The Real-time Disaster Damage Information Sharing System for Information Acquiring in Large-scale Natural Disaster

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Abstract

In this paper, we propose the Real-time Disaster Damage Information Sharing System for the disaster countermeasures headquarters at the time of large-scale natural disaster. This Real-time Disaster Damage Information Sharing System consists of the Post Damage Picture Smartphone Application, the Post Damage Picture Facebook Application, and the Web-GIS Disaster Information Management Site. The Post Damage Picture Smartphone Application and the Post Damage Picture Facebook Application are the disaster prevention support systems for posting the damage picture to the Web-GIS Disaster Information Management Site installed in the disaster countermeasures headquarters in real time from the disaster sites. The Web-GIS Disaster Information Management Site is the disaster prevention support system for managing various damage situation based on Web-GIS. By this system, the disaster countermeasures headquarters can grasp the damage situation by large-scale natural disaster in real time. This enables quick and accurately response to the disaster sites or the refugees.

Keywords: Smartphone Application, Facebook Application, Large-Scale Natural Disaster, Disaster Countermeasures Headquarters

1 Introduction

There are extremely-numerous natural disasters in Japan, such as earthquakes, typhoons and volcanic eruptions. The Great East Japan Earthquake on March 11, 2011 caused a great deal of damage in East Japan. In preparation for large-scale natural disaster, Cabinet Office constructed the Comprehensive Disaster Prevention Information System [4]. The Comprehensive Disaster Prevention Information System is a large scale system for the government grasping the disaster situations at an early stage, and supporting quick and accurately decision-making. Disaster prevention information is shared as geographical space information between the disaster relevant organizations. Early grasping of the disaster situations are expected in estimating earthquake damage automatically based on observation seismic intensity information or statistical information immediately after the occurrence of an earthquake disaster. The damage estimation result is utilized for judgment of establishment of the disaster countermeasures headquarters etc. Moreover, the government can grasp visually the damage situation and activity situation which are reported from the relevant organizations on a map. These disaster information is shared by concerned government ministries meeting. However, since the Comprehensive Disaster Prevention Information System of Cabinet Office has spent the immense budget, cost effectiveness is regarded as questionable

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from various quarters [6, 5]. Moreover, since this system is not in cooperation with the local government, it cannot share information densely with as cities, towns and villages. Then, we focused on the disaster prevention system for the disaster countermeasures headquarters at the time of large-scale natural disaster. We find out various issues at the time of large-scale natural disaster, and are constructing the practical information system. When large-scale natural disaster like the Great East Japan Earthquake occurs, the municipal employees and fire corps volunteers are obligated to report the damage situation of the disaster sites to the disaster countermeasures headquarters [16]. The municipal employees photo the damage situation with a digital camera, and bring the damage picture data back to the disaster countermeasures headquarters. Therefore, the disaster countermeasures headquarters spends much time on grasp of the damage situation. Spending much time on grasp of the damage situation causes the problem that it cannot respond promptly in an emergency. Moreover, the disaster countermeasures headquarters uses the paper-based disaster countermeasure map in order to confirm the damage positions. However, it is difficult for the all involved of the disaster countermeasures headquarters to share information on this paper-based disaster countermeasure map [10, 9, 13, 14]. Then, we propose the Post Damage Picture Smartphone Application and the Post Damage Picture Facebook [1] Application for the municipal employees and fire corps volunteers to report the damage picture directly from the disaster sites. Moreover, we propose the Web-GIS Disaster Information Management Site for the disaster countermeasures headquarters to grasp the damage situation in real time.

In the followings, the purpose of this research is descried in section 2. System configuration and architecture of our proposed the Real-time Disaster Damage Information Sharing System are explained in section 3 and section 4, respectively. The Post Damage Picture Smartphone Application, the Post Damage Picture Facebook Application, and the Web-GIS Disaster Information Management Site which constitute the Real-time Disaster Damage Information Sharing System are described in section 5. Usefulness and operability evaluation of the Disaster Information Sharing System is described in section 6. Finally, the conclusion and future work are summarized in section 7.

2 Purpose of This Research

We propose the ”Real-time Disaster Damage Information Sharing System” for real time to grasp the damage situation in large-scale disaster developmental time. Our proposal the Real-time Disaster Damage Information Sharing System consists of the Post Damage Picture Smartphone Application, the Post Damage Picture Facebook Application, and the Web-GIS Disaster Information Management Site. Previously, the disaster countermeasures headquarters spent much time on grasp of the damage situation. Then, in this research, we construct the Post Damage Picture Smartphone Application and the Post Damage Picture Facebook Application which can post the damage picture in real time to the disaster countermeasures headquarters from the disaster sites. When posting the damage picture from both applications, geographical tag information is automatically added to the damage picture.

Furthermore, in this research, we construct the Web-GIS Disaster Information Management Site for visualizing the damage picture on Web-GIS [8, 7]. The damage picture posted to the Application Server from the Post Damage Picture Smartphone Application or the Post Damage Picture Facebook Application is stored in the Database Server. Then, the damage picture registered into the Database Server is automatically mapped on the Web-GIS Disaster Information Management Site.

The municipal employees and fire corps volunteers can report the damage picture to the disaster countermeasures headquarters from the disaster sites, by the Post Damage Picture Smartphone Application and the Post Damage Picture Facebook Application. Therefore, the municipal employees and fire corps volunteers can save time and effort which returns to the municipal employees and fire corps volunteers, in order to report damage situation. Furthermore, the disaster countermeasures headquarters can grasp

the damage picture and disaster position which were posted from the Post Damage Picture Smartphone Application or the Post Damage Picture Facebook Application in real time on the Web-GIS Disaster Information Management Site. Moreover, the all involved of the disaster countermeasures headquarters can share the damage situation on the Web-GIS Disaster Information Management Site.

3 System Configuration

The system configuration of this research is shown in Figure 1. This system consists of the Post Damage Picture Agent, the Web-GIS Disaster Information Management Agent, the Application Server, and the Database Server.

