3-2 Development of Cellular Phone Application for Safety/Disaster Information Collection and Transmission; "Easy-Reporter"

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We have developed a cellular phone application "Easy-Reporter" that simplifies the process of initial damage report to the disaster response headquarter, where a report is comprised of the GPS location, photos and the predetermined event categories selected by the user. It can be used to collect safety information under the normal circumstance such as disaster drills as well as the emergency conditions such as communication congestion after a large scale earthquake.

Keywords
Easy-Reporter, Safety information collection and transmission, Cellular phone application, Communication congestion

1 Introduction

The growth in the availability of cell phones in recent years has been remarkable, and the functions have become increasingly sophisticated. Needless to say, the cell phone has become ubiquitous as part of everyday use. If the characteristics of a cell phone, such as widespread use, portability, operability, independence, the ability to record images and suchlike, could be used to collect information in the event of a disaster, the information would be of benefit in supporting targeted emergency action.

Immediately after an earthquake, it is necessary to track the damage from the disaster as quickly as possible, and to take immediate and appropriate action. In the Great Hanshin Earthquake of 1995, a blank period in collecting information on the damage immediately after the earthquake made it impossible to take prompt emergency action. Experience such as this has prompted the development of information collection systems using devices such as PDAs and notebook PCs[1][2].

However, many of the information collection systems refer to map data for position information. Therefore, while information on the position is accurate, it takes time to provide terminals to gather the information and to install the data. In addition, the information collection systems are difficult to operate. Under the current circumstances, therefore, these systems have not yet been able to assist the heads of administrative organizations in prompt decision-making immediately after a disaster occurs.

In response to this situation, attempts are now being made to gather information on the damage with exceptional speed at the time of a disaster using cell phones, making use of their superior portability and operability, etc.[3]. Akimoto et al.[4] have proposed a damage tracking system, in which an application is downloaded in advance to a cell phone with internet access. In the event of a disaster, the user launches the application and responds to questions, then transmits the information to a predetermined server together with position information represented as latitude and longitude. However, since the data gathered in this system is transmitted to the server over a packet communication network, there is the risk that data cannot be transmitted if the base station stops transmission due to a power failure or if the transmission channel goes offline, as was the case in the 2011 off the Pacific coast of Tohoku Earthquake on March 11, 2011. Another risk is that data transmission may be considerably delayed if the network becomes overloaded.

Against this backdrop, the authors have developed a disaster information collection system that augments the functions of the cell phone as a tool for efficiently acquiring and promptly sharing information about damage immediately after an earthquake occurs. The system assists the disaster headquarters and other agencies in decision-making in taking targeted action, and enables the information to be shared.

This system is currently registered as "Easy-Reporter" on the server that provides downloads, and is classified as a cellular phone application for safety/disaster information collection and transmission. Although it is still limited to the specific cell phone models of specific carriers, anyone can now download and try Easy-Reporter (hereinafter referred to as "the system").

This paper gives an overview of the system, including the spatial framework we have developed, the positioning of the system, and operating procedure. The paper then reports the demonstration experiments we conducted to verify operability and reliability of the system.

2 Spatial framework of information collection system in the event of a disaster and positioning of Easy-Reporter

To collect information more efficiently, the research group of the author et al., conducted a survey by interviewing the people in charge of disaster prevention of several autonomous agencies. Based on the results, we propose the following information collection structure[5].

1) Divide a jurisdiction into blocks (elementary school districts), and designate public facilities (elementary schools) in those blocks as the disaster prevention base, which acts as the information base. Taking full advantage of residents' ability to report the damage information, collect, check, and summarize the information.
2) Deploy a base information system at each base. Input and transmit the damage information while having staff members of an autonomous body or suchlike check it.
3) Connect the base with the disaster headquarters via a robust communications infrastructure, and attempt to share the information with external organizations.
4) Disseminate the aggregated damage information or disaster prevention information to residents through the base information system.

