normal users were able to use this system. The following is answer of general users.

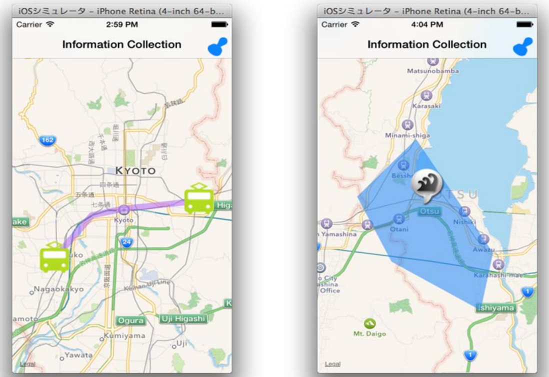
- It is easy to use this system because it only uses pictograms.
- If we have operated this system once, we can use when a disaster occurs.
- Because the display is based on GIS, we could ascertain both the geography and situation of our surroundings simultaneously.
- We could understand the meaning of the information quickly, as there was no need to read text.
- 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.

From the results of the evaluation experiment using this system, we were able to confirm the effectiveness of this nonlinguistic approach using pictograms and GIS to simplify information transmission and collection related to disaster information sharing. On the other hand, to make disaster victims understand the disaster situation, the subjects pointed out the problems about the variation of provided information and the display format of them.

## VI. Discussion about the Multidimensional Information

### *A. Multidimensional Information Sharing*

In our research, we implemented during the preliminary research, information was shared as zero-dimensional information on GIS, single-dimension information and two-dimensional information, such as section and area, were also expressed as zero-dimensional information. This zero-dimensional information showed single-point information that corresponded only to one specific coordinate. However, among the information required by disaster victims during a disaster, there exists some information that is difficult to express as zero-dimensional information. One typical case is the zones of available public transportation operation. Although this information is important for disaster victims in order to evacuate or return home, it is desirable to handle this information as single-dimensional information, as a line connecting the transport route from the starting station to the terminal station. Similarly, when describing areas of damage such as flooding on GIS, this information is expressed as a plane - in other words, two-dimensional information. Specifically, this can be expressed by colorizing the corresponding area, as shown in Fig. 4. No disaster information sharing system currently exists that is able to deal with this kind of multidimensional information easily. We aim to construct an information sharing system that can input/output multidimensional information for victims when a disaster occurs, in addition to the same interface as the previous stage of our research. We are currently considering the following contents in relation to information collection and provision.




Single Dimensional Information    Two-dimensional Information

Fig. 4. Input / Output of Multidimensional Information.

In future, by incorporating such elements, we aim to construct a disaster information sharing system which enables disaster victims to acquire necessary information including multidimensional information, and supports the evacuation activities of users during a disaster. Subsequently, we plan to verify the effectiveness of this system by conducting evaluations using multiple evaluators, including persons who do not understand local language.

## VII. Conclusion

In this research, we proposed a system that can be utilized by a wide range of disaster victims during the occurrence of a disaster, including tourists and persons who do not understand the local language, by constructing a system for disaster information collection and provision using a nonlinguistic approach. In order to share information that contains zone and area information, which is vital when disasters occur, we proposed a system that enables disaster victims to collect and provide multidimensional information to take results of evaluation experiment. Furthermore, in this research, collection of information from a large number of disaster victims is a means to achieve the objective of creating a “Wisdom of Crowds” during disasters. Accordingly, a future task will be to consider the safety and reliability of information that is shared when disasters occur. In future, we are considering methods such as peer-evaluation of user-provided information, or to verify the reliability of information based on the location of the information provider, as in Yokobe and Nakatani’s research. In addition, as stated in Section VI, we will verify the effectiveness of this nonlinguistic system by conducting evaluation experiments with subjects including persons who are geographically unfamiliar with the area, persons who cannot communicate in a local language, and experts on disaster mitigation such as Japanese and non-Japanese.

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