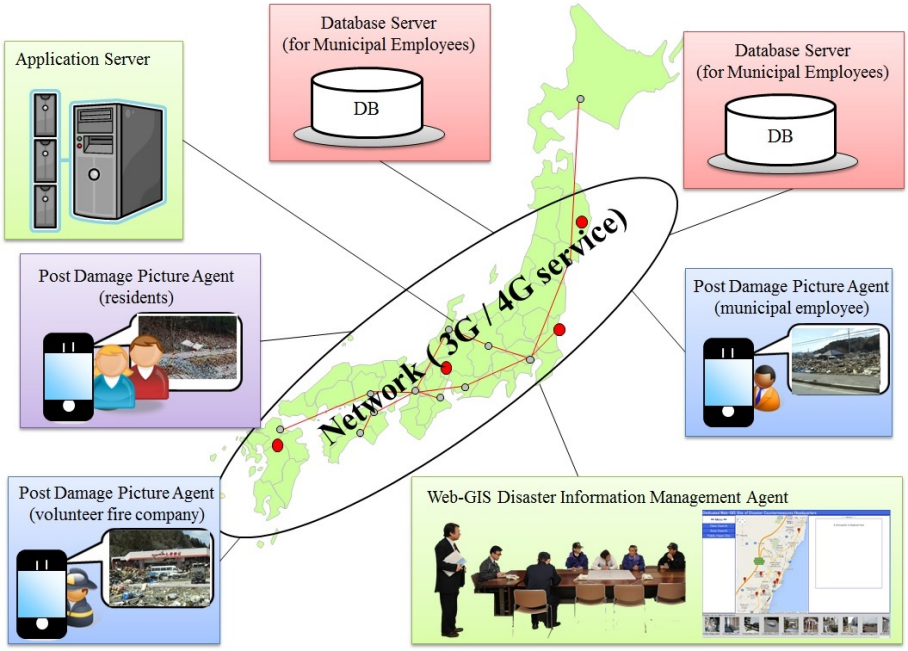

Figure 1: System Configuration

(A) The Post Damage Picture Agent
At the time of large-scale natural disaster, the Post Damage Picture Agent posts the damage picture, such as collapsed houses and road damage, to the Application Server. The Post Damage Picture Agent assumes the municipal employees and fire corps volunteers. Moreover, general population can also post the damage picture. The Post Damage Picture Agent can post the damage picture from dedicated the Smartphone Application or the Facebook Application.

(B) The Web-GIS Disaster Information Management Agent
The Web-GIS Disaster Information Management Agent browses and edits Web-GIS by which the damage picture was mapped. This agent has the date search function, the map search function, and the route guidance function, etc. The disaster countermeasures headquarters can grasp various disaster situations in real time by this agent.

(C) The Application Server
The Application Server receives the damage picture data posted from the Post Damage Picture

Agent. Then, the damage picture data is stored in the Damage Picture Storage Database Server for Public Users or the Damage Picture Storage Database Server for Municipal Employees.

(D) The Database Server
The Database Sever consists of the Damage Picture Storage Database Server for Public Users and the Damage Picture Storage Database Server for Municipal Employees. The damage picture data posted from general population is stored in the Damage Picture Storage Database Server for Public Users. On the other hand, the damage picture data posted from the municipal employees or fire corps volunteers is stored in the Damage Picture Storage Database Server for Municipal Employees.

4 System Architecture

The system architecture of this research is shown in Figure 2. Each agent's module composition is described below.

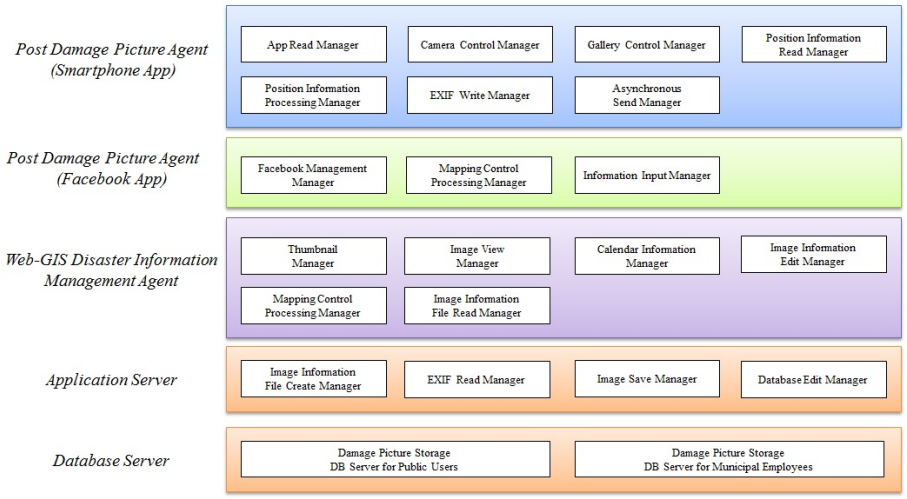

Figure 2: System Architecture

The Post Damage Picture Agent (Smartphone Application) consists of App Read Manager, Camera Control Manager, Gallery Control Manager, Position Information Read Manager, Position Information Processing Manager, EXIF Write Manager, and Asynchronous Send Manager. App Read Manager has the function to start camera application or gallery application according to a user's action. Camera Control Manager has the function to pass EXIF Read Manager the destination place of the damage picture taken with camera application. Gallery Control Manager has the function to pass EXIF Read Manager the destination place of the damage picture selected with gallery application. Position Information Read Manager has the function to acquire the position information written in the EXIF file of the damage picture. Position Information Processing Manager has the function to determine the position information of the damage picture. EXIF Write Manager has the function to writes the position information of the damage picture in an EXIF file. Asynchronous Send Manager has the function to transmit the damage picture to the Application Server by asynchronous communication.

The Post Damage Picture Agent (Facebook Application) consists of Facebook Management Manager, Mapping Control Processing Manager, and Information Input Manager. Facebook Management Manager has the function to manage login and the post to the Facebook. Mapping Control Processing

Manager has the function to set up the position information of the damage picture. Information Input Manager has the function to add a comment to the damage picture.

The Web-GIS Disaster Information Management Manager consists of Thumbnail Manager, Image View Manager, Calendar Information Manager, Image Information Edit Manager, Mapping Control Processing Manager, and Image Information File Read Manager. Thumbnail Manager has the function to displays the thumbnail of the damage picture posted from the Post Damage Picture Agent. Image View Manager has the function to enlarge the selected picture. Calendar Information Manager has the function to manage the damage picture posted from the Post Damage Picture Agent for every date. Image Information Edit Manager has the function to delete the damage picture stored in the Database Server. Mapping Control Processing Manager has the function to displays the position information of the damage picture posted from the Post Damage Picture Agent on a map. Image Information File Read Manager has the function to acquire the picture path, the date information, and position information which were stored in the JSON file.

The Application Server consists of Image Information File Create Manager, EXIF Read Manager, Image Save Manager, and Database Edit Manager. Image Information File Create Manager has the function to writes the picture path, date information, and position information of the damage picture which were registered into the Database Server in the JSON file. EXIF Read Manager has the function to read the date information and position information written in the EXIF file of the damage picture. Image Save Manager has the function to save the damage picture posted from the Post Damage Picture Agent. Database Edit Manager has the function to edit the data stored in the database.

The Database Server consists of Damage Picture Storage Database Server for Municipal Employees and Damage Picture Storage Database Server for Public Users. The picture which the municipal employees and fire corps volunteers posted from the Post Damage Picture Agent is stored in Damage Picture Storage Database Server for Municipal Employees. And, the picture which general population posted from the Post Damage Picture Agent is stored in Damage Picture Storage Database Server for Public Users.

5 The Real-time Disaster Damage Information Sharing System

In this section, the Post Damage Picture Smartphone Application, the Post Damage Picture Facebook Application, and the Web-GIS Disaster Information Management Site of the ”Real-time Disaster Damage Information Sharing System” are described.

5.1 The Post Damage Picture Smartphone Application

We developed the Smartphone Application as a tool for posting the damage picture in real time to the Web-GIS Disaster Information Management Site at the time of large-scale natural disaster. The prototype of this Smartphone Application is shown in Figure 3. The operating procedure of this Smartphone Application is as follows.

(1) Step1. After an initial screen displays, ”Take a Photo” and ”Select Galley” are selected.

(2) Step2. When ”Take a Photo” is selected, the damage picture is taken from camera application. When ”Select Galley” is selected, the damage picture saved at gallery application is selected.

