4-4 Research and Development for Victims Information Registration and Retrieval System (IAA System) and its Application to Natural Disasters

EBINA Tsuyoshi, MATSUMOTO Fumiko, and OHNO Hiroyuki

When a huge disaster happens, many telephone calls rush into the disaster area. We developed an internet-based disaster victim safety information registration and retrieval system (IAA system) and also had on-the-spot inspections.

We also developed a World Wide IAA system (WWIAA system) by re-arranging IAA system to the world. Moreover, the WWIAA system is tested for the natural disasters and showed the efficiency as the result.

Keywords
IAA system, Survival information, Emergency communication, Telecommunications for disaster relief

1 Introduction

The telephone is often used as a means of inquiring about the status of disaster victims in disasters such as earthquakes. However, this can easily lead to congestion over the lines. We have therefore developed a system that uses the Internet[1]. We refer to this system as a "disaster victim safety information registration and retrieval system", or by the acronym IAA , from the expression "I am alive".

Figure 1 presents a conceptual diagram of the IAA system. Disaster victims enter details on their status in the database on the Internet via web, fax, fixed telephone line, mobile phone, or various other available means. Similarly, others can use the Internet to search for information on possible victims.

While there are several IAA systems, including standard and portable IAA systems, our research and development efforts have centered on a large-scale IAA system capable of withstanding the enormous traffic anticipated in the event of a large-scale disaster.

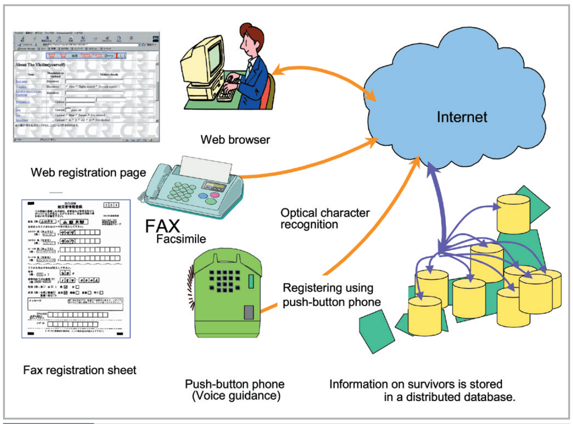

Fig.1 Conceptual Diagram of the IAA System

2 Research and development of a standard IAA system

The standard IAA system (Fig.2), comprised of a combination of rack-mounted PCs, was developed first as a mobile system capable of responding to up to several thousand safety inquiries, and was transported to shelters or other locations provided with relatively secure communications. Later, a portable IAA system (Fig. 3), comprised of notebook PCs originally designed for production lines, was developed for further weight reduction and enhanced durability[2].

Fig.2 Standard IAA System

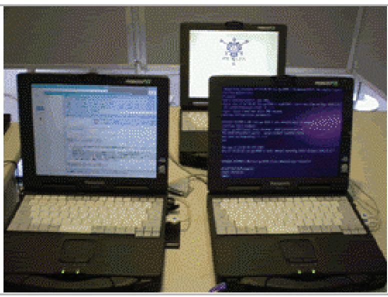

Fig.3 Portable IAA System

The standard and portable IAA systems are each made up of two PCs, featuring performance enabling even municipalities and corporations to establish their own safety-information systems (PCs with a Pentium III 700 MHz processor and 128 MB memory—the standard specification in 2000 when the systems were developed). As a result, PCs for normal use can be diverted for IAA system use in the event of a disaster.

Among the actual system performance tests conducted are an operating system (FreeBSD) security verification test, confirmation of time required from equipment assembly to system startup (approx. one day per set) and an operation test using multiple OSs. Other tests were also conducted, taking advantage of standard IAA system portability, including user interface tests through participation in a variety of disaster prevention drills and database distribution tests in cooperation with the WIDE project[3].

Further, startup expertise has been developed through experimental operations in real-life disasters, and reflected in later system developments.