Figure 1 is a schematic representation of the system that embodies the above points. Its effectiveness has already been demonstrated through experiments conducted in Suita City and Toyohashi City[6][7]. This system is positioned as the cornerstone of the framework for the information collection structure shown in Fig. 1. When residents or staff members of an autonomous agency hurry to a disaster prevention base or disaster headquarters, the system makes it possible to store details of the damage as characters in an external memory (SD or Mini SD, etc.) attached to the cell phone, together with images taken with the camera in the cell phone. The external memory also records the position measurements obtained by GPS. The base information systems installed in disaster prevention bases such as evacuation centers capture the information. At the same time, if communication is possible, the system transmits the data through a packet network. It is assumed that the damage information is collected using this system within one day of a disaster occurring.

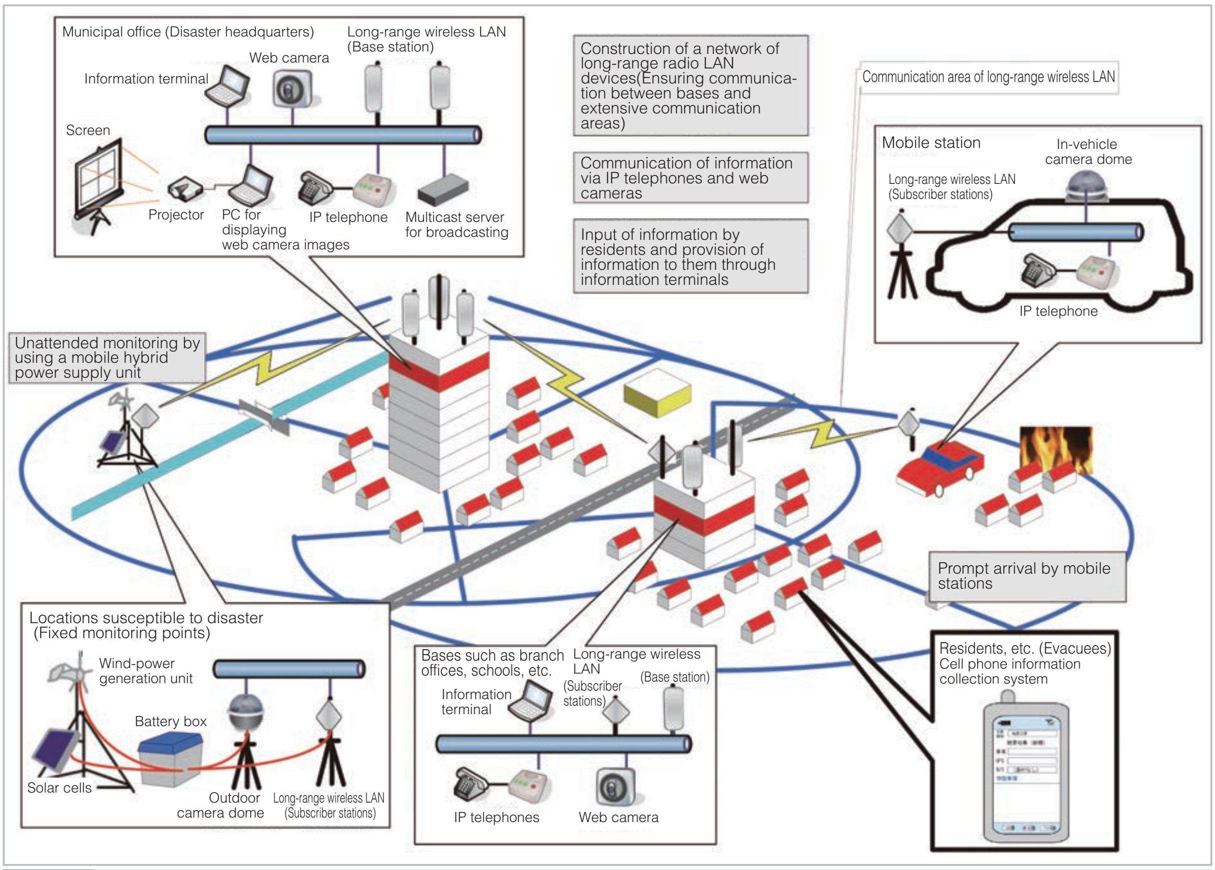

Fig.1 *Spatial framework of information collection system*

3 Overview and characteristics of the system

3.1 Overview of the system

Since residents or staff members of autonomous agencies who collect damage information are not necessarily familiar with information communication techniques, we have configured the screens to closely resemble cell phone email screens that may be familiar to the user. An overview of the system follows:

(1) To use the system to collect information in the event of a disaster, first launch Easy-Reporter (Fig. 2).

(2) Select the system that suits your purpose (For example, in the event of an earthquake, select Earthquake).

(3) Select the type of disaster from the list (fire, damage to buildings, etc.) and indicate whether there are any casualties.

(4) Use the built-in camera to record images of the disaster. The position information is automatically appended.

Fig.2 *Initial screen of Easy-Reporter*

(5) If time permits, enter comments as special remarks. This is not mandatory.

(6) Press the Register button to register the information in steps (3) to (5) above.

Figure 3 shows the screen transition.

