An Information Display System with Information Scrapping User Interface Based on Digital Signage Terminals and Mobile Devices for Disaster Situations

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Abstract. In the East Japan Earthquake of 2011, a lot of people stranded at a station in a metropolitan city gathered and stayed in front of digital signage terminals displaying disaster information. The situation had the potential to cause a secondary disaster such as crowding accidents. To solve this problem, we propose an information display system with information scrapping user interface based on a digital signage terminal and mobile devices. Users can watch disaster information on the screen of their own mobile device by access to a digital signage terminal through Wi-Fi connection. The information scrapping user interface allows users to save target disaster information on the screen of their own mobile device and meta-information related with the target information by encircling the target information roughly. The main effect of this system is to shorten the time needed to access disaster information and save the desired information in a mobile device. We conduct a field experiment to evaluate the performance of the proposed system. The main effect of the system was confirmed by comparing with noting or taking photos of desired information among disaster information displayed by a digital signage terminal.

Keywords: Disaster · Digital signage · HTML5 · Information scrapping

1 Introduction

We aim to construct an information display system for stranded people, who gather and stay in front of digital signage terminals after disasters happen, to quickly access the disaster information stored in the digital signage terminals by their own mobile device and save their target information with meta-information even if they roughly operate the mobile device in a panic situation. In the East Japan Earthquake of 2011, digital signage terminals at stations displayed disaster information and many stranded people gathered and stayed in front of the digital signage terminals for a long time to get disaster information. This crowd had the potential to cause a secondary disaster such as a

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stampede. Since digital signage terminals are expected to be key disaster information presentation devices, it is important to solve this problem. Shortening the time needed to find and save disaster information cuts the time they stay together in front of the terminal.

There are various ways for digital signage terminals to present information on the screen. General digital signage terminals display information on the screen in Slideshow view. Recent interactive digital signage terminals display multiple pieces of information on the screen at the same time and details of selected information are presented in response to touch inputs. However, the details shown on the screen will not satisfy all users. Even if the details include user's target information, it is difficult to save the information by camera etc. due to the crowded situation. Due to the East Japan Earthquake of 2011, major centers, where a lot of people gather, have been setting Wi-Fi cells and electricity generators. Therefore, we focus on a system that maximizes the utility of digital signage terminals and mobile devices.

A recent study proposed an information display system that combines a digital signage terminal and mobile devices for a multiuser environment [1]. A user can actively select his/her target information from among multiple pieces of information on the screen of a digital signage terminal by using his/her mobile device to implement pointing input; details of the target information are sent to the user's mobile device for display and screenshot capture. Each user can access his/her own target information directly and watch it on the screen of his/her own mobile device. However, it is difficult for users to perform pointing operations given the extreme crowding expected. Moreover, the screenshot will include not only the desired information but also extraneous information and may not include meta-information related to the desired information such as a title and so on. The meta-information helps the user to remember which screenshot holds which information. The work in [2] allows users to cut their target information from screenshots and add notes by finger action to the target information. However, the finger action isn't suitable for the panic situation likely to develop after a disaster due to the extra time needed to finish writing the information and rough finger action.

Thus, it is important for users to quickly access disaster information stored in a digital signage terminal by their own mobile phone and save the desired information together with meta-information by rough operations in a panic situation. Our contributions include an

Fig. 1. The scene of the field test Left: Conventional system, Right: The proposed system

information display system with an information scrapping user interface suitable for digital signage terminals and mobile devices and the results of a field test, see Fig. 1.

2 Related Work

2.1 Roles and Problems of Digital Signage for Disaster Situations

Digital signage terminals are seen as attractive information display devices in disaster situations. Actually, digital signage terminals displayed disaster information and helped stranded people to obtain disaster information after the East Japan Earthquake of 2011. Since centers such as department stores and stations have installed many digital signage terminals and portable generators recently, digital signage terminals would be used in future disaster situations. However, after a disaster, stranded people tend to panic when a crowd forms around sites that might offer information. The situation has the potential to cause a further disaster and block the street in front the digital signage terminal. In discussions with a company managing digital signage terminals, we found that they were concerned about further injuries and damage. To solve this problem, it is important for stranded people to shorten the time when they find their desired information and save the information to their own mobile device.

