Proposal of the Disaster Information Sharing System for the Disaster Countermeasures Headquarters

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Abstract
This paper proposes the Disaster Information Sharing System at the time of wide-scale disaster. This system assumes use in the disaster cautions headquarters and the disaster countermeasures headquarters which are established in each prefectural office and local municipalities. The Disaster Information Sharing System consists of the Web-GIS Disaster Management System, the IC Card Authorization Safety Confirmation System, and the Disaster Information Unified Management System. This paper explains these systems and shows the efficacy. At the time of wide-scale disaster, the disaster countermeasures headquarters can grasp damage information by using the Disaster Information Sharing System. And, the disaster countermeasures headquarters can grasp the refugees information in each evacuation center. Furthermore, the disaster countermeasures headquarters can consolidate damage information and refugees information on the Tiled Display Wall System.

Keywords: Tiled Display Wall System, Disaster Countermeasures Headquarters, Evacuation Center, Web-GIS, Safety Confirmation System

1 Introduction

We are working research and development of the Disaster Information Sharing System for the disaster countermeasures headquarters of local municipalities at the time of wide-scale disaster in response to the Great East Japan Earthquake. The disaster countermeasures headquarters is an organization established in the national or local municipalities, when a disaster occurs. This disaster countermeasures headquarters spent much time on grasp of damage situations and disaster victims in case of the Great East Japan Earthquake. Furthermore, the all involved of the disaster countermeasures headquarters were not always able to share information. The cause is because the barrage of information in the disaster countermeasures headquarters is managed by the analog tools. For example, at the time of wide-scale disaster, the disaster countermeasures headquarters dispatches the municipal employees to the disaster sites in order to grasp damage situations. The dispatched municipal employees confirm damage situations and photo it with a digital camera. Then, the dispatched municipal employees report damage pictures to the disaster countermeasures headquarters. The disaster countermeasures headquarters projects on a screen the
damage pictures data which the dispatched municipal employees reported. Therefore, at the time of wide-scale disaster, the disaster countermeasures headquarters wastes many time and staffs to grasp of damage situations. This produces the problem which the disaster countermeasures headquarters cannot cope with promptly to damage situations. In fact, the disaster countermeasures headquarters needs the tool which can grasp damage situations promptly at the tie of wide-scale disaster.

Moreover, in preparation for wide-scale disaster, many services for confirming the safety of families or acquaintances are provided. Since various safety confirmation services were provided, the safety confirm of families or acquaintances was very difficult in case of the Great East Japan Earthquake. On the other hand, residents take refuge in the evacuation center specified by a local municipality, in order to escape disaster. However, it was difficult for the disaster countermeasures headquarters to grasp the situation and the number of refugees of each evacuation center in utter turmoil. Accordingly, the relief supplies supply shortage problem arose. In fact, the disaster countermeasures headquarters needs the tool which can grasp the exact information on each evacuation centers in real time.

Furthermore, at the time of wide-scale disaster, barrage of information comes into the disaster countermeasures headquarters. Since this barrage of information is organized by a blackboard and vellum papers, the disaster countermeasures headquarters spends much time on scrutinization of information. Moreover, there is risk of the information impactedness for the disaster countermeasures headquarters. Therefore, the disaster countermeasures headquarters was confused owing to the barrage of incoming information in case of the Great East Japan Earthquake. In fact, the disaster countermeasures office needs the tool which can consolidate the barrage of incoming information.

In order to solve these problems, this paper proposes the Web-GIS Disaster Management System, the IC Card Authorization Safety Confirmation System, and the Disaster Information Unified Management System. The Web-GIS Disaster Management System is a tool with which the disaster countermeasures headquarters can grasp damage situations promptly at the time of wide-scale disaster. This system can report the damage situation of disaster sites to the disaster countermeasures headquarters in real time over a network by using the smartphone application which we developed. Since a damage location and a damage picture are automatically mapped on Web-GIS, the disaster countermeasures headquarters can confirm damage situations quickly.

The IC Card Authorization Safety Confirmation System is a tool with which the disaster countermeasures headquarters can grasp the exact information on each evacuation centers in real time. By this system, the refugees can register own safety information easily by using the IC card. Thereby, the number of refugees of each evacuation center can be gathered in real time. Since the number of refugees of each evacuation center can be grasped in real time, the disaster countermeasures headquarters can ration the quantity of suitable relief supplies. Moreover, disaster victims’ safety information can be offered at a world by cooperates the refugees information gathering in the disaster countermeasures headquarters with a municipal Web server.