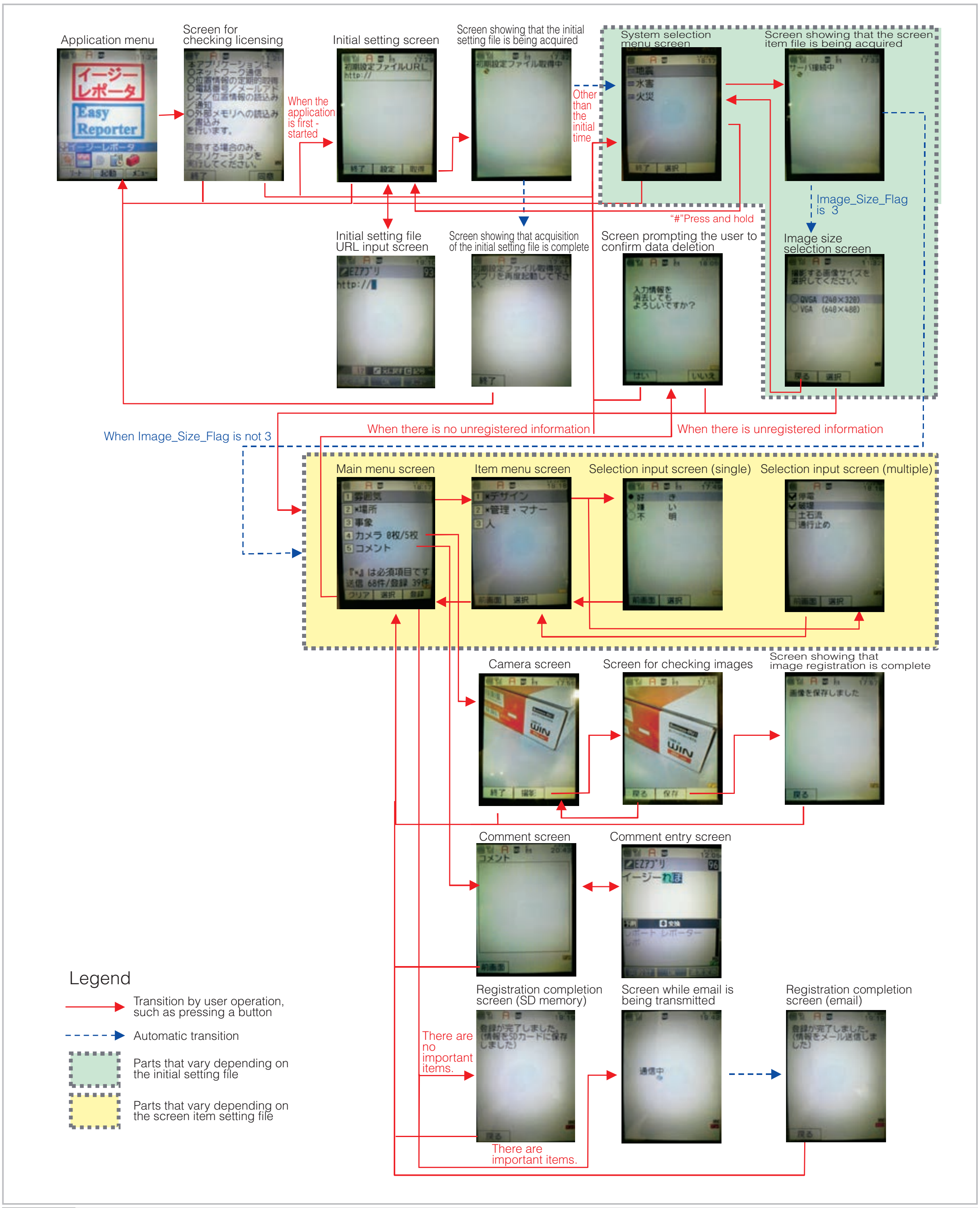

Fig.3 *Screen Transition Diagram of Easy-Reporter*

3.2 System characteristics

As shown in Fig. 4, the system has three characteristics, each of which is described below.

(1) Response when a cell phone base station is damaged due to a large-scale disaster, such as an earthquake, or communication is congested

As most of information collection systems collect or transmit information via the internet based on instructions from an aggregator (a server that aggregates information), it is likely