General digital signage terminals in the market aren't suitable for situations where multiple users want to obtain information at the same time. Since most centers have established strong Wi-Fi coverage, collaboration between digital signage terminals and mobile devices is feasible in the near future, as was predicted [3, 4]. Therefore, we focus on creating efficient collaboration systems.

2.2 Collaboration Between Digital Signage and Mobile Devices

The main topics when addressing the collaboration of digital signage and mobile devices are operation methods of digital signage terminals using mobile devices for users to access the desired information on the screen of the terminals and information scrapping methods that can download the information to the user's mobile device.

Practical operation methods in the field areas include sending system commands from the mobile device to the digital signage terminal by SMS or voice input and entering digital signage terminal cursor operation commands by touch operations on the screen of the mobile device [1]. Collaboration systems currently in the research stage include an interaction system for NFC devices and digital signage terminals [5], and a flashlight-based pointing interface [6]. Current information scrapping methods are capturing the information displayed by the digital signage terminal by the mobile device's camera or making gestures while holding mobile devices [3, 8].

However, no of these systems are suitable for the situation envisaged, many stranded people attempting to access the same digital signage terminal and save disaster information stored in the terminal to their own mobile device. It is critical that the stranded people be able to rapidly confirm if the terminal holds the desired information and save the information to the mobile device without impeding the other people's access to the

terminal. In the envisaged situation, it is preferable that they can watch the information stored in the terminal on the screen of their own mobile device.

2.3 Information Scrapping Methods on the Screen of Mobile Devices

Since disaster information displayed by digital signage terminals includes the information to share and check repeatedly at another location, it is preferable for stranded people to save the information in their own mobile device. However, the saved information isn't useful when they cannot remember which saved information includes what kinds of information. It is difficult to include meta-information on the images captured by screenshot etc., in the case that disaster information isn't watched without screen scrolling. Cutting operations by finger action may have a loss of some information. Especially, operations are rough in a panic situation. Therefore, it is important to save target information with meta-information such as title and so on by the rough operations.

3 Proposed System

From the discussions given in Sect. 2, we focus on a collaboration system based on digital signage terminals and mobile devices to shortening the time to find and save target disaster information stored in the terminals. The system should meet two points.

- To check the disaster information stored in a digital signage terminal quickly
- To scrape and save target disaster information with meta-information in mobile devices by rough finger action

Our proposed information display system satisfies these two conditions. The system has two features.

Feature 1: Disaster information held by a digital signage terminal is displayed on the mobile device through a wireless connection. Figure 2 shows the feature. Users do not have to wait for their desired information to be displayed on the terminal but can actively browse the information on their own mobile device within the range of the wireless connection. This reduces the time taken to find the desired information. Another key merit is eliminating the need to have line of sight to the terminal. They can also move from the digital signage terminal to a safety position due to the connection

Feature 2: When roughly encircling target information with single finger on the mobile device, not only the target information but also meta-information related with the target are scrapped and saved to the mobile device (Fig. 3). In Fig. 3, the image about a location and a part of a text about a way to go to the location are scrapped by finger action and the saved information include the name of the location as meta-information and the full of the image and the text. Thus, the system automatically adds meta-information and save the full of the target information even if finger action is rough. Meta-information helps the user to remember what information the entry includes and why they saved the information. Both are helpful when users access the saved information later.