(3) Step3. The marker of the photography position displayed on the map is confirmed. When an error is in the position of a marker, the position is corrected by dragging a marker.

(4) Step4. The damage picture is posted to the Application Server by pushing a ”Post” button after decision of the position.

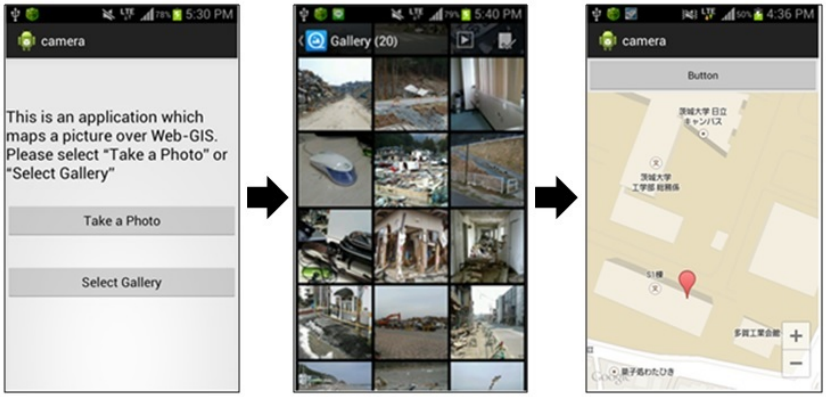

Figure 3: The Post Damage Picture Smartphone Application

As shown in Figure 4, the damage picture posted from the Smartphone Application is transmitted to the Application Server. Then, the damage picture is mapped to the Web-GIS Disaster Information Management Site in real time from the Application Server. In this research, in order to attain decentralization of the system device at the time of large-scale natural disaster, the Application Server is installed in Osaka University and Ibaraki University. Thereby, even when large-scale natural disaster occurs, it becomes possible to continuous use this system.

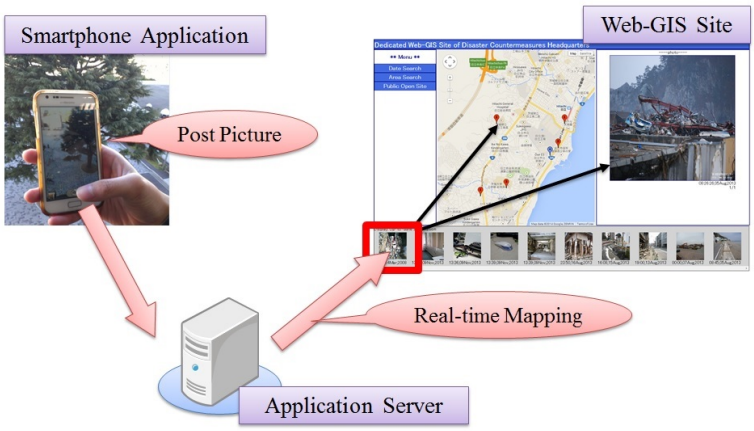

Figure 4: The Flow of Real-time Mapping

The sequence of the Post Damage Picture Smartphone Application is shown in Figure 5. Figure 5 shows the sequence until a user posts the damage picture to the Application Server from the Smartphone Application and is mapped on the Web-GIS Disaster Information Management Site. A user accesses the Smartphone Application and takes a picture or selects a picture. Next, a user requests to the Google server and acquires map information. Then, a user sends a picture to the Application Server. The Application Server registers the sent picture information into the database.

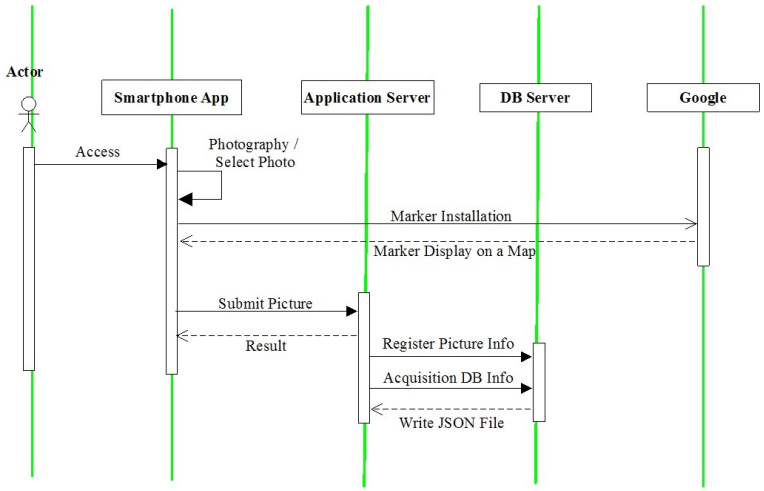

Figure 5: The sequence of the Post Damage Picture Smartphone Application

5.2 The Post Damage Picture Facebook Application

We also developed the Facebook Application as a tool for posting the damage picture in real time to the Web-GIS Disaster Information Management Site at the time of large-scale natural disaster. The prototype (PC version and Mobile version) of this Facebook Application is shown in Figure 6 and Figure 7. The operating procedure of this Facebook Application is as follows.

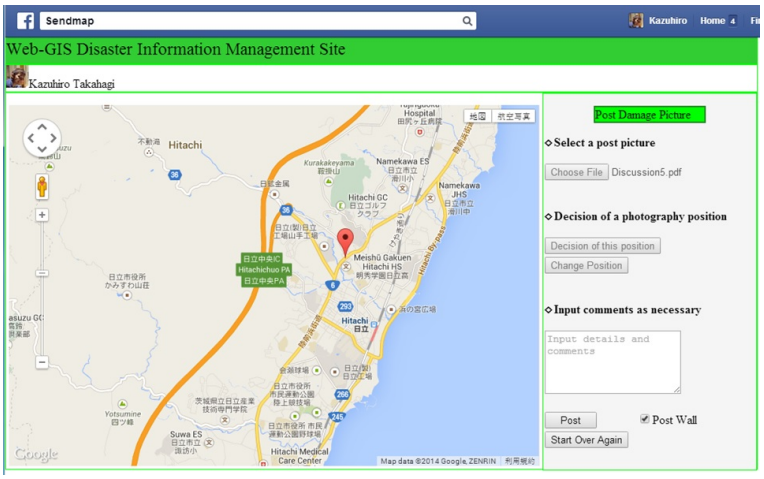

Figure 6: The Post Damage Picture Facebook Application (PC version)

(1) Step1. Click a ”Choose File” button, and it selects the picture to post.

(2) Step2. The position information of picture is displayed as a marker on a map. The marker of the photography position displayed on the map is confirmed. When there is no error of the position of a marker, a ”Decision of this position” button is clicked. When an error is in the position of a marker, the position is corrected by dragging a marker.

(3) Step3. Information is inputted into a comment field when adding a comment to the picture.

(4) Step4. The damage picture is posted by Application Server by pushing a ”POST” button.