The Disaster Information Unified Management System is a tool with which the disaster countermeasures headquarters can consolidate the barrage of incoming information. This system can consolidate various information (including damage information or evacuation center information) by using the Tiled Display Wall System. Since the disaster countermeasures headquarters can consolidate various information rapidly, the all involved of the disaster countermeasures headquarters can share every type of information.

In the followings, the Great East Japan Earthquake and the purpose of this research are explained in section 2 respectively. System configuration and architecture of our proposed the Disaster Information Sharing System are explained in section 3. The Web-GIS Disaster Management System, the IC Card Authorization Safety Confirmation System, and the Disaster Information Unified Management System which constitute Disaster Information Sharing System, and effectiveness evaluation of the Disaster Information Sharing System are described in section 4. Finally, the conclusion and future work are
2 The Large-scale Natural Disaster and Purpose of This Research

In this chapter, we explain the Great East Japan Earthquake and the disaster countermeasures headquarters. Furthermore, we explain the purpose of this research for the disaster countermeasures headquarters to share various disaster information at the time of wide-scale natural disaster.

2.1 The Great East Japan Earthquake

The 9.0 magnitude earthquake centered in Sanrikuoki happened on March 11, 2011. Iwate Prefecture, Miyagi Prefecture, Fukushima Prefecture, Ibaraki Prefecture, and Tochigi Prefecture measured upper 6 on the Japanese intensity scale by this earthquake. Then, huge tsunami was measured in the Pacific coast. Especially, the Pacific coast of the Tohoku region and the Kanto region suffered destructive damage. Furthermore, there was another problem such as ground liquefaction, land subsidence and dam break [14]. Especially in Iwate Prefecture, more than 5,800 people were left dead or missing, and more than 18,300 houses were completely destroyed [9]. Figure 1 shows the picture of the tsunami damage in the Iwate coast. In Kamaishi city, Iwate Prefecture, the disaster countermeasures headquarters spent much time grasp of damage situation of each place owing to the limitation of communication method by power outage, and road closing by tsunami in case of the Great East Japan Earthquake. The municipal employees confirmed the damage scale and the situation of the evacuation center on foot in the aftermath of an earthquake. At this time, the communication method which can be used only radio communication network, fire radio network, and transceivers [5]. And, in Miyako city, Iwate Prefecture, the disaster countermeasures headquarters spent much time grasp of the damage situation of each place owing to many municipal employees were engaged in evacuation center management in case of the Great East Japan Earthquake. Since a telephone network was not able to be used by congestion and prolonged major power outage, the disaster countermeasures headquarters was difficult for grasp of damage situations. Therefore, the disaster countermeasures headquarters of Miyako city spent huge time on grasp of damage situations [6].

Figure 1: Tsunami Damage of the Iwate Coast
Furthermore, also in Takizawa city of the land in Iwate prefecture, the disaster countermeasures headquarters was difficult for grasp of damage situations owing to many house damage, water outage, and prolonged power outage [8]. The author was engaged in the disaster countermeasures headquarters of Takizawa city, and strove for grasp of damage situations. However, since barrage of information concentrated on the disaster countermeasures headquarters, we spent much time on scrutinization of information. Moreover, as in the case of Kamaishi city and Miyako city, while the communication method was limited, the municipal employees and the fire corps volunteers confirmed the damage spot one by one and reported the damage situation to the disaster countermeasures headquarters directly. Therefore, the disaster countermeasures headquarters spent much time on grasp of the damage situation.

2.2 Response of Local Government to the Great East Japan Earthquake

When a wide-scale disaster occurs, the disaster cautions headquarters and the disaster countermeasures headquarters are established in each prefectural office and local municipalities. Figure 2 shows the disaster countermeasures headquarters actually established in Takizawa city when the Great East Japan Earthquake occurs. The disaster cautions headquarters and the disaster countermeasures headquarters are the decision-making body when a disaster occurs, and it has the following special role as the decision-making body [7].

Figure 2: The disaster countermeasures headquarters of the Great East Japan Earthquake

(A) Information exchange and adjustment with the prefectural office and neighboring local municipalities.

(B) Collection, arrangement, and concentration of the information from the relevant organs, residents, and the municipal employees.