3 Research and development of a large-scale IAA system

In the event of a near-field earthquake in the Tokyo metropolitan area, the number of victims unable to return home is expected to amount to roughly 3.71 million people[4]. Specifically, this refers to victims unable to return home by foot as a result of disruptions to public transportation services immediately after an earthquake.

It is not difficult to imagine the congestion when victims unable to return home try to call their families or acquaintances to reassure them or to find out whether they are safe. In the event of a large-scale disaster, a high load will presumably be imposed on any IAA system. We have therefore developed a new large-scale IAA system capable of withstanding enormous traffic[5]. Figure 4 presents a configuration diagram of the large-scale IAA system.

The large-scale IAA system is made up of two parts: the IAA database unit, managing the IAA system's safety information database and serving as the back end of the IAA system; and a group of application servers acting as web servers for users, serving as the front

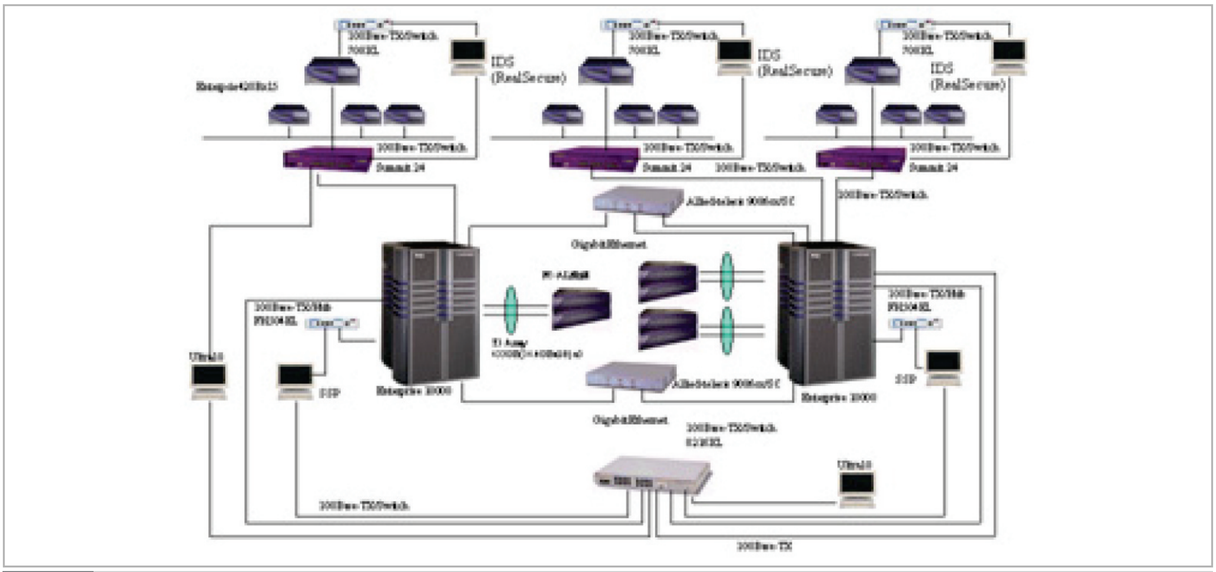

Fig.4 Configuration Diagram of the Large-Scale IAA System

end of the IAA system. Adopting this configuration allows the system not only to distribute database load but also to manage the database unit and the application server group separately, with distinct management policies.

A group of high-performance DB servers together form the IAA database. Equipped with DBMS, these servers together replicate the safety registration data. If a remote DB server stops functioning in the event of a disaster, the IAA database will continue to function using a different server.

On the other hand, the application server group is made up of several web servers, thus distributing user access load. This allows for an increase in the number of application servers in response to an increase in load.

The IAA system is both a safety inquiry system and a database of personal information. As a result, countermeasures are required against unauthorized access and other information leakage. The large-scale IAA system thus incorporates a variety of measures to prevent such leakage.