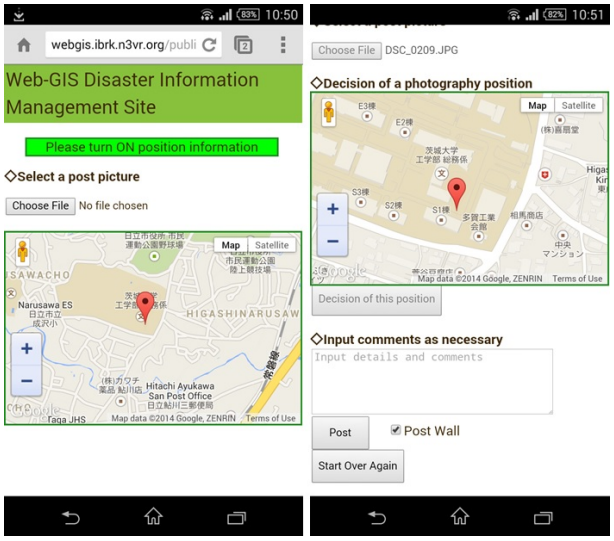

Figure 7: The Post Damage Picture Facebook Application (Mobile version)

The sequence of the Post Damage Picture Facebook Application is shown in Figure 8. Figure 8 shows the sequence until a user posts the damage picture to the Application Server from the Facebook Application and is mapped on the Web-GIS Disaster Information Management Site. After login to Facebook, a user requests to the Google server and acquires map information. Then, a user sends a picture to the Application Server. The Application Server registers the sent picture information into the database. Furthermore, a user can post a picture to the wall of Facebook arbitrarily.

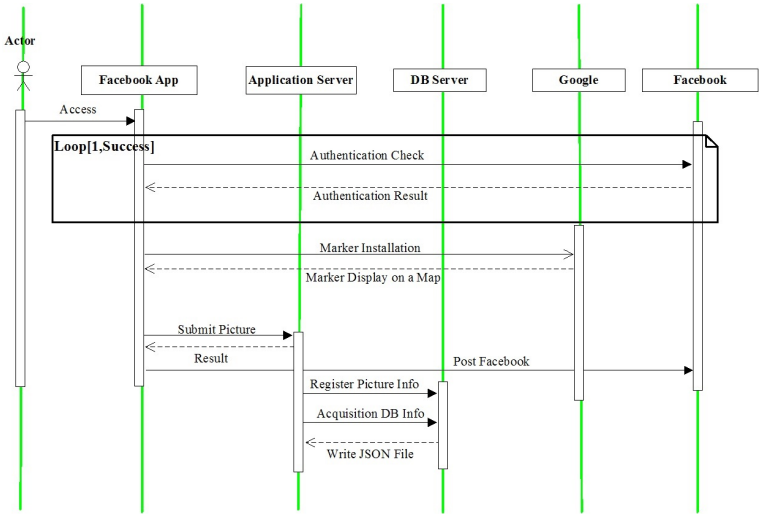

Figure 8: The sequence of the Post Damage Picture Facebook Application

5.3 The Web-GIS Disaster Information Management Site

We constructed the Web-GIS Disaster Information Management Site for the disaster countermeasures headquarters to grasp visually the damage picture on Web-GIS posted from the Post Damage Picture

Smartphone Application and the Post Damage Picture Facebook Application. The disaster countermeasures headquarters can browse the damage picture posted from various disaster places on this Web-GIS Disaster Information Management Site. The prototype of the Web-GIS Disaster Information Management Site is shown in Figure 9. Moreover, the Web-GIS Disaster Information Management Site has the following functions.

(A) Real-time Data Update Function

(B) Map Display Function

(C) Damage Picture Browsing Function

(D) Thumbnail Gallery Function

(E) Date Search Function

(F) Keyword Search Function

(G) Damage Picture Management Function

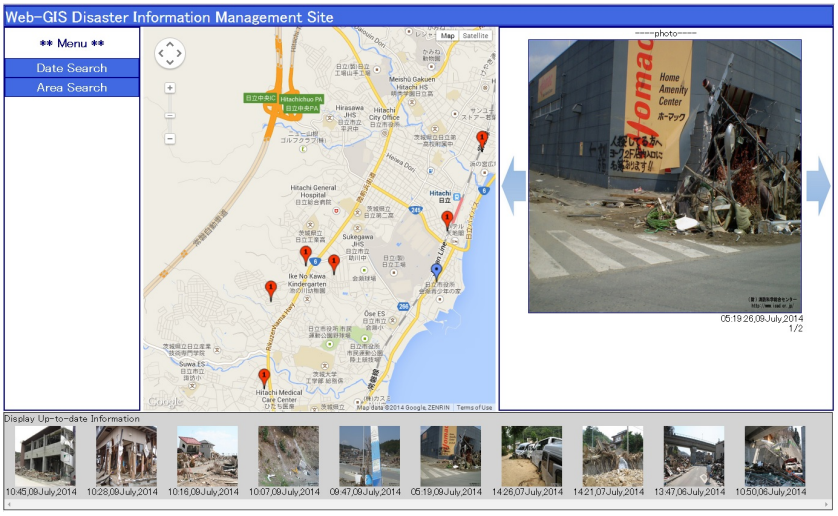

Figure 9: The Web-GIS Disaster Information Management Site

5.3.1 Real-time Data Update Function

At the time of large-scale natural disaster, in order to always report damage situation to the disaster countermeasures headquarters quickly, we implemented the real time data update function. When the damage picture is posted from the municipal employees and fire corps volunteers, this function registers picture information into the database, and writes the contents in the database to the JSON file. In the disaster countermeasures headquarters, it is possible to acquire picture information, such as collapsed houses or road damage, by reading the JSON file. Furthermore, it communicates with the Application Server asynchronously by Ajax at the time of acquisition of the JSON file. Therefore, also while communicating with the Application Server, the disaster countermeasures headquarters can do other work on a browser. In other words, it is the structure dynamically updated in the contents of the page, without updating a screen.

5.3.2 Map Display Function

Google Maps [2, 12, 15, 3] was used for Web-GIS which is main contents of this system. A marker is displayed on a map using the longitude and latitude information of the picture acquired from the Application Server. By click each marker displayed on Web-GIS, the picture photoed at the point is displayed on the screen right with detailed information. Simultaneously, a map zooms in centering on the clicked marker. Moreover, at the time of large-scale natural disaster, it is assumed that two or more pictures are posted from the same disaster point. Therefore, clustering processing was performed in this research. Furthermore, when two or more pictures are posted from the same disaster point, the number of pictures is displayed within a marker. Thereby, the disaster countermeasures headquarters can confirm easily the number of the pictures photoed at the point from the number within a marker.

5.3.3 Damage Picture Browsing Function

By clicking the picture of a marker or a thumbnail gallery, the selected damage picture is displayed on the main screen right. When two or more damage pictures are registered into the marker on a map, the arrow for moving to the following picture is displayed. It becomes possible to check two or more photographs taken in the same position by clicking an arrow. The prototype of Damage Picture Browsing Function is shown in Figure 10.