(C) Investigation of house damage or road damage.

(D) Record and organize of disaster responses in the disaster countermeasures headquarters.

(E) Liaison and coordination with a press and public relations activities by a press conference.

(F) Information provision of the lifeline information and damage information to residents.
(G) Request the dispatch of the disaster detached unit of the Japan Self-Defense Forces.

(H) Ensure communications means of a telephone network or a municipal disaster management radio communication network.

(I) Set up and administrative operation of the evacuation centers. And, distribute relief supplies to the evacuation centers.

(J) Evacuate support of vulnerable people.

(K) Request the cooperation of the medical institutions.

However, there are also the following problems in management of the disaster countermeasures headquarters established at the time of disaster. Therefore, it is necessary to grasp damage situations and evacuation center information quickly, and to take the appropriate responses.

(1) The disaster countermeasures headquarters confirms disaster location information with the paper-based map. Therefore, it is difficult for the all involved of the disaster countermeasures headquarters to share disaster location information.

(2) The disaster countermeasures headquarters organizes the collected disaster information and refugees information in a blackboard and vellum papers. Therefore, it is difficult to organize various information.

(3) The disaster countermeasures headquarters grasps damage situations visually with the pictures which the municipal employees took in the disaster site. Therefore, the disaster countermeasures headquarters spends much time on grasp of damage situations, and cannot respond promptly.

2.3 Purpose of This Research

We propose the "Disaster Information Sharing System", in order to solve the problem of the disaster countermeasures headquarters at the time of wide-scale disaster. The Disaster Information Sharing System consists of the Web-GIS Disaster Management System, the IC Card Authorization Safety Confirmation System, and the Disaster Information Unified Management System.

The Web-GIS Disaster Management System can map a damage picture automatically on Web-GIS from a smartphone. We developed the android application for posting a damage picture from a smartphone. The users can post a picture to the Web-GIS server directly from a disaster site using this android application. When posting a picture, geotagging information is automatically given to a picture. If a picture with geotagging information is transmitted to the server, the server stores the picture in the database. Then, a picture is automatically mapped on Web-GIS. At the time of wide-scale disaster, the disaster countermeasures headquarters can confirm the damage situations of collapsed houses or road damage on Web-GIS by use of this system. Moreover, a prompt response is attained because the disaster countermeasures headquarters grasp damage situations in real time.

At the time of wide-scale disaster, the IC Card Authorization Safety Confirmation System summarizes the refugees information on evacuation centers quickly, and the disaster countermeasures headquarters and general population can utilize this information. We assume use of the integrated circuit-embedded individual number card issued by the social security and tax number system. We construct the system which registers refugees information into the database by using the IC card. Furthermore, we construct the prototype system which refugees’ safety can confirm by publicizing evacuation center information and refugees information from each local government. At the time of wide-scale disaster,
confusion of the disaster countermeasures headquarters can be minimized by organizing refugees information quickly by use of this system. Moreover, since refugees information can be grasped in real time, the disaster countermeasures headquarters can ration suitable relief supplies to each evacuation center.

At the time of wide-scale disaster, the Disaster Information Unified Management System consolidates the Web-GIS Disaster Management System, the IC Card Authorization Safety Confirmation System, and other disaster information in the disaster countermeasures headquarters. In this system, various information is visually organized using the Tiled Display Wall System. The all involved of the disaster countermeasures headquarters can share disaster information by using this system which utilized this Tiled Display Wall system. Moreover, the disaster countermeasures headquarters can grasp damage situations and refugees information exactly based on the disaster information displayed on the Tiled Display Wall system. This is lead to the prompt response to various disaster problems.

We think that the Disaster Information Sharing System which consists of the Web-GIS Disaster Management System, the IC Card Authorization Safety Confirmation System, and the Disaster Information Unified Management System brings many beneficial effects at the time of wide-scale disaster.

3 System Configuration and System Architecture

The system configuration of this research is shown in Figure 3. This research consists of the Disaster Countermeasures Headquarters Agent, the Evacuation Center Agent, the Post Disaster Image Agent, the Tiled Display Agent, the Web-GIS Application Server, and the DB Server.

(A) The Disaster Countermeasures Headquarters Agent
The Disaster Countermeasures Headquarters Agent browses and edits refugees information registered into the Disaster Information Storage DB Server. And, this agent browses and edits damage pictures on Web-GIS.