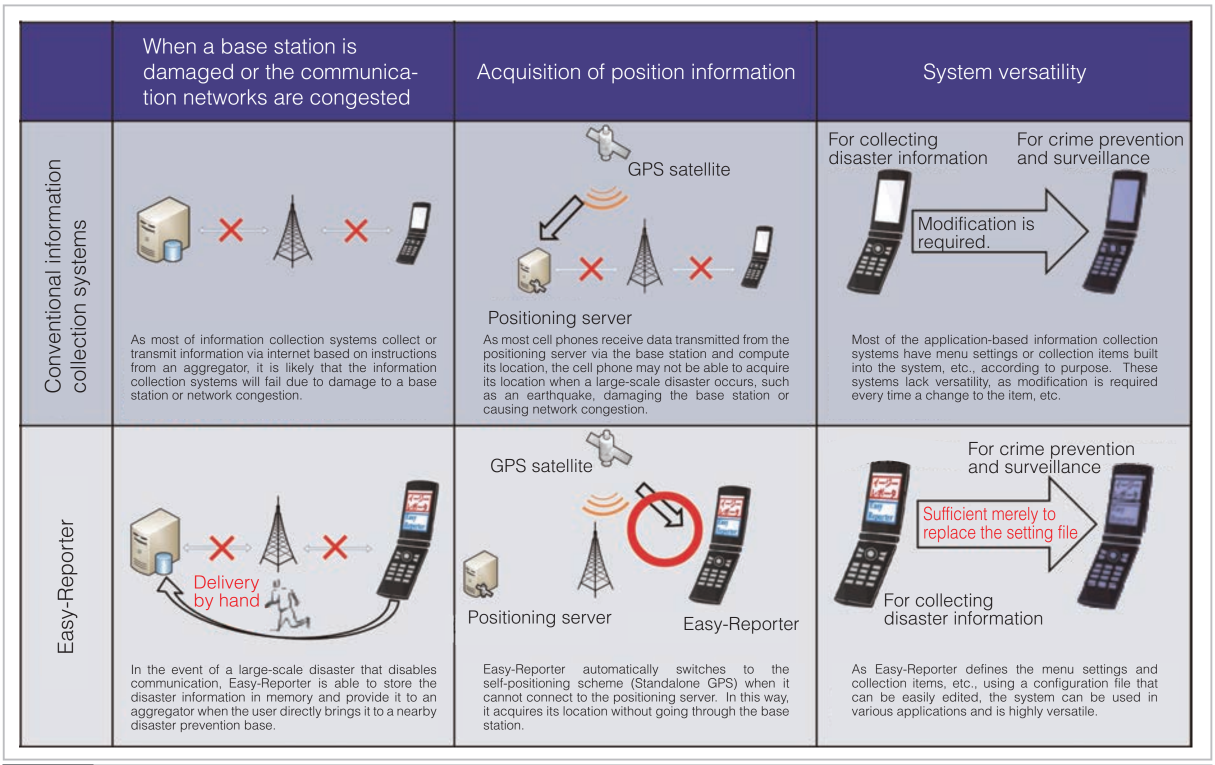

Fig.4 *Characteristics of Easy-Reporter*

that the information collection systems will fail due to damage to a base station or network congestion, etc.

In contrast, in the event of a large-scale disaster that disables communication, this system is able to store disaster information in memory and provide it to the aggregator when the user brings it directly to a nearby disaster prevention base.

(2) Acquisition of position information

In general, when a cell phone acquires position information, it receives assisted GPS data at regular intervals from an assisted GPS server via a base station, thereby reducing computing time. As the cell phone terminal computes its final location (MS-based scheme), it is possible that the cell phone may not be able to acquire its location in the event of a large-scale disaster, such as an earthquake, that damages the base station or causes network congestion.

When this system computes the position, it measures positions using the MS-based scheme by default, similar to existing information collection systems. However, if it is not possible to communicate with a GPS satellite due to poor transmission and reception, the system automatically switches to positioning using the MS-assisted scheme. If, in the event of a large-scale disaster, such as the 2011 off the Pacific coast of Tohoku Earthquake the system cannot communicate with the base station, it automatically switches to positioning using the Autonomous scheme.

In addition, when communication with the base station is restored, the system automatically switches from positioning using the Autonomous scheme to that of the MS-based or MS-assisted scheme. Table 1 shows the conditions for switching the positioning systems.

(3) System versatility

Most of the application-based information collection systems have menu settings or collection items built into the system, etc., according to purpose. These systems lack versatility, as modification is required every time a change is made to the item, etc.