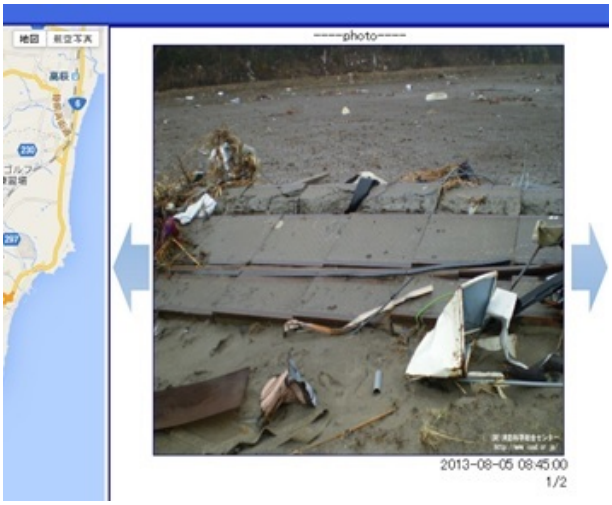

Figure 10: Damage Picture Browsing Function

5.3.4 Thumbnail Gallery Function

As shown in Figure 11, Thumbnail Gallery Function displays the picture of the ten newest acquired from the Application Server. If the picture of a thumbnail gallery is selected, the selected picture is enlarged by Damage Picture Browsing Function. Furthermore, a map zooms in the photography position of the selected picture by Map Display Function.

5.3.5 Date Search Function

By selecting ”Date Search” from the menu bar of the Web-GIS Disaster Information Management Site, we implemented the function which can browse the posted damage picture for every date. This function reads the date information from the picture, and is linked to the date of the calendar. The disaster

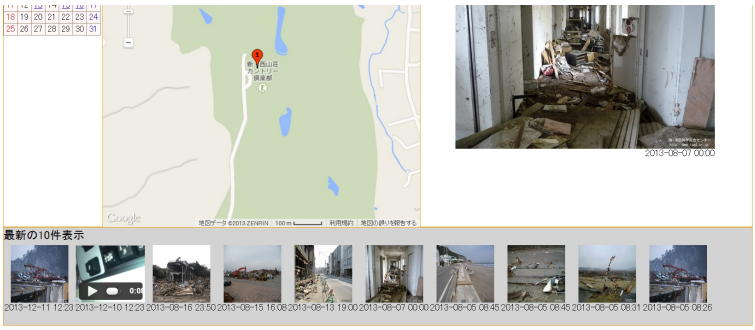

Figure 11: Thumbnail Gallery Function

countermeasures headquarters can confirm the damage picture taken by the selected date. Similarly, the position information on all the damage pictures taken by the selected date is displayed as a marker on a map. Furthermore, all the damage pictures taken by the selected date also as the thumbnail gallery column are displayed. The prototype of Date Search Function is shown in Figure 12.

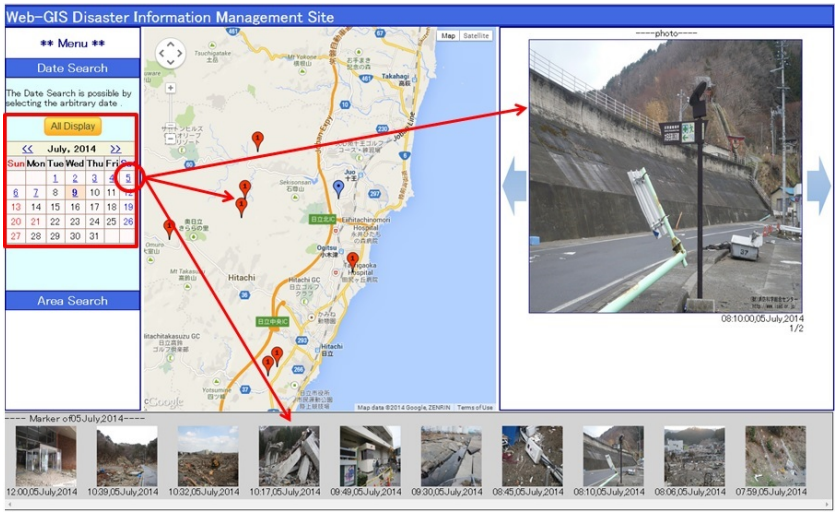

Figure 12: Date Search Function

5.3.6 Keyword Search Function

The area search menu is displayed by selecting ”Area Search” from the menu bar of the Web-GIS Disaster Information Management Site. In this function, we implemented keyword retrieval which uses the geocoding technology of Google Maps. This function is inputting a keyword and an address into an input box, and the map of a search position is displayed.

5.3.7 Damage Picture Management Function

As shown in Figure 13, we implemented the function in which the damage picture is manageable, supposing the case where general population posts the unsuitable picture. Moreover, we also implemented the function in which the disaster corresponding states of the local government are manageable. In Damage Picture Management Function, the damage picture is deleted from the Database Server by clicking

”Delete” button. Moreover, it is possible to manage the disaster corresponding states of the local government by three kinds, ”Unconfirmed”, ”Confirming”, and ”Confirmed”.

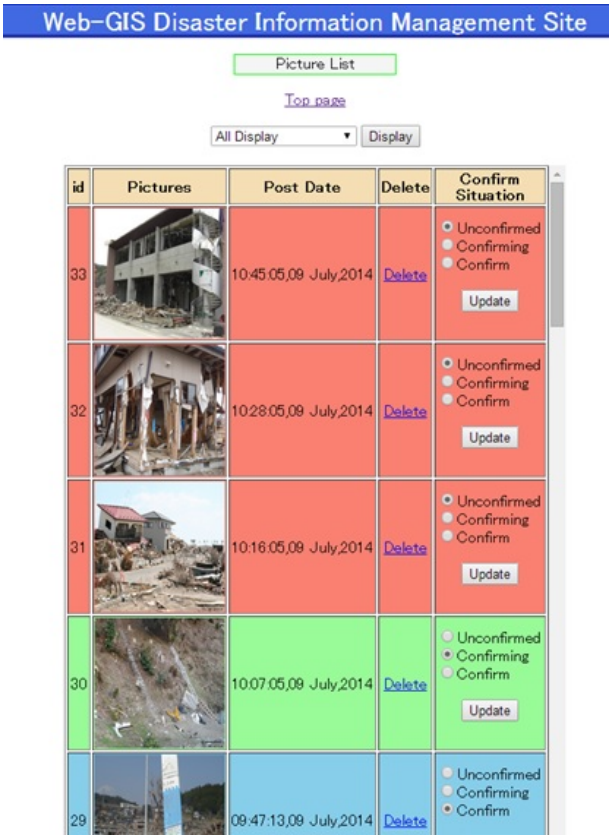

Figure 13: Damage Picture Management Function

The sequence of the Web-GIS Disaster Information Management Site is shown in Figure 14. Figure 14 shows the sequence at the time of a user using each function on the Web-GIS Disaster Information Management Site. A user accesses the website and requests to the Application Server. Next, a user requests to the Google server and acquires map information. Then, a user accesses the Application Server at regular intervals, and acquires the JSON file. Furthermore, a user requests to the Google server and acquires marker information. Moreover, a user acquires the picture of a thumbnail gallery from the Application Server. When a user selects the marker on Google Maps, a user acquires marker information from the Google server. Then, a user acquires the selected picture from the Application Server, and the selected picture is displayed on the website. When a user selects arrow, a user acquires a picture from the Application Server by picture path, and a picture is displayed on the website. When a user selects the picture of a thumbnail gallery, a user acquires marker information from the Google server. Then, a user acquires the selected picture from the Application Server, and a picture is displayed on the website. When a user selects the date from a calendar, a user acquires marker information of selected date from the Google server. Then, a user acquires the picture of the selected date from the Application Server, and a picture is displayed on a thumbnail gallery. When a user selects area search, the map of search area is displayed on the website by performing geocoding.