(B) The Evacuation Center Agent
At the time of wide-scale disaster, the Evacuation Center Agent registers a refugee’s safety information into the Disaster Information Storage DB Server using the IC card.

(C) The Post Disaster Image Agent
At the time of wide-scale disaster, the Post Disaster Image Agent posts the damage pictures of collapsed houses or road damages to the Web-GIS Application Server.

(D) The Web-GIS Application Server
The Web-GIS Application Server receives the damage pictures data posted from the Post Disaster Image Agent, and stores it in the Image Information Storage DB Server.

(E) The Tiled Display Agent
The Tiled Display Agent consolidates information on the Disaster Countermeasures Headquarters Agent, the Evacuation Center Agent, and the Post Disaster Image Agent. Moreover, it is possible to arrange various contents freely on the Tiled Display.

(F) The DB Server
The DB Server consists of the Image Information Storage DB Server which stores the damage pictures posted from the Post Disaster Image Agent, the Refugees Personal Information DB Server which stores the residents’ personal information, and the Disaster Information Storage DB Server which stores the refugees information registered from the Evacuation Center Agent.

The system architecture of this research is shown in Figure 4.

The Post Disaster Image Agent consists of App Read Manager, Camera Control Manager, EXIF Read Manager, and Mapping Control Processing Manager.

(A) App Read Manager
Camera application is started according to action from a user.

(B) Camera Control Manager
The picture path of the picture photoed with camera application is returned.
The Disaster Information Sharing System for the DCH Ishida, Takahagi, Uchida, and Shibata

(C) EXIF Read Manager
The location information written in the Exif file of the picture path is read.

(D) Mapping Control Processing Manager
If necessary, the location information read by EXIF Read Manager is modified.

The Evacuation Center Agent consists of IC Card Scan Manager, Database Search Manager, Safety Information Register Manager, and Database Register Manager.

(A) IC Card Scan Manager
A personal identification number is read in the IC card.

(B) Database Search Manager
The information which consists with a personal identification number is retrieved from the Disaster Information Storage DB Server.

(C) Safety Information Register Manager
It optimizes in order to register refugees information into the Disaster Information Storage DB Server.

(D) Database Register Manager
The refugees information is registered into the Disaster Information Storage DB Server.

The Tiled Display Agent consists of Information Free Layout Presentation Manager and High-Definition Contents Presentation Manager, Text Information Presentation Manager, Web-GIS Presentation Manager, and Evacuation Center Information Manager.

(A) Information Free Layout Presentation Manager
The information displayed on the Tiled Display is arranged freely.

(B) High-Definition Contents Presentation Manager
The high-definition contents relevant to disaster management are displayed on the Tiled Display.

(C) Text Information Presentation Manager
The text information relevant to disaster management is displayed on the Tiled Display.

(D) Web-GIS Presentation Manager
Web-GIS is displayed on the Tiled Display.

(E) Evacuation Center Information Manager
The refugees information on each evacuation center is displayed on the Tiled Display.

The Disaster Countermeasures Headquarters Agent consists of Image View Manager, Mapping Control Processing Manager, Image Information File Read Manager, and Image Information Edit Manager, Refugees Information Manager, Refugees Information Edit Manager, and All Refugees Information Gathering Manager.

(A) Image View Manager
The damage picture which the disaster countermeasures headquarters selected on Web-GIS is enlarged.

(B) Mapping Control Processing Manager
The picture information stored in array is displayed as a marker on Web-GIS.
(C) Image Information File Read Manager
   The JSON file is acquired from the Web-GIS Application Server, and it stores in array.

(D) Image Information Edit Manager
   The picture information stored in the Image Information Storage DB Server is edited.

(E) Refugees Information Manager
   The disaster countermeasures headquarters displays arbitrary refugees information.

(F) Refugees Information Edit Manager
   The refugees information stored in the Disaster Information Storage DB Server is edited.

(G) All Refugees Information Gathering Manager
   All refugees information stored in the Disaster Information Storage DB Server is displayed.

The Web-GIS Application Server consists of Image Information File Create Manager, Exif Read Manager, Image Save Manager, and Database Edit Manager.

(A) Image Information File Create Manager
   The data in the database is written in the JSON file.

(B) Exif Read Manager
   The location information on the damage picture posted from the Post Disaster Image Agent is acquired.

(C) Image Save Manager
   The damage picture posted from the Post Disaster Image Agent is saved at a post picture folder.

