Disaster-Response Information Sharing System Based on Cellular Phone with GPS

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Abstract. In disasters, the victims must be provided with various bits of information. The information needed also changes with the situation. In this paper, we analyze the characteristics of such information and introduce an information sharing system. A prototype is developed around a cellular phone with GPS and its effectiveness is described.

Keywords: Disaster Information, Information Sharing System, Cellular Phone with GPS, meta-data.

1 Introduction

The victims of a disaster need various bits of information. Examples include disaster scale, safety areas, and rescue plans. Unfortunately, such information is now unevenly distributed among key spots such as safety areas. The information needed is too complex for reliable verbal transmission or bulletin boards. Because no fixed information structure can remain effective in the face of a disaster, victims receive only fragmentary and unreliable information. This confuses the victims and fails to minimize the damage.

This paper collects the features of disaster-response information. Next, we set the requirements to design a system that shares accurate information to respond to a disaster. A prototype of the information sharing system that is based on the requirements is described.

2 Information After a Disaster

After a disaster, the situation changes hourly, as does the information needed by the victim. In other words, one characteristic of disaster information is that it depends upon the current situation.

The information that the victim needs after a disaster, in this instance a large earthquake, is shown in Table 1.

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Table 1. Needed disaster response information (Earthquake)

time: t

Disaster Information	*t -1*	*t 0*	*t 1*	*t 2*	*t 3*	*t 4*
A) Earthquake info.	*	***	***	**	*	
B) Aftershock info.			***	***	**	*
C) Evacuation info.			***	**	*	
D) Damage info.			*	**	**	*
E) Rescue info.			**	**	**	**
F) Life info.				**	***	***
G) Victim info.			**	***	**	*

"***" maximum need.

Time progression in disaster

Time	Situation	Passage of time
t -1	imminent earthquake	before time
t 0	earthquake occurrence	at the time
t 1	immediate aftermath of earthquake	after some hours
t 2	after a day of earthquake	after a day
t 3	after some day of earthquake	after some days
t 4	after earthquake	after a week …

Disaster Information are following in Table 1.

A) Earthquake info. : earthquake scale and tsunami forecast, etc.
B) Aftershock info. : outlook for future earthquakes, etc.
C) Evacuation info. : refuges and escape routes, etc.
D) Damage info. : casualties and damage to buildings and lifelines, etc.
E) Rescue info. : the rescuer necessary and the rescuer supply, etc.
F) Life info. : restoration of lifeline, etc.
G) Victim info. : safety of family, friends, and acquaintances etc.

2.1 Information Transmission

Currently, the main method of information passing in a disaster is mass-media, i.e. TV and radio. The same contents are passed to all receivers. Moreover, the information is tailored to suit large areas. The most useful information is very personal and has a limited shelf-life. The victim currently obtains such information by using "private-media" such as bulletin boards and word-of-mouth communication. Table 2 shows the suitability of the two media.

Some time after the disaster, the information that the victim needs becomes personal information. Mass media cannot be used to transmit such information.

When information is passed from person to person, it becomes distorted to the point of becoming a rumor. Because the source is ambiguous and the information is fragmentary, intermediary message passers often "supplement" the information.

Table 2. Media support for disaster response information

Information	mass-media	private-media	time period
A) Earthquake info.	**		*t 0 – t 1*
B) Aftershock info.	**	*	*t 1 – t 3*
C) Evacuation info.	*	**	*t 1 – t 2*
D) Damage info.	**	**	*t 2 – t 3*
E) Rescue info.	**	**	*t 1 – t 4*
F) Life info.	*	***	*t 2 -*
G) Victim info.		***	*t 1 -*

"**" indicates a high degree of support.

We believe that information provided by the mass-media is reliable, but it is not timely nor is it sufficiently personalized. Information via private-media can be timely and sufficiently personalized, but the source cannot be trusted; it is necessary to validate the information.

2.2 Meta-data of Information

Information is generally validated by acquiring similar information from two or more sources that can be trusted. When there is no source or we judge authenticity from just the contents of the information itself, we need to determine:

- Who sent it? / Who said it?
- When was it sent? / When you heard it?
- Where is it? / What place?