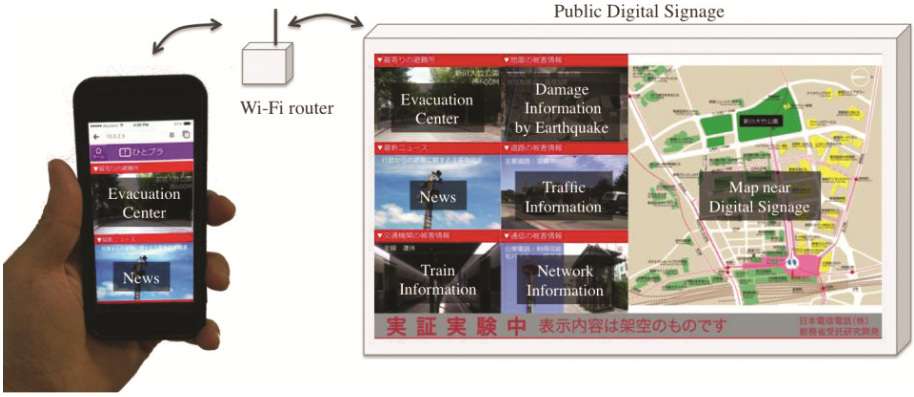

Fig. 2. Proposed information display system

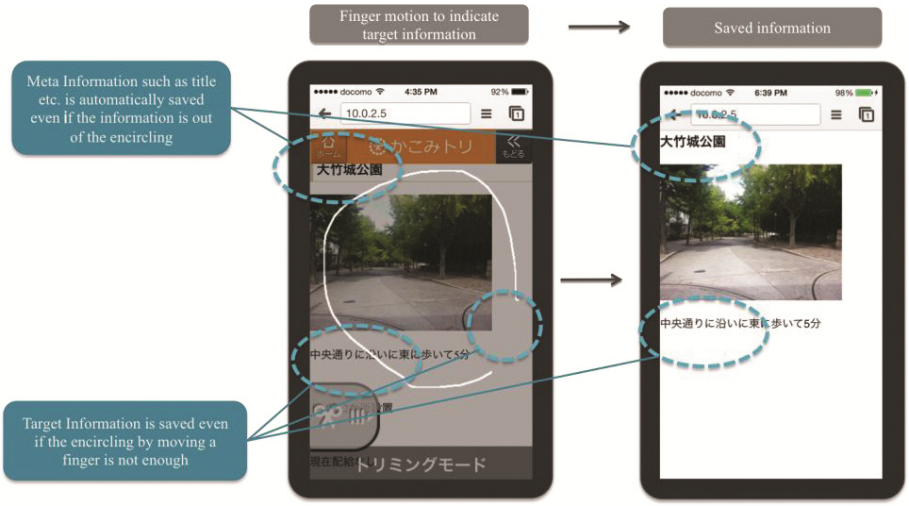

Fig. 3. Information scrapping user interface

Figure 4 shows an example of the flow of this system.

1. To access the digital signage terminal from a mobile device through a wireless connection and display the list of disaster information on the mobile device
2. To select an item of the list and find target information among the details by screen scrolling on the device
3. To trigger the information scrapping user interface and encircle the target information
4. To push a decision key such as OK button

These simple operations reduce the dwell time in front of the digital signage terminal.

Fig. 4. The flow of the proposed system

4 Implementation

4.1 Communication Method

We adopt Wi-Fi as the communication method linking digital signage terminals to mobile devices. Wi-Fi access points are being set in various major centers and Wi-Fi is standard in most smartphones. Users are becoming more familiar with Wi-Fi connections in daily life. Blutooth, which is superior to Wi-Fi in terms of power consumption, is not suitable as not many people are familiar with it. NFC is not suitable since its short communication distance will encourage crowding.

4.2 Web-Based Implementation

The proposed system is a client-server system and instead of native applications of Android or iOS is realized as an HTML5 compliant Web application. This web-based implementation has many merits.

Merit 1: Users can use their favorite web browser without further action. Native applications of Android or iOS would have to be downloaded from the Internet and then installed. However, Internet connections are unreliable in disaster situations and the application servers would become overloaded. It is a burden for users to download and update native applications in advance. Either of HTML5 browsers tends to be preinstalled in current mobile devices.
Merit 2: Users can access information simply by connecting their own mobile device to the Wi-Fi portal of the digital signage terminal, and launching their favorite web browser. Since dense Wi-Fi cells are being created in various major spots, users know that they exist. Familiar operations are useful in panic situations. The Wi-Fi portal redirects to the registered URL, which eliminates the need to input the URL of the terminal.
Merit 3: Meta-information related to the target information selected by users is found easily. Since HTML pages are formed as combinations of elements such as headers,

paragraphs, items and so on and the structure of the pages is clear, the system can easily find the meta-information from the elements and the relationship between the elements. Basic HTML texts consist of headers such as (<h1>) and paragraph elements (<p>). If a paragraph element (<p>) is selected by users, the system regards the header immediately above the paragraph element as the meta-information. HTML pages made for disaster relief must be simple so this feature is useful.

Merit 4: The proposed system uses CSS to the display the scrapped and saved information. Since the system save all information including elements, it is easy to adjust layout and character size. To support users in using safety information in disaster situations, readability and viability are important factors.

Merit 5: Cost and resources needed to develop applications are minimized. Since HTML5 is a Web technology standardized by W3C, web-based systems are most suitable for disaster situations since many kinds of mobile devices will try to access the system.