(D) Database Edit Manager
   The damage pictures from the Post Disaster Image Agent are edited.

The DB Server consists of the Image Information Storage DB Server, the Refugees Personal Information DB Server, and the Disaster Information Storage DB Server.

(A) The Image Information Storage DB Server
   The damage pictures information from the Post Disaster Image Agent is stored.

(B) The Refugees Personal Information DB Server
   Residents’ personal information is stored and it is used at the time of disaster.

(C) The Disaster Information Storage DB Server
   The refugees information from the Evacuation Center Agent is stored.

4 The Disaster Information Sharing System

In this section, we describes configuration of the Web-GIS Disaster Management System, the IC Card Authorization Safety Confirmation System, and the Disaster Information Unified Management System.
4.1 The Web-GIS Disaster Management System

At the time of wide-scale disaster, the disaster countermeasures headquarters use a disaster countermeasure map in order to confirm the location of collapsed houses and road damage. Figure 5 is a disaster countermeasure map actually used in the disaster countermeasures headquarters of Takizawa city. This disaster countermeasure map is a paper-based map. Therefore, at the time of wide-scale disaster, it is difficult for all involved of the disaster countermeasures headquarters to share disaster information using this disaster countermeasure map. In this way, many local governments are confirming the location of disaster sites by the analog method. Therefore, the mechanism in which the all involved of the disaster countermeasures headquarters can share disaster location information is required. Furthermore, there is also a problem of spending much time on grasp of damage situations. At the time of wide-scale disaster, in order to grasp damage situations, the disaster countermeasures headquarters dispatch the municipal employees and the volunteer fire companies to the disaster sites. In this case, the municipal employees and fire corps volunteers are photographed with the digital camera of damage situations, and are reported to the disaster countermeasures headquarters. Then, the disaster countermeasures headquarters confirms damage situations from the damage pictures projected on the screen. However, by this method, the disaster countermeasures headquarters spends much time on grasp of damage situations. When a large-scale disaster occurs, the disaster countermeasures headquarters needs to grasp damage situations visually promptly. Therefore, in order for the disaster countermeasures headquarters to correspond promptly to emergency situation, the mechanism in which damage situations can be grasped immediately is required [10, 17].

This system used Google Maps [3] for main contents. Moreover, PHP (Hypertext Preprocessor) [2] was used in order to build a dynamic Web page. Furthermore, MySQL [1] was used for the database. This system communicates with the server asynchronously using Ajax technology. The information of id identifier, thumbnail identifier, latitude, longitude, picture pass, and picture direction is stored in the Image Information Storage DB Server. The table structure of the Image Information Storage DB Server is shown in Table 1.

In this research, we constructed the Web-GIS Disaster Management System in order to solve these problems. In this system, we also developed the dedicated android application which can post damage pictures directly from disaster sites. Users take damage pictures with this android application, and transmit picture data to the Web-GIS Application Server. The Web-GIS Application Server stores the received data in the database. Then, damage pictures are automatically reflected in the Web-GIS site as shown in Figure 6. The posted pictures are displayed by the time series on the Web-GIS site. Moreover, since
Table 1: The Database Table of the Image Information Storage DB Server

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>column logical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>int</td>
<td>id identifier</td>
</tr>
<tr>
<td>thumb</td>
<td>int</td>
<td>thumbnail identifier</td>
</tr>
<tr>
<td>date</td>
<td>datetime</td>
<td>post date</td>
</tr>
<tr>
<td>lat</td>
<td>float</td>
<td>latitude</td>
</tr>
<tr>
<td>lng</td>
<td>float</td>
<td>longitude</td>
</tr>
<tr>
<td>pass</td>
<td>varchar</td>
<td>picture pass</td>
</tr>
<tr>
<td>orientation</td>
<td>int</td>
<td>picture direction</td>
</tr>
</tbody>
</table>

Geotagging information is reflected as a marker on a map, the disaster countermeasures headquarters can grasp visually the exact position information on disaster sites. If the picture displayed on the thumbnail item of the Web-GIS site is selected, the selected picture will be magnified. Moreover, if it clicks the marker on a map, the picture taken at the point will be magnified. At the time of wide-scale disaster, by this system, the municipal employees of disaster sites can report damage pictures to the disaster countermeasures headquarters over the network from the dedicated android application. This saves the time and effort from which the municipal employees return to the disaster countermeasures headquarters. Therefore, this system reduces sharply time to report damage situations to the disaster countermeasures headquarters. On the other hand, since the damage pictures which the municipal employees posted is reflected in real time on Web-GIS, the disaster countermeasures headquarters can grasp damage situations instantly. Thereby, the disaster countermeasures headquarters can respond promptly to emergency situation. Furthermore, by cooperation of this Web-GIS Disaster Management System and the Disaster Information Unified Management System described in subsection 4.3, it enables the all involved of the disaster countermeasures headquarters to share damage situations and its location information.