In contrast, the system proposed here defines menu settings and collection items,

Table 1 *Conditions for switching the GPS*

		Conditions for GPS satellite	
		Capturing enabled (outdoors)	Capturing disabled (indoors)
Base Station	Communication enabled (in normal circumstances)	MS-Based	MS-Assisted
	Communication disabled (in the event of a disaster)	Autonomous	Positioning disabled

etc., using a configuration file that can be easily edited. Therefore, it can be used in various applications and is exceptionally versatile.

4 Demonstration experiments with members of the public

To verify whether this system can be positioned as an effective disaster information collection system that can be used in the event of an unpredictable disaster, such as an earthquake, we have conducted follow-up experiments on same subjects who used the system over one year.

4.1 Preliminary experiments and the results

On February 29 and March 1, 2008, we conducted preliminary experiments on 29 members of the public in Takamatsu City, Kagawa Prefecture (Fig. 5), and reviewed the operability and other aspects of the system. The results are as follows: Of 29 subjects, 28 could easily operate the system. These subjects were less than 50 years of age. Those who were able to understand how to operate the system and collect information were company employees, students and part-time workers. These people had at least four years' experience of using a cell phone. We also found a correlation between the user's familiarity with cell phone emails was and the user's ability to understand how to operate the system[8].

4.2 Experiment schedule and follow-up experiments

To ensure that the system can be smoothly operated, we first simulated the situation immediately after a disaster, and conducted a preliminary experiment (February 2008) that was positioned as a disaster drill and training in use of the system. One month later (in March 2008), and one year later (March 2009), we conducted follow-up experiments.