Merit 6: The algorithm to recognize information scrapped by encircling roughly is simple. Elements of HTML5 have attributes such as position, width and height. If more than three points among five points in an element shown in Fig. 5 are within a polygon created by finger action, the system save the selected element.

Fig. 5. Recognition of scrapped information

4.3 Digital Signage Contents

A digital signage terminal that implements our proposal must clearly show that it holds safety information useful to the users. Thus it must have significant physical presence to show its location, and its screen must clearly show the type of information that its holds. The screen of the terminal is divided into multiple frames and each frame holds a different kind of information. An example is shown in Fig. 2 right. The contents are likely to consist of evacuation centers, traffic around the digital signage terminal, train, network, damaged situation, news about the disaster and map of surroundings. Other types of information could

be added if found necessary. The digital signage terminal is useful for users who don't have mobile devices and have the devices running out of the battery.

5 Field Experiment

5.1 Purpose

To evaluate the feasibility of the proposed system, we conducted an experiment in front of the digital signage terminal at Shinjuku station, see Fig. 1. This digital signage terminal displayed disaster information after the East Japan Earthquake of 2011 and many people gathered and stayed for a long time in front of the terminal. The terminal's location sees heavy foot traffic every day.

5.2 Experiment Design

A within-subject test was used. The independent variable was Method (MEMO, PHOTO, The proposed system). The dependent variable was time to complete "TASK", which required the subject to find the answers (information) to five queries associated with disaster information and to save the answers by Method. The five queries were derived from the results of a prior investigation and given by the experimenter. One query was "Find the magnitude of this earthquake in the area your parent lives in", see Fig. 6.

Fig. 6. One query

In the case of "MEMO", volunteers searched and noted the answers on the screen of the digital signage terminal that displayed disaster information by Slideshow. In the case of "PHOTO", volunteers searched for and took photos of the answers on the screen of the digital signage terminal that displayed disaster information by Slideshow. Figure 7 left shows an example of disaster information on the screen of the digital signage terminal.

Twenty volunteers per day participated and a total of 100 volunteers participated. Figure 8 shows the rate of their ages. 83 % of the volunteers had experience in using smartphones or tablets. A net research company gathered the volunteers and we asked the company to focus on relatively inexperienced IT users. This is because various kinds of people will need disaster information.

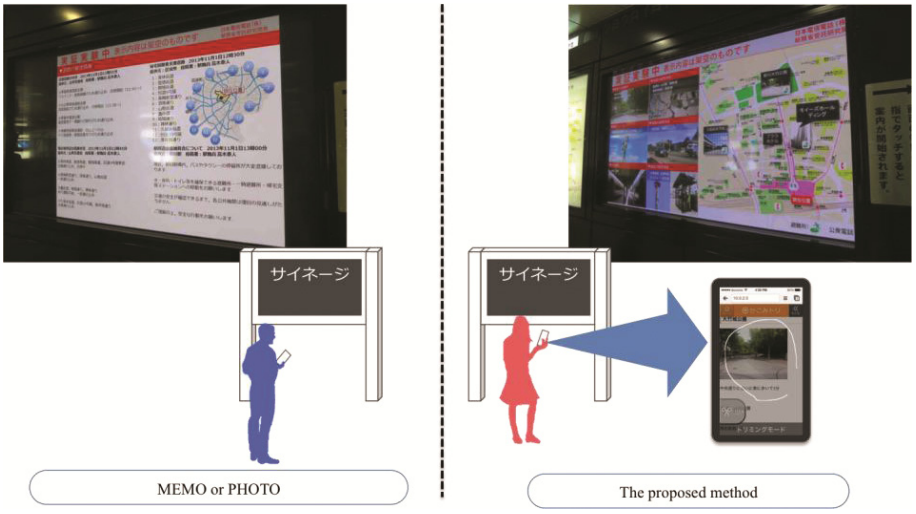

Fig. 7. The screen of the digital signage terminal in the field test Left: Conventional system, Right; The proposed system

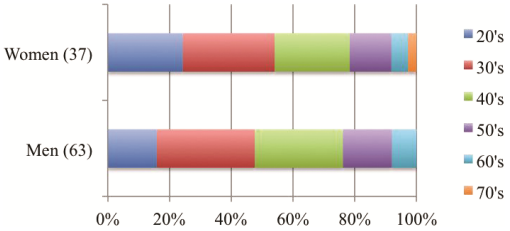

Fig. 8. Ages of volunteers

5.3 Procedure

Twenty volunteers at a time gathered at some distance from the digital signage terminal. Each volunteer was randomly assigned a smartphone (iphone 5 or Android4.x). Volunteers received instruction on how to use the information scrapping user interface of the proposed system for thirty minutes at most. The 20 volunteers were divided into two groups (GA, GB). When GA took the test, GB waited at the center. This is because the number of volunteers in front of the digital signage terminal was limited to ten for safety.