The first such measure is designed to prevent unauthorized access. The system not only eliminates unauthorized access requests via firewalls but also accepts alerts from intrusion detection systems (IDSs) in the event of attempted intrusion. Further, system vulnerabilities were investigated through advance security auditing of the system as a whole; through patching and other means, these vulnerabilities were eliminated.

The second measure is designed to prevent electromagnetic wave leakage. Information may leak through a PC monitor cable, the monitor itself, and in other ways (for more details on information leakage, refer to 3-13, “A Trial of the Interception of Display Image Using Emanation of Electromagnetic Wave”, in this journal). Therefore, the entire room accommodating the large-scale IAA system is provided with an electromagnetic shield that prevents the leakage of electromagnetic waves and the information these waves carry.

The third measure is designed to block the entry of outsiders into the system room. Countermeasures against unauthorized access and leakage of electromagnetic waves are useless if there is free access to the system room. In addition to ID card authentication, a fingerprint authentication scheme has been introduced to prevent intrusion.

4 Evolution of WWIAA system

As mentioned earlier, the IAA system distributes its databases to reduce possible damage to the system in the event of a disaster and

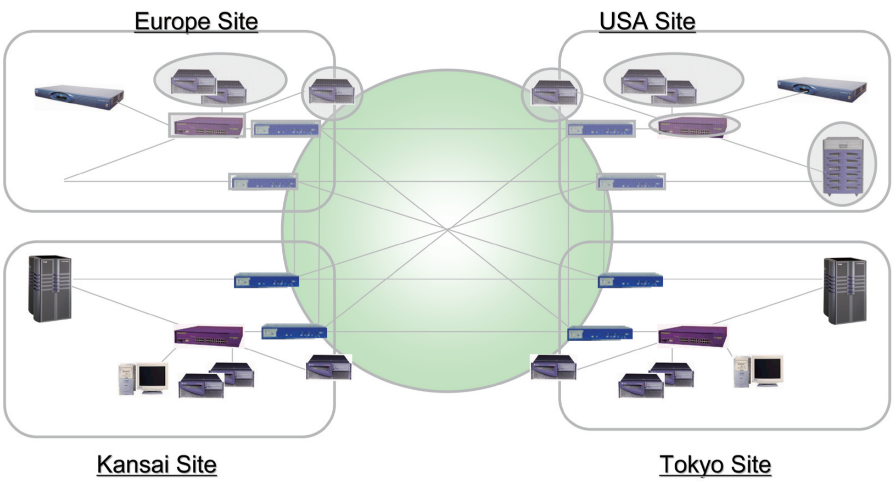

Fig.5 Configuration Diagram of the WWIAA System

to distribute the communication load. To reduce damage to the IAA system resulting from a wide-area disaster, it is important to maximize the physical distance between databases. Therefore, the large-scale IAA system has been reconfigured for distribution throughout the world, for a newly established World Wide IAA System (WWIAA System). Figure 5 presents a configuration diagram of the WWIAA system.

The WWIAA system is provided at four sites: Tokyo and Osaka in Japan, Louisville, Colorado, in the US; and Toulouse, in Haute-Garonne, France, with IAA system databases at three of these sites (Tokyo, Osaka, and Louisville). The system databases are synchronized using the replication mechanism within each. This setup offers a number of advantages. For example, a person in the US can search from the Louisville site for details on victims registered in Tokyo. Subject to a public experiment beginning in January 2005, the WWIAA system has demonstrated its registration and search capabilities.

5 Research and development of the IAA system user interface

Disasters do not choose a place or time to occur. Because of the range of communication means that may be available at the time of a disaster, various user interfaces are at the ready within the IAA system, using the web, fax, telephone, or mobile phones, for example.

A variety of user interfaces are also necessary in that victims may not be able to use one or another. For example, many of the elderly are presumably poor at manipulating the PC, whereas the hearing disabled cannot use telephones or mobile phones. Therefore, compatibility with various user interfaces also provides universal accessibility. A quantitative comparison and study of registration-related issues by users (divided into five groups: adults, the elderly, the visually disabled, the hearing disabled, and elementary school-age children) showed that the elderly, for example, encounter difficulties in registering safety information[6].