4.2 The IC Card Authorization Safety Confirmation System

Many refugees were produced in Iwate Prefecture, Miyagi Prefecture, and Fukushima Prefecture by the earthquake damage, tsunami damage and a nuclear accident in the Great East Japan Earthquake. At this time and many people accessed various safety confirmation services, in order to confirm the safety of families, relatives, and acquaintances. Currently, safety confirmation service is provided from cell-phone carriers or various companies. However, these safety confirmation systems must register safety information for every individual. Therefore, safety information cannot be registered if the disaster victims do not have a terminal which registers information. Moreover, at the time of wide-scale disaster, disaster victims take refuge in the evacuation center which the local government specified beforehand. Figure 7 shows the situation of the evacuation center installed in Takizawa city in case of the Great East Japan Earthquake.

At the time of the Great East Japan Earthquake, since it was the environment which cannot use a mobile phone, many evacuation centers puted refugees information up on vellum papers in the entrance of the evacuation centers. Therefore, people who want to confirm a family’s safety had to visit many evacuation centers directly. Furthermore, the big difference arose in evacuation center management among the evacuation centers. Since the disaster countermeasures headquarters spent much time on information gathering, the evacuation center of food shortage and the evacuation center which cannot secure the necessaries of elderly people and young children occurred [13].

Therefore, in this research, we construct the IC Card Authorization Safety Confirmation System by
Figure 6: The Web-GIS Disaster Management System Prototype

Figure 7: The Evacuation Center in the Great East Japan Earthquake
which the disaster countermeasures headquarters and general population can utilize the refugees information adjusted quickly. This system assumes use of the integrated circuit-embedded individual number card issued by the social security and tax number system. The social security and tax number system is a system of managing the individual number managed separately in two or more public institutions by one My Number. Thereby, the efficiency and transparency of social security and tax number system are improved, and it inquires as social infrastructure for realizing fair and equitable society [19]. Moreover, the whole nation will own "My Number" by this social security and tax number system. The Japanese government is planning the distribution of an individual number card which registered this My Number, the name, the address, the birth date, and the individual photograph into IC chip [18].

The prototype of the IC Card Authorization Safety Confirmation System is shown in Figure 8. This system is registering refugees information into the database from the IC card, and the disaster countermeasures headquarters can grasp the exact refugees information on each evacuation centers. Moreover, families and relatives can browse refugees information by publicizing refugees information from the local governments’ Web server.

In this system, PHP was used in order to build a dynamic Web page, PHP was used, and MySQL was used for database. This system uses the Refugees Personal Information DB Server and the Disaster Information Storage DB Server. The information of id identifier, name, furigana, sex, birth date, address, and my number is stored in the Refugees Personal Information DB Server. The table structure of the Refugees Personal Information DB Server is shown in Table 2. And, the information of id identifier, name, furigana, sex, age, municipal name, address, evacuation center’s name, admission or exit date, and extra information is stored in the Disaster Information Storage DB Server. The table structure of the Disaster Information Storage DB Server is shown in Table 3.

It assumes establishing this system permanently from time of peace in all the evacuation centers.
Table 2: The Database Table of the Refugees Personal Information DB Server

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>column logical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>int</td>
<td>id identifier</td>
</tr>
<tr>
<td>name</td>
<td>varchar</td>
<td>name</td>
</tr>
<tr>
<td>furigana</td>
<td>varchar</td>
<td>furigana</td>
</tr>
<tr>
<td>sex</td>
<td>varchar</td>
<td>sex</td>
</tr>
<tr>
<td>birth</td>
<td>varchar</td>
<td>birth date</td>
</tr>
<tr>
<td>address</td>
<td>varchar</td>
<td>address</td>
</tr>
<tr>
<td>num</td>
<td>varchar</td>
<td>my number</td>
</tr>
</tbody>
</table>