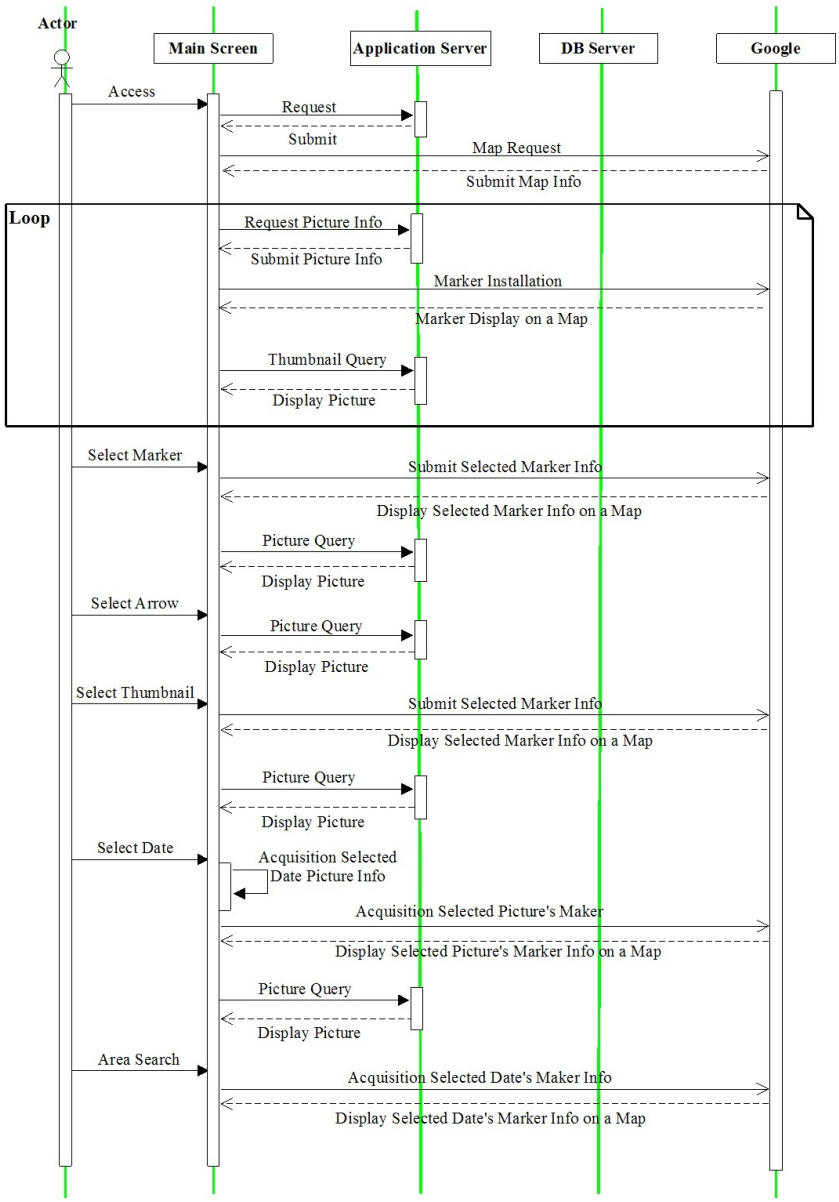

Figure 14: The sequence of the Web-GIS Disaster Information Management Site

6 Evaluation

In order to evaluate the usefulness and the operability of this research, the questionnaire survey was carried out to 67 persons (25 municipal employees, 42 general populations). The municipal employees and general populations actually experienced the Real-time Disaster Damage Information Sharing System, and evaluated the usefulness and the operability at the time of large-scale natural disaster.

6.1 The Usefulness of the Post Damage Picture Smartphone Application

The usefulness evaluation result of the Post Damage Picture Smartphone Application is shown in Figure 15. About the usefulness at the time of large-scale natural disaster of the Post Damage Picture Smartphone Application, about 90 percent of the subject answered ”Useful” or ”Somewhat useful”. About the

reason answered that the Post Damage Picture Smartphone Application is useful, the subject answered ”This system can be used immediately in the disaster sites” or ”Since this system can correct a disaster position, it can report the accurate information to the disaster countermeasures headquarters”. Therefore, we were able to confirm the great usefulness of the Post Damage Picture Smartphone Application at the time of large-scale natural disaster by this questionnaire survey.

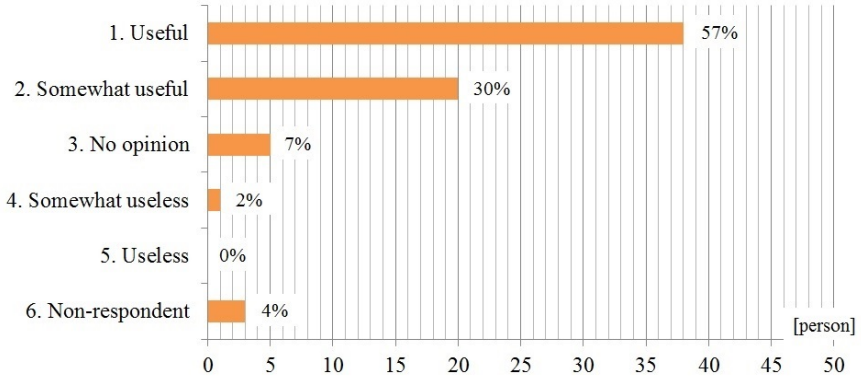

Figure 15: Questionnaire on the Usefulness of the Post Damage Picture Smartphone Application

6.2 The Operability of the Post Damage Picture Smartphone Application

The operability evaluation result of the Post Damage Picture Smartphone Application is shown in Figure 16. About the operability of the Post Damage Picture Smartphone Application, about 70 percent of the subject answered ”Easy” or ”Somewhat easy”. About 10 percent of the subject answered ”Difficult” or ”Somewhat difficult”. Therefore, we were able to confirm the great operability of the Post Damage Picture Smartphone Application by this questionnaire survey.

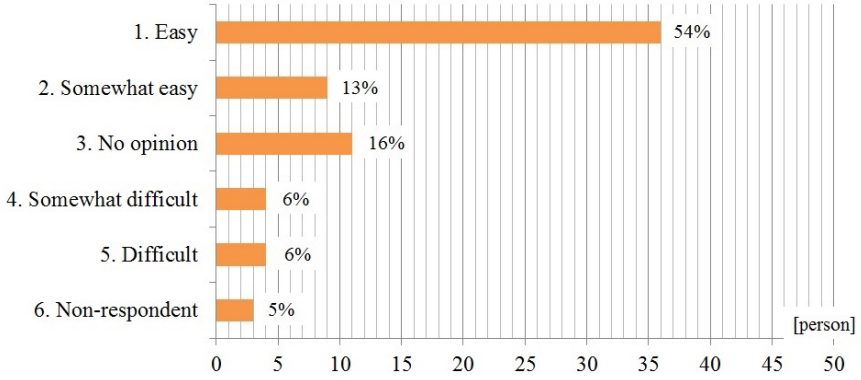

Figure 16: Questionnaire on the Operability of the Post Damage Picture Smartphone Application

6.3 The Usefulness of the Post Damage Picture Facebook Application

The usefulness evaluation result of the Post Damage Picture Facebook Application is shown in Figure 17. The usefulness of the Post Damage Picture Facebook Application carried out the questionnaire survey only to general populations. About the usefulness at the time of large-scale natural disaster of the Post

Damage Picture Facebook Application, about 80 percent of the subject answered ”Useful” or ”Somewhat useful”. Therefore, we were able to confirm the great usefulness of the Post Damage Picture Facebook Application at the time of large-scale natural disaster by this questionnaire survey.