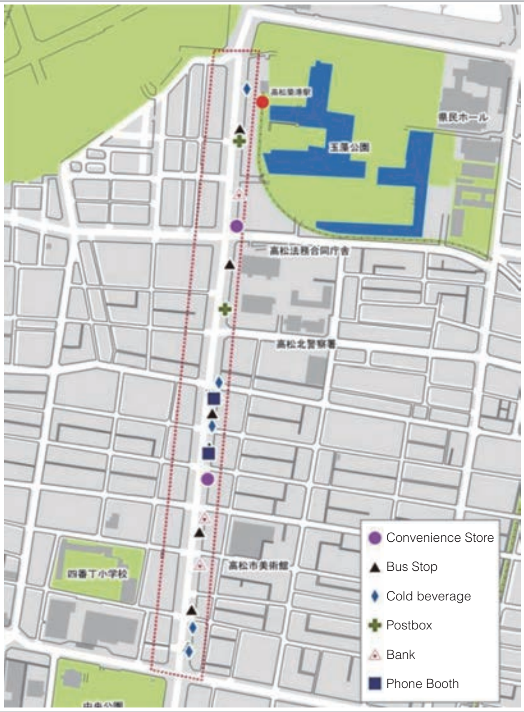

Fig.5 *Area for demonstration experiment and Items gathered during the experiment*

When the preliminary experiment was conducted, many subjects in their 50s and 60s failed to collect data and their collection time fluctuated. Therefore, we recruited 15 new subjects in their 50s and 14 subjects in their 60s for the experiment one year later (March 2009), and conducted the preliminary experiment (February 2009) and follow-up experiments. Table 2 shows the experiment participants and their attributes, and Fig. 6 shows how they performed.

Table 2 *Attributes of participants in the experiment and transition*

Age group	Primary preliminary experiment (2008.2)			Primary follow-up experiment (2008.3)			Secondary follow-up experiment (2009.3)		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
20s	4	3	7	4	3	7	4	1	5
30s	1	5	6	1	5	6	1	2	3
40s	1	5	6	1	5	6	1	4	5
50s	0	5	5		5	5		4	4
Over 60	2	3	5	2	2	4	2	2	4
Total	8	21	29	8	20	28	8	13	21
Age group				Secondary preliminary experiment (2009.2)			Secondary follow-up experiment (2009.3)		
				Men	Women	Total	Men	Women	Total
50s				7	8	15	7	8	15
Over 60				10	4	14	9	4	13
Total				17	12	29	16	12	28

Fig.6 *Picture of the demonstration experiment*

To prevent the experimental subject from becoming aware of this system, we did not inform them of whether experiments would be conducted one month later or one year later. Consequently, when we conducted the experiment one year later, we were unable to contact some of the subjects, and thus the number of subjects decreased.

The experimental method was as follows. In the preliminary experiment, we explained this system to the subjects for about 10 minutes before starting the experiment. However, in the follow-up experiment, we gave no explanation about the system, only provided them with a list of target items to collect (those listed on the reverse side of the name plate and experimental procedure manual), and instructed them to collect the information.

As in the case of the preliminary experiment, we set six data items to be collected, namely, drink vending machines, postboxes, bus stops, convenience stores, banks, and phone booths that were located on the pathway of the experimental site, as disaster information (collapsed buildings, fires, etc.), and gathered the information (Fig. 5).

4.3 Experiment schedule and follow-up experiments

In developing this system, we have configured the screens to closely resemble cell phone emails that may be familiar to the subjects, so they can operate this system even though they are not necessarily familiar with operating systems such as PCs or cell phones. Because of this, although the percentage of operation was 97% in the preliminary experiment, 67% of the subjects could still operate the system without any problems even after one year (Table 3). Note that we classified each subject as able to operate the system if he/she could obtain data on any one of the 22 collection target places.