Table 3: The Database Table of the Disaster Information Storage DB Server

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>column logical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>s-id</td>
<td>int</td>
<td>id identifier</td>
</tr>
<tr>
<td>s-nama</td>
<td>int</td>
<td>name</td>
</tr>
<tr>
<td>s-furigana</td>
<td>datetime</td>
<td>furigana</td>
</tr>
<tr>
<td>s-sex</td>
<td>float</td>
<td>sex</td>
</tr>
<tr>
<td>s-age</td>
<td>float</td>
<td>age</td>
</tr>
<tr>
<td>s-municipal</td>
<td>varchar</td>
<td>municipal name</td>
</tr>
<tr>
<td>s-address</td>
<td>int</td>
<td>address information</td>
</tr>
<tr>
<td>s-evacuation</td>
<td>varchar</td>
<td>evacuation center’s name</td>
</tr>
<tr>
<td>s-inout</td>
<td>int</td>
<td>admission or exit date</td>
</tr>
<tr>
<td>s-extra</td>
<td>int</td>
<td>extra information</td>
</tr>
</tbody>
</table>

Figure 9 shows the flow to which the refugees registers own safety information into from this system, and the safety information is publicized.

1. My Number is read in the IC card.
2. My Number read in the IC card and My Number registered into the Refugees Personal Information DB Server are matched.
3. If My Number of the IC card and the Refugees Personal Information DB Server agrees, a registrant’s name, age, sex, and address will be automatically reflected in a user interface from the database.
4. Refugees information is registered into the Disaster Information Storage DB Server by selecting the ”Admission” button of Figure 8.
5. The information registered into the Disaster Information Storage DB Server is summarized by the system of the disaster countermeasures headquarters. Moreover, it is also possible by cooperating with the local governments’ Web server to publicize the refugees information for every evacuation centers to the world.
4.3 The Disaster Information Unified Management System

At the time of wide-scale disaster, following barrage of information comes into the disaster countermeasures headquarters. Therefore, the disaster countermeasures headquarters has to summarize this disaster relevant information in the disaster confusion.

(A) Evacuation Center Information, Refugees List, Ration Information

(B) Lifeline Information, Collapsed Houses Information, Road Damage Information, Human Suffering Information

(C) Medical Institution Information, Volunteer Information

(D) Press Information

The disaster countermeasures headquarters summarize the above various information in a blackboard and vellum papers as shown in Figure 10. At the time of the crisis, the disaster countermeasures headquarters have to manage all information correctly. However, the disaster countermeasures headquarters have big problems in the method of summarizing information. It is difficult to organize disaster information in order to write down barrage of information in a blackboard and vellum papers. Moreover, the disaster countermeasures headquarters has the risk of miss important information.

Some management techniques of the disaster situations are proposed [4]. On the other hand, we propose operation of the Tiled Display Wall System in the disaster countermeasures headquarters. The Tiled Display Wall System is the technology of arranging two or more liquid crystal displays and plasma displays in a reticular pattern, and building one large-sized high resolution display. It is possible to build an efficient wide screen system on this high resolution display environment. The Tiled Display Wall System is shown in Figure 11. The Tiled Display Wall System has the following functions [15, 11, 16].

(A) Display of movie file (MPEG/WMV/AVI form) and still picture file (JPEG/BMP/PNG/GIF form).

(B) Allocation of monitor layout and contents layout with console software.

(C) A free monitor layout is possible, and it is possible to synchronous display according to bezel width and the monitor interval.