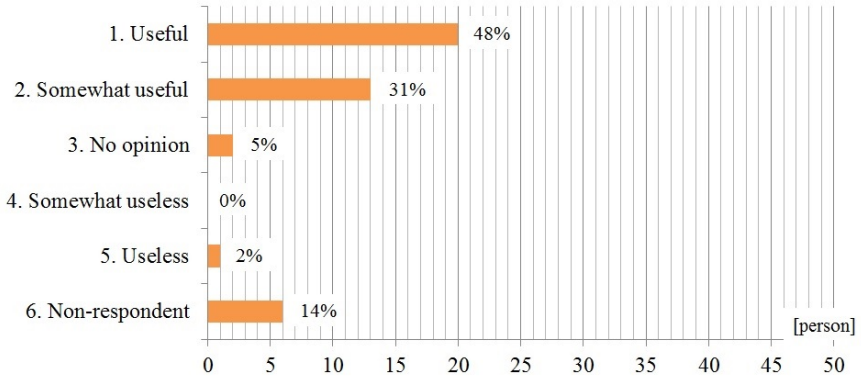

Figure 17: Questionnaire on the Usefulness of the Post Damage Picture Facebook Application

6.4 The Operability of the Post Damage Picture Facebook Application

The operability evaluation result of the Post Damage Picture Facebook Application is shown in Figure 18. The operability of the Post Damage Picture Facebook Application also carried out the questionnaire survey only to general populations. About the operability of the Post Damage Picture Facebook Application, about 70 percent of the subject answered ”Easy” or ”Somewhat easy”. About 10 percent of the subject answered ”Difficult” or ”Somewhat difficult”. Therefore, we were able to confirm the great operability of the Post Damage Picture Facebook Application by this questionnaire survey.

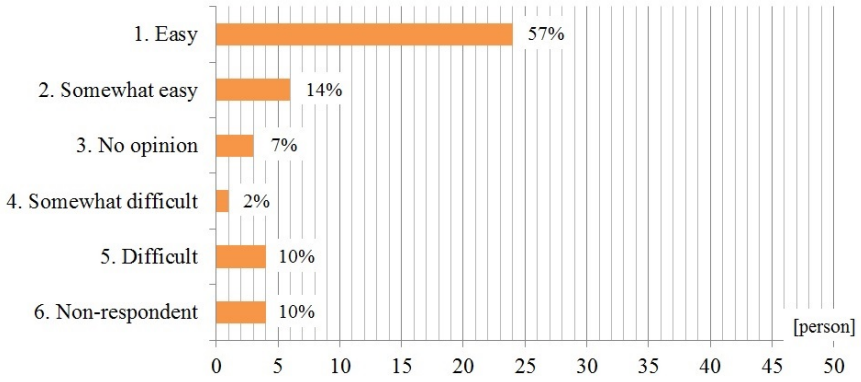

Figure 18: Questionnaire on the Operability of the Post Damage Picture Facebook Application

6.5 The Usefulness of the Web-GIS Disaster Information Management Site

The usefulness evaluation result of the Web-GIS Disaster Information Management Site is shown in Figure 19. About the usefulness at the time of large-scale natural disaster of the Web-GIS Disaster Information Management Site, about 90 percent of the subject answered ”Useful” or ”Somewhat useful”. About the reason answered that the Web-GIS Disaster Information Management Site is useful, the subject

answered ”At the time of large-scale natural disaster, it is very important that the damage picture is mapped on this system in real time” or ”Since the damage picture is automatically mapped from Post Damage Picture Smartphone Application or Post Damage Picture Facebook Application, it is better than the paper based disaster countermeasure map”. Therefore, we were able to confirm the great usefulness of the Web-GIS Disaster Information Management Site at the time of large-scale natural disaster by this questionnaire survey.

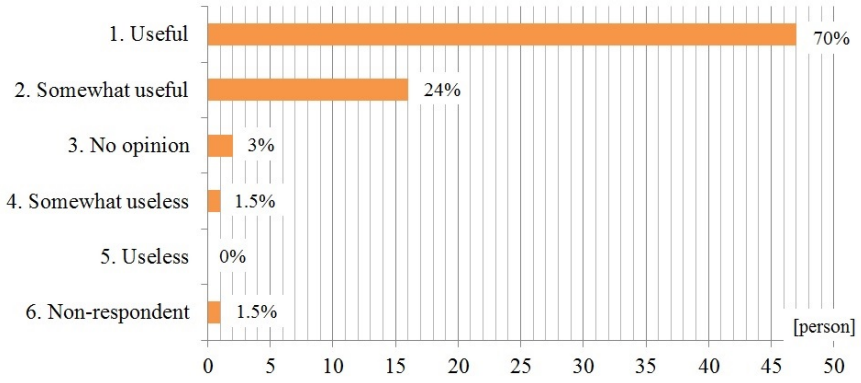

Figure 19: Questionnaire on the Usefulness of the Web-GIS Disaster Information Management Site

6.6 The Operability of the Web-GIS Disaster Information Management Site

The operability evaluation result of the Web-GIS Disaster Information Management Site is shown in Figure 20. About the operability of the Web-GIS Disaster Information Management Site, about 70 percent of the subject answered ”Easy” or ”Somewhat easy”. About 5 percent of the subject answered ”Difficult” or ”Somewhat difficult”. Therefore, we were able to confirm the great operability of the Web-GIS Disaster Information Management Site by this questionnaire survey.

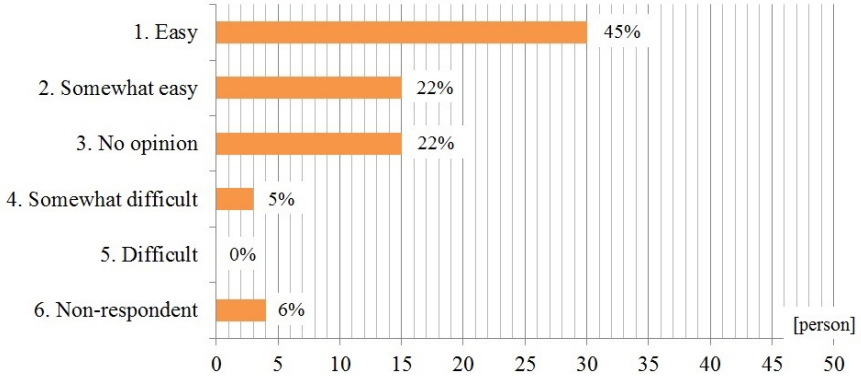

Figure 20: Questionnaire on the Operability of the Web-GIS Disaster Information Management Site

7 Conclusion and Future Work

In this paper, we introduced the Real-time Disaster Damage Information Sharing System for the disaster countermeasures headquarters. The Real-time Disaster Damage Information Sharing System consists of

the Post Damage Picture Smartphone Application, the Post Damage Picture Facebook Application, and the Web-GIS Disaster Information Management Site. We realized the function in which the municipal employees and fire corps volunteers can report the damage picture to the disaster countermeasures headquarters in real time, by the Post Damage Picture Smartphone Application and the Post Damage Picture Facebook Application. Moreover, we realized the function in which the disaster countermeasures headquarters can grasp the damage picture and the disaster position which were posted from the Post Damage Picture Smartphone Application or the Post Damage Picture Facebook Application in real time, by the Web-GIS Disaster Information Management Site.