When the subjects were asked whether

Table 3 *Transition in percentage of successful operation of this system (%)*

Age group	Primary preliminary experiment (2008.2)			Primary follow-up experiment (2008.3)			Secondary follow-up experiment (2009.3)		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
20s	100	100	100	100	100	100	100	100	100
30s	100	100	100	100	100	100	100	100	100
40s	100	100	100	100	100	100	100	100	100
50s		100	100		60	60		25	25
Over 60	100	67	80	100	50	75	50	0	25
Total	100	95	97	100	85	89	88	54	67
Age group				Secondary preliminary experiment (2009.2)			Secondary follow-up experiment (2009.3)		
				Men	Women	Total	Men	Women	Total
50s				100	100	100	71	75	73
Over 60				90	100	93	67	50	62
Total				94	100	97	69	67	68

they remembered how to operate the system after one year, about 30% answered that they still remembered, while 60% of the subjects answered affirmatively when they operated the system again. The start button for the application triggered the subjects' recall in the case of ten subjects and the button positions triggered recall in the case of five subjects.

5 Summary

In the event of an emergency, particularly an earthquake, it is feared that the communication networks will become congested. Under these circumstances, a cell phone could become a highly effective tool for collecting information, considering its widespread use, people's proficiency in operating it, etc. By focusing on the capabilities of the cell phone other than communications, we developed a safety information collection system known as "Easy-Reporter" using the cell phone. Since the precision of GPS has improved recently, Easy-Reporter is believed to be effective in determining emergency action in the very early stages after a disaster occurs (about 1 to 2 hours).

The system has already been used in real-life situations. It was used and evaluated by Japan Atomic Energy Agency and the Nuclear Emergency Assistance & Training Center in actual transportation as a means of recording the transport path of nuclear materials and as a means of providing a brief report in the case of a traffic accident. The system was also adopted as a component of the early disaster information collection system deployed by Tokyo Fire Department for its personnel and members of the fire brigade in 2010.

At present, Easy-Reporter can be installed only on specific models, namely au W55T, W62S, and W62K. In the future, we will strive to make it available also for smart phones.

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References

1 A. Shibayama and Y. Hisada, "An Efficient System for Acquiring Earthquake Damage Information in Damaged Area," Journal of Social Safety Science, Institute of Social Safety Science, No. 5, pp. 95–103, 2003. (in Japanese with English abstract)

2 S. Zama et al., "Development of Disaster Information Collection Terminal-As an Element of Information System for Support of Fire-fighting Activities," Proceedings of the Annual Conference of the Institute of Social Safety Science, Institute of Social Safety Science, No. 11, pp. 113–116, 2001. (in Japanese with English abstract)

3 H. Ide et al., "Experimental study on Collection of Disaster Information by using Mobile Phone with GPS," Proceedings of the Annual Conference of the Institute of Social Safety Science, Institute of Social Safety Science, No. 25, pp. 89–92, 2009. (in Japanese with English abstract)

4 K. Akimoto et al., "Development of the Seismic Damage Mapping System with GPS Cellular Phone," Journal of Social Safety Science, Institute of Social Safety Science, No. 4, pp. 159–165, 2002. (in Japanese with English abstract)

5 S. Zama et al., "Spatial Framework on Effective Gathering of Disaster Information," Proceedings of the Annual Conference of the Institute of Social Safety Science, Institute of Social Safety Science, No. 15, pp. 47–48, 2004. (in Japanese with English abstract)

6 S. Zama et al., "Experimental Study on Collection and Transmission of Earthquake Disaster Information," The 12th Japan Earthquake Engineering Symposium, pp. 1406–1409, 2006. (in Japanese with English abstract)

7 Y. Ozawa et al., "Experiment on Earthquake Damage Collection and Fire Extinction by Local Residents," The 12th Japan Earthquake Engineering Symposium, pp. 1398–1401, 2006. (in Japanese with English abstract)

8 B. Jeong et al., "Development of a Disaster Information Collection System using Cellular Phone," Journal of JAEE, Japan Association for Earthquake Engineering, Vol. 9, No. 2, pp. 102–112, 2009. (in Japanese with English abstract)

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