The Tiled Display Wall System architecture is shown in Figure 12. The Tiled Display Wall System architecture consists of the Application Host, the Tile Manager, and the Rendering Cluster. In the Application Host, the Pixel Capture module acquires pixel data from the frame buffer, and stores it in a buffer.
Then, the Data Sender transmits the data in a buffer to Rendering Cluster as a pixel stream. Moreover, the Tile Controller generates the message which realizes synchronous processing, and transmits to the Tile Manager through the Data Sender module. The Tile Manager holds the size of each tile, session information, and the picture size information of a client as internal data. This Manager is accessed to these information based on the message received from the Application Host, and performs drawing processing control to the Tiled Display Wall. Moreover, this manager exchanges a synchronous message between the Rendering Cluster, and performs frame synchronization processing between each tile. The Rendering Cluster stores data in a buffer, after receiving the pixel stream transmitted from the Application Host. Then, pixel data are acquired from a buffer based on the message for synchronous processing, and drawing processing is performed to the Tiled Display Wall. By utilizing the Tiled Display Wall System, it becomes possible to arrange various information visually. Furthermore, the all involved of the disaster countermeasures headquarters can share many information by cooperating the Web-GIS Disaster Management System and the IC Card Authorization Safety Confirmation System to this Tiled Display Wall System. We propose this Disaster Information Unified Management System the local governments’ disaster countermeasures headquarters, and are having var-
ious discussions. Exact assessment of the situation and information sharing are led to the right judgment of the disaster countermeasures headquarters. Therefore, it is considered that practical use of the Tiled Display Wall System in the disaster countermeasures headquarters is very useful. At the time of wide-scale disaster, the disaster countermeasures headquarters judges damage situations and refuge situations exactly from various information, and can respond promptly to various problems by operates the Disaster Information Unified Management System using the Tiled Display Wall System. The example of practical use of the Disaster Information Unified Management System in the disaster countermeasures headquarters is shown in Figure 13.

4.4 Evaluation of the Disaster Information Sharing System

In order to evaluate the effectiveness of this research, the questionnaire survey was carried out to 25 municipal employees. The municipal employees actually experienced the Web-GIS Disaster Management System and the IC Card Authorization Safety Confirmation System, and evaluated the effectiveness at the time of the disaster of each system. Actual questionnaire survey is shown in Figure 14.

The questionnaire survey was directed at the municipal employees of Hitachi city and Hitachiyota city, Ibaraki Prefecture. The evaluation result of the Web-GIS Disaster Management System is shown
in Figure 15. About the effectiveness at the time of the disaster of the Web-GIS Disaster Management System, about 90 percent of the subject answered “Useful” or “Somewhat useful”. About the reason answered that the Web-GIS Disaster Management System is effective, the subject answered “This system can grasp damage situations by easy operation” or “This system can share damage situations quickly”. Therefore, we were able to confirm the great effectiveness of the Web-GIS Disaster Management System at the time of a disaster by this questionnaire survey.

Next, the evaluation result of the IC Card Authorization Safety Confirmation System is shown in Figure 16. About the effectiveness at the time of the disaster of the IC Card Authorization Safety Confirmation System, about 80 percent of the subject answered “Useful” or “Somewhat useful”. About the reason answered that the IC Card Authorization Safety Confirmation System is effective, the subject answered “Residents’ safety information which we gathered was paper-based information in case of the Great East Japan Earthquake. However, paper-based information was cumbersome and very inconvenient. Therefore, this system is very effective since a refugee’s safety information can be summarized easily”. Therefore, we were able to confirm the great effectiveness of the IC Card Authorization Safety Confirmation System at the time of a disaster by this questionnaire survey.
5 Conclusion and Future Work

In this paper, we introduced the Disaster Information Sharing System for the disaster countermeasures headquarters. The Disaster Information Sharing System consists of the Web-GIS Disaster Management System, the IC Card Authorization Safety Confirmation System, and the Disaster Information Unified Management System. We realized the function which can map damage pictures in real time on Web-GIS of the disaster countermeasures headquarters from disaster sites by the Web-GIS Disaster Management System. Moreover, we realized the safety registration function using the IC card which can gather the numbers of refugees of evacuation centers in real time by the IC Card Authorization Safety Confirmation System. Furthermore, we realized the function in which can consolidate various information in the disaster countermeasures headquarters by the Disaster Information Unified Management System. The Disaster Information Sharing System developed by us was able to confirm the great effectiveness by the questionnaire survey to the municipal employees.

We are discussing with two or more local governments now toward the practical use of our system in the disaster countermeasures headquarters at the time of wide-scale disaster. Sometime in the future, we expect that the appropriate information transmission, search and rescue activities, and evacuation center management will be realized by putting to practical use the Disaster Information Sharing System which can grasp the damage situation of disaster sites, and the situation of evacuation centers in real time.

Furthermore, we are discussing in order to use the Disaster Information Sharing System in peace time. For example, the Web-GIS Disaster Management System has a possibility that it can use effective in road management of local governments in peace time. Moreover, the Disaster Information Unified Management System is utilized as advertising media by displaying routine vaccination information, local government’s financial condition, and various events information on the Tiled Display Wall.

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References


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