This section discusses the various user interfaces.

(1) Web

The web is the most fundamental means of access. However, problems with web accessibility were indicated based on webpage design. The webpage has thus been redesigned to ensure easy accessibility for the visually disabled and others.

(2) Interactive fax

With the widespread use of optical character recognition (OCR) technology, schemes have been developed for converting handwrit-

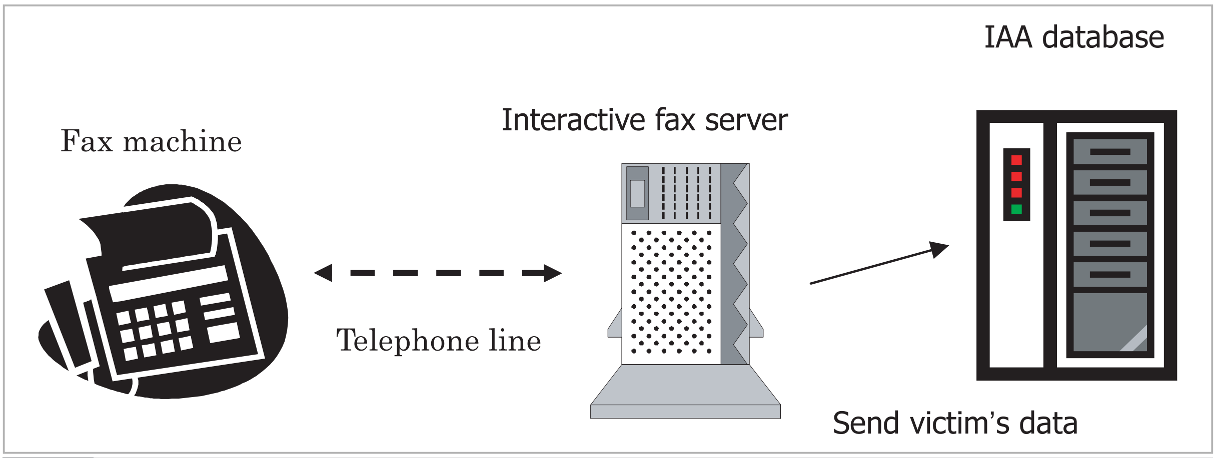

Fig.6 *Interactive Fax System*

ten characters into character codes and for the registration of such codes. However, OCR technology falls short of 100% recognition; recognition results thus require calibration.

Being a paper medium, fax is more familiar and easier to use for the elderly. On the other hand, as a unidirectional means of communication, it cannot confirm with certainty that the transmitted information has been received by the intended party. Therefore, a method has been developed for the interactive registration of safety information through the return of transmission results to the sender[7]. A disaster victim sends a registration form after entering his/her safety information. The fax server runs the transmitted information through an OCR program, generating and returning a modified form. The sender goes over the returned modified form, makes corrections if necessary, and resends it. The fax server recognizes the document via OCR and issues an initial confirmation document to the sender. If there is no further transmission from the sender during a given time interval, the fax server determines that there are no more corrections, and registers the safety information in the IAA server.

This procedure allows even those among the elderly unaccustomed to PC use and the hearing disabled to register safety information and to confirm the registration results.

(3) Mobile phone

Mobile phones are everywhere, with the latest handsets offering not only voice communication but also email, web access, and JAVA capabilities. We have thus created a webpage and application form for mobile phones. The mobile phone web page is a simplified version of the PC web page.

For the application form, a scheme has been developed for storing personal data in advance, such as the name, and adding and transmitting only disaster-dependent information in the event of disaster, such as the gravity of injury. This has made it possible for the user to enter and send the minimum required amount of information in time of disaster.