If each point is clear, the authenticity of information is high. Authenticity is further raised by the addition of photographs and images that can validate the information objectively. In other words, information authenticity is increased by the addition of meta-data such as, Who, When, Where, and What (4W).

Information authentication consists of two parts. It is one to acquire supporting information from other source. The other is to appraise the information itself.

3 Implementation

Our approach to authenticating private channel information is to transmit meta-data with the information. We set the following requirements to designing the system.

1) Time resolution
Timely information must be sent hourly to keep up with the changing situation. Moreover, the information should be received properly.

2) Spatial resolution
Detailed location information must be given. It is hoped that the information is place that can be concrete, and specified.

3) Objectivity of event
Photographs and images that can objectively should be appended. For instance, it is easy to understand information to which the photograph is appended more than information on the text-only when reporting on a fire.

4) Usability interface
It is necessary to add the meta-data to information easily. Therefore, the system expects the interface that automatically adds the meta-data.

3.1 Prototype

A prototype of the system was constructed on a weblog. Weblogs are mainly used by for distributing personal information and are a type of diary with frequent updates. A very recent trend is the emergence of Moblogs (mobile weblogs); they are created and maintained by cellular phone users. Modern mobile phones make it possible to append locally-captured photographs and sound clips to an e-mail, so timely information entry via Moblogs is now possible. Furthermore, if the cellular phone offers a GPS (Global Positioning System) service, it is possible to acquire and append detailed location information (latitude and longitude). As shown in Figure 1, the prototype consists of

OS: Windows 2003 Server
Web Server: Apache
DB Server: MySQL
Weblog tool: WordPress ME [1]
Client terminal: A cellular phone with GPS / PC

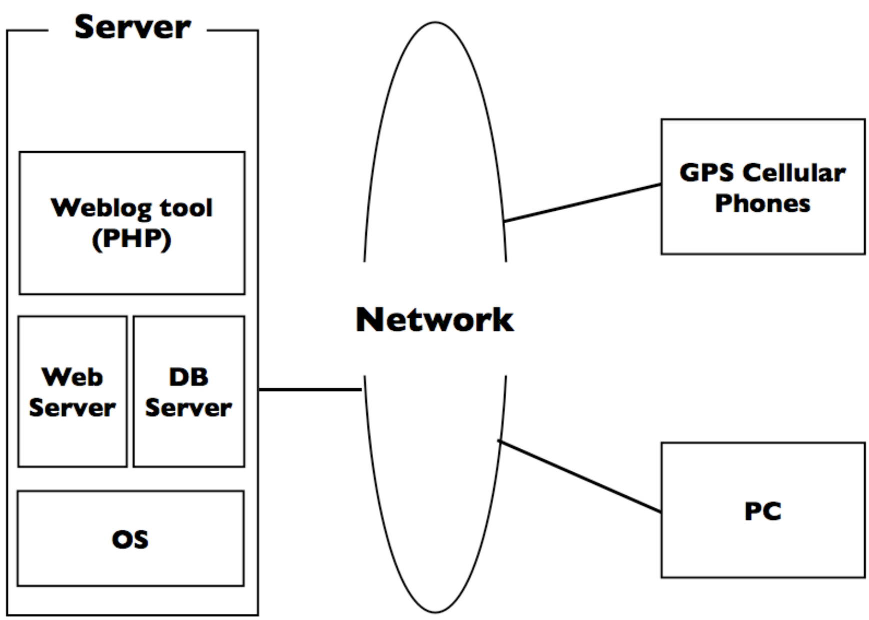

Fig. 1. System construction

Weblog posts were entered on a digital map based on the location information to confirm the information presented by the camera data (Figure 2). We used Googlemaps [2] as the digital map. In this prototype, the 4W meta-data is automatically added to allow authentication of the information as shown in Figure 2.