Either of the groups moved the digital signage terminal from the center by about five minutes walking. Since we needed the volunteers to react as in a disaster situation, we conducted a scenario-based experiment. The volunteers heard the following scenario in front of the digital signage terminal.

"You live with your family. You came here by train. You have just had lunch. Suddenly, your own smartphone issues an Earthquake Early Warning. A big earthquake then strikes. You wait at the center until the earthquake stops. This takes a few minutes.

You try to use of your smartphone to get information, but phone and Internet are disconnected. You are worried about the safety of your family and are not familiar with this area. You decide to go the nearest station. You see the digital signage terminal around which a lot of people have gathered. You see that the terminal is displaying disaster information. You go to the digital signage terminal to collect disaster information."

After hearing the scenario, the volunteers received five queries from the experimenter. The experimenter told them "you are in a panic and you try to find the answers one by one". The experimenter instructed them to save the answers by MEMO, PHOTO or the proposed method. When the volunteer finished the task, they told the experimenter their completion. After all volunteers finished, they returned to the center. They rested at the center for thirty minutes. Each group repeated the test three times. METHOD was counterbalanced.

5.4 Result and Discussion

The average completion time of each METHOD (MEMO/PHOTO/The proposed method) was 14.8/12.9/8.3 min, respectively. We performed a within-subject analysis of variance (ANOVA) for Method. Figure 9 shows the results. The proposed method is effective in shortening the time taken to access and save the disaster information.

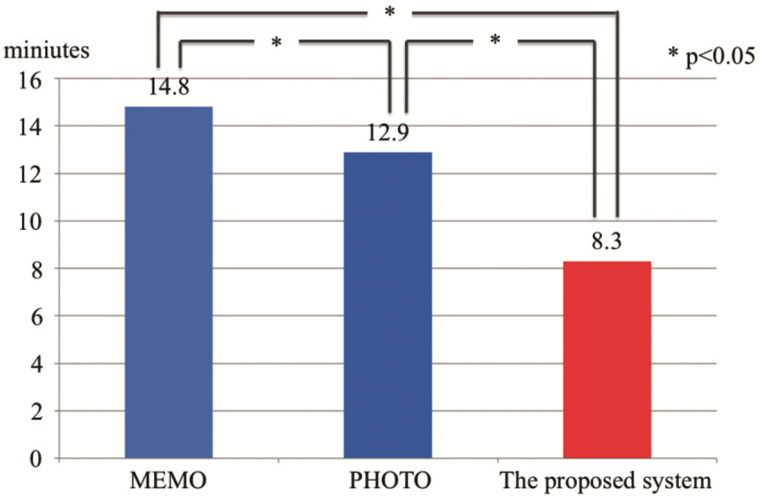

Fig. 9. Proposed information display system

Since the information is shown in Slideshow view, the user has to wait the entire Slideshow if the target information is missed the first time. Every time a new slide is shown, the user has to scan all information on the slide to confirm its contents. In addition, noting on paper takes a long time. Taking photos of a slide takes less time. However, the users disturb each other in their attempt to get a good position. Since the photos are taken in a panic, the photos are sometimes blurry so average speeds are lower. This shows that feature 1 of the proposed system is effective.

77 % of the volunteers answered that the content of scrapped information was adequate. 24 % of the volunteers noticed the meta-information and all of them answered that the meta-information was useful.

6 Conclusion

This paper focuses on the problem of overcrowding in front of digital signage terminals in disaster situations. Our contribution is to propose an information display system with the information scrapping user interface, that links digital signage terminals to mobile devices via wireless links, and report the evaluation of the system in the field test. The field experiment confirmed that the proposed method is very effective in reducing the time users stay in front of a digital signage terminal to collect the desired information and the level of effort needed to store the information in their personal mobile devices.

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