(4) PDA

In consideration of the communication environment in a disaster, sending multiple items of safety information at once is more effective than sending them separately. We have therefore developed a PDA-based registration method. This method consists of first transferring the registered safety information from one PDA to another, thus focus a great deal of information within a single PDA. That PDA is then removed from the disaster area and connected to the Internet or other network for registration. This allows for safety information to be registered even in the total absence of communications within the disaster area.

(5) Other registration methods

In addition to the aforementioned methods, other registration methods—using touch-dial telephone and amateur radio—have been developed. At the same time, study of a guideline for registration methods was undertaken[8]. A study was also conducted on the efficacy of voice recognition in the registration of safety information[9]. Further, privacy awareness in terms of personal information was compared between Japan and Korea to investigate how normal opinions on this matter might change in the event of a disaster[10].

6 Operational track record of the IAA system

The operational track record of the IAA system includes experimental operations during real-life disasters and operational experiments in disaster prevention drills sponsored by municipalities and other organizations. The following illustrates the operations of the IAA system in response to real-life disasters:

Table 1 Operational Track Record of the IAA System

Date operated	Incident triggering experimental operation
April 2000	Eruption of Mount Usu
June 2000	Miyake Island, Izu Islands
Sep 2001	Sep 11 terrorist attacks in US
Mar 2003	Iraq war-related
July 2003	Northern Miyagi Earthquake
Sep 2003	2003 Tokachi Offshore Earthquake
Oct 2004	Niigata-Chuetsu Earthquake
Dec 2004	Sumatra Offshore Earthquake
Mar 2005	Western-Fukuoka Offshore Earthquake
Mar 2005	Sumatra Offshore Earthquake

Demands of the IAA system were collected from the user's standpoint--for example, through experimental operations--and reflected in later developments. In the process, the IAA system has been confirmed as an emergency communication system that can readily be put to practical use.

To date we have launched the IAA system in response to a number of disasters, and will report below on the response to the Niigata-Chuetsu Earthquake and others using the WWIAA system as an example of recent experimental operations.

On Saturday, October 23, 2004, large-scale earthquakes took place with the epicenter located at the Chuetsu region in Niigata Prefecture (Niigata-Chuetsu Earthquake). The National Institute of Information and Communications Technology's Secure Networks Group and IAA Alliance coordinated efforts to launch the IAA system and to begin experimental operation of the safety inquiry service.

Figure 7 illustrates the cumulative numbers of registrations and searches. A clear jump is seen in the numbers of registrations and searches at the early stages of the disaster, followed by stabilization over time. The IAA system for the Niigata-Chuetsu Earthquake ended at 17:00 on Dec 28, 2004, with the final numbers of registrations and searches at 630 and 79,076, respectively.

Of special note in terms of the response to the Niigata-Chuetsu Earthquake is the successful coordinated response with the Niigata Prefectural Government. This response differed considerably from those seen in the past. Also noteworthy is the large number of people who registered with and searched the IAA system using links provided by local governments and NGO organizations, and the Niigata Prefectural Government, in order to trace individuals.

The response to the Sumatra Offshore Earthquake, on the other hand, differs in many ways from past disaster responses. Due to the lack of initial information, for example, the IAA system was not initially placed in operation. The system was started later, however, because the earthquake damage was found to be more severe than expected and requests began to come from various circles for launch of the IAA system. While still in operation as of the writing of this paper, the WWIAA system for the Sumatra Offshore Earthquake has recorded 266 registrations and 50,728 searches. The Sumatra Offshore Earthquake is different in many ways from past earthquakes in that the number of missing accounted for a high percentage of casualties.