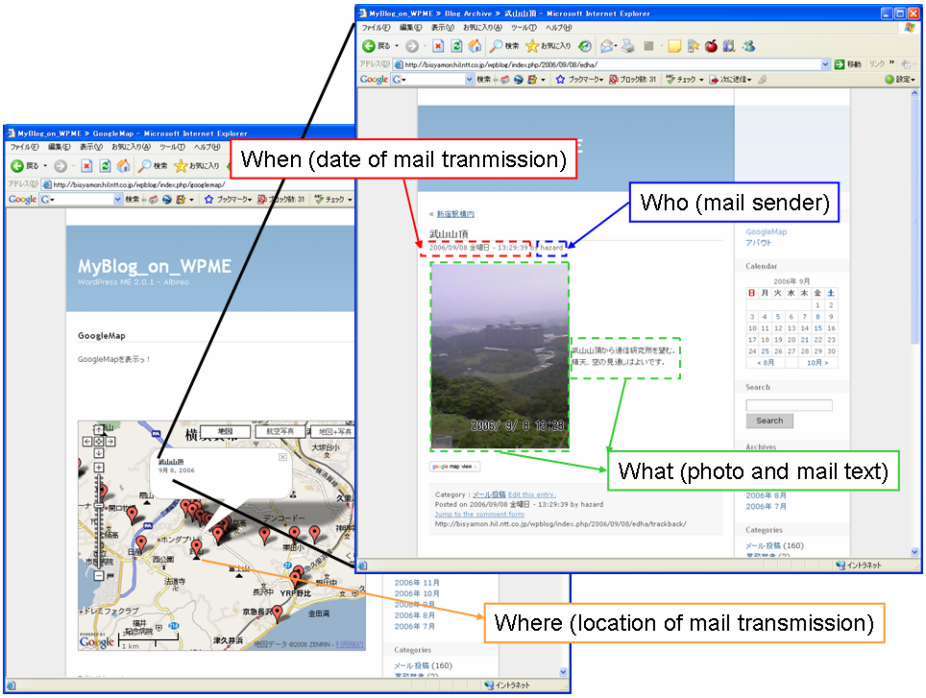

Fig. 2. Typical screens of prototype system

4 Discussions

We conducted an experiment on the prototype system in which four users employed the system over a two month period. Since each posting was stamped with the time of transmission, the temporal validity of the information could be verified. Photographs attached to each post effectively supplemented the text information, so that the description of the phenomenon was adequate and efficient. Outdoors, the accuracy of the GPS information was acceptable. Indoors, the GPS accuracy was rather poor and capture times were long. A simple problem with the prototype system was that three distinct operations were needed to acquire GPS coordinates, capture local images, and create the text message; usability of the system must be improved.

4.1 Location Information: GPS Limits

Some information sharing systems that uses cellular phones with GPS have been proposed [3]. Another approach visually shares information on a map in cooperation with GIS (Geographic Information System) [4]. Reports indicate that information accompanied by location data and photographs can transmit information more efficiently than text-based information. However, each approach assumes only outdoor use.

While many disasters involve outdoor responses, there are many cases in which indoor use is essential. Since the current GPS is rather ineffective indoors, we need to supplement GPS. One candidate is the system based on RFID (Radio Frequency Identification) tags.

4.2 Information Structure

In this paper, we proposed that information authenticity can be increased by the addition of 4W meta-data. The basic set of 4W information is essential but we need to consider higher data granularity. "Floor number" and “Apartment numbers” are needed for condominiums while, "Lane" is necessary for roads.

4.3 Interface

Our system uses the cellular phone as the information sending interface. The current prototype was created by simply concatenating several application programs so operation was rather clumsy and time consuming. Operation can be improved by altering the picture taking function so that GPS data and time are automatically appended to each photo. Given our goal of responding to disasters, the interface of the system must be as stress-free as possible.

5 Conclusion

This paper assessed the types and temporal attributes of information needed to respond to disasters. Next, we proposed an information sharing system for victims of disasters that uses meta-data (4W) to improve authenticity. A prototype system was constructed on a moblog foundation; the terminals are cellular phones with cameras and GPS functionality. We confirmed that our system is able to offer information sharing with some assurance of information authenticity. In the future, we will investigate how to increase information granularity by extending 4W, and improve the usability of the system.

References

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