We were able to confirm the great usefulness and operability of the Real-time Disaster Damage Information Sharing System by the questionnaire survey to the municipal employees and general populations. We are discussing with two or more local governments and relevant organizations now toward the practical use of our system in the disaster countermeasures headquarters at the time of large-scale natural disaster. In the future, we aim at construction of the Comprehensive Disaster Prevention Support System for solving various issues at the time of large-scale natural disaster as shown in Figure 21. We expect that suitable information transmission, rescue support, and evacuation center management will be attained at the time of large-scale natural disaster by construction of the Comprehensive Disaster Prevention Support System.

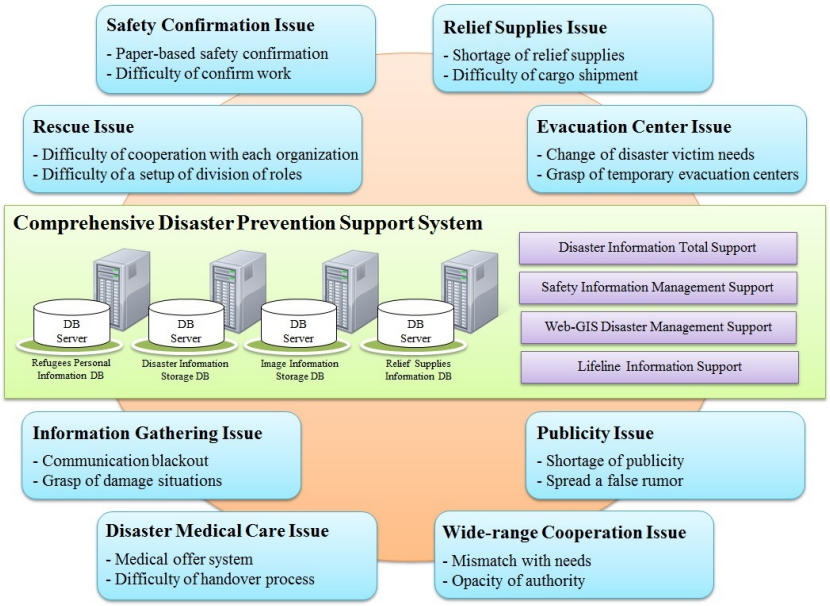

Figure 21: Comprehensive Disaster Prevention Support System

Acknowledgments

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References

[1] Facebook. `https://www.facebook.com`, last viewed July 2014.

[2] Google Maps. https://maps.google.co.jp, last viewed July 2014.

[3] K. Asakawa, K. Hirano, T. Tsukada, Y. Hayashi, Y. In, Y. Omiya, T. Hamai, and H. Murakami. Collection and presentation system of safety information in disaster : An application of GPS mobile phone. *Institute of Image Information and Television Engineers Technical Report*, 33(11):123–126, February 2009.

[4] Cabinet Office. Employment of comprehensive disaster prevention information system towards sharing of information. http://www.bousai.go.jp/oukyu/higashinihon/4/pdf/naikakufu2.pdf, last viewed July 2014, September 2011.

[5] Cabinet Office. Cabinet secretariat and head office of cabinet office project reviews "disclosure process". http://www.cao.go.jp/yosan/kanshi_korituka/pdf/sheet_6.pdf, last viewed July 2014, June 2012.

[6] Cabinet Office. Maintenance cost of comprehensive disaster prevention information system (administration projects review sheet, 2012). http://www.cao.go.jp/yosan/kanshi_korituka/pdf/sheet_6.pdf, last viewed July 2014, 2012.

[7] T. Ichii, T. Aoyama, and Y. H. Masahiro Murakami. Study on sharing of tourist and disaster prevention information using webgis system - investigation and structure of database based on izu's tourist facilities -. In *Proc. of The 12th Japan Earthquake Engineering Symposium, Tokyo, Japan*, pages 1370–1373, November 2006.

[8] H. Ikemi, T. Esaki, and Y. Mitani. Sustainable data-sharing for disaster based on the wiki and gis technologies. *Theory and applications of GIS*, 17(1):93–99, June 2009.

[9] T. Ishida, A. Sakuraba, N. Uchida, K. Hashimoto, and Y. Shibata. A unified large scale disaster information presentation system using ultra gis based tiled display environment. In *Proc. of the 8th International NBiS Workshop on Network-based Virtual Reality and Tele-existence (INVITE'12), Melbourne, Australia*, pages 550–555. IEEE, September 2012.

[10] T. Ishida, A. Sakuraba, N. Uchida, and Y. Shibata. Proposal of disaster management support system using tiled display wall environment. In *Proc. of the 9th International NBiS Workshop on Network-based Virtual Reality and Tele-existence (INVITE'13), Gwangju, Korea*, pages 305–310. IEEE, September 2013.

[11] T. Ishida, K. Takahagi, Y. Shimizu, A. Sakuraba, N. Uchida, and Y. Shibata. The information sharing system using web-gis at the time of wide-scale disaster. In *Proc. of The 8th International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS'14), Birmingham, United Kingdom*, pages 133–138. IEEE, July 2014.

[12] I. N. Piarsa, A. A. K. A. C. Wiranatha, and Y. P. Putra. Land sale geographic information system based on web and web mobile using google map. *International Journal of Modern Engineering Research (IJMER)*, 2(4):2500–2503, August 2012.

[13] A. Sakuraba, T. Ishida, and Y. Shibata. An input method for high-resolution large 2d desktop environment using wireless device with joystick. In *Proc. of the 26th International Conference on Advanced Information Networking and Applications (AINA'12), Fukuoka, Japan*, pages 1–6. IEEE, March 2012.

[14] A. Sakuraba, T. Ishida, and Y. Shibata. A method for user-location estimation for intuitive input system on very large display space. In *Proc. of the 8th International Workshop on Network-based Virtual Reality and Tele-existence (INVITE'12), Melbourne, Australia*, pages 528–533. IEEE, September 2012.

[15] T. Seto, A. Muranaka, G. Tanibata, and T. Nakaya. Potential of Web-based Maps for Community Disaster Prevention and Daily Security : Study by a Workshop with the Participation of Residents in Shino Town, Kameoka City. *Journal of Geography*, 121(6):946–961, January 2012.

[16] Takizawa City. Regional disaster prevention planning. http://www.city.takizawa.iwate.jp/chiiki-bousai, last viewed July 2014, 2010.

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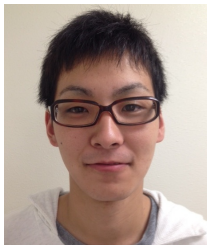

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