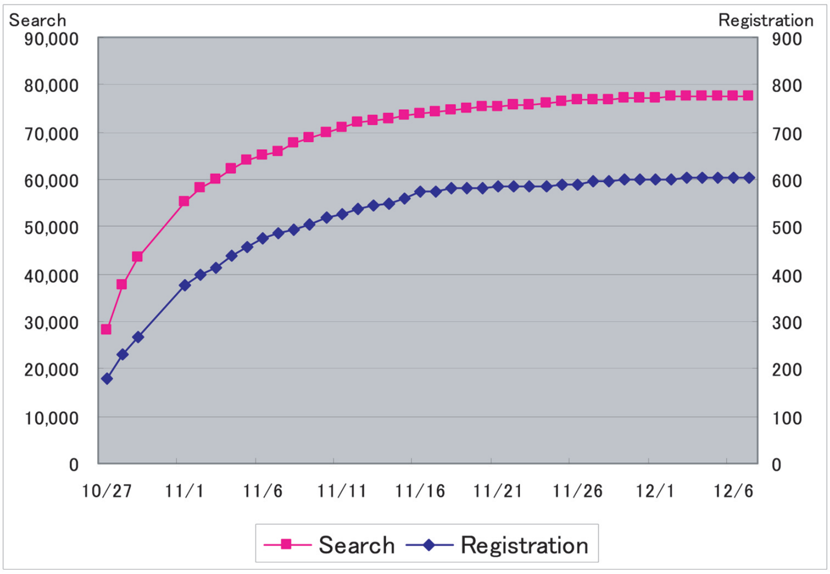

Fig.7 *Progress of Numbers of Registrations and Searches in the IAA System for the Niigata-Chuetsu Earthquake (Cumulative Numbers)*

In the case of the Western-Fukuoka Earthquake, at a seismic intensity of six-lower, a tremor comparable to the Niigata-Chuetsu Earthquake in terms of seismic intensity hit Fukuoka City, and the WWIAA system was launched in preparation for secondary tsunami damage. The system for the Western-Fukuoka Earthquake is still in experimental operation as of the writing of this paper. However, it has been discovered that very few are taking refuge at shelters and other places despite the significant seismic intensity. Although we have so far relied on a seismic intensity of five-upper as a guide for launching the WWIAA system, the seismic intensity does not necessarily correspond to the scale of damage. It has thus become apparent that the initial assessment of conditions is important when launching the WWIAA system in the future.

7 Commitment in IAA alliance

To present the research results of the IAA system to the outside world, the IAA Alliance, a collaborative organization of industry, academia, and government, was launched in August 2002, with the participation of various groups and individuals engaged in IAA system research and development[11]. The IAA Alliance is currently engaged in external deployment of the IAA system through the following activities[12]:

- Providing a setting for information exchange between participating members
- Verification experiments on the efficacy of the IAA system in times of large-scale disaster in concert with other related organizations
- An educational campaign to promote public understanding of the IAA system through verification experiments
- Verification experiments postulating user-side operation of the IAA system; feedback of results to further development
- Campaign for standardizing safety inquiry systems for disasters
- Tests to ensure that safety inquiry systems for disasters may be interconnected

In recent years, the IAA system's disaster responses have been conducted in cooperation with the IAA Alliance. These activities have helped gradually raise awareness of the IAA system, as witnessed, for example, in the establishment of a link from the Niigata Prefectural Government's homepage to the IAA Alliance; this awareness is expected to continue to grow.

8 Conclusions

This paper discussed the types, features, and user interfaces available with an IAA system designed to register and search victim safety information in the event of a disaster. The paper also discussed the experimental operations of the system in response to the recent Niigata-Chuetsu Earthquake, the Sumatra Offshore Earthquake, and the Western-Fukuoka Earthquake.

The research results of the IAA system are being transferred to the IAA Alliance. Going forward we will focus on an emergence response system and a future framework, as we also work to expand the IAA system into more municipalities through the IAA Alliance.

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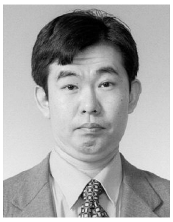

EBINA Tsuyoshi

Senior Researcher, Secure Networks Group, Information and Network Systems Departmen

User interface

***OHNO Hiroyuki**, Dr.Sci.*

Group Leader, Secure Networks Group, Information and Network Systems Department

Computer Network, Crisis Management

MATSUMOTO Fumiko

Researcher, Security Advancement Group, Information and Network Systems Department

User Interface, Security Log Analysis