Towards More Practical Information Sharing in Disaster Situations

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Abstract. This paper presents how to design a more practical information sharing service for disaster situations based on the requirements learned from many disaster experiences in Japan in the past. In designing technologies to be used in disaster situations, it is important to add resiliency that can handle changes in the situation. To provide more people with an information sharing service, the technologies should be independent of Internet availability and should work on many types of user devices. We develop and evaluate a resilient information sharing platform and some applications, all of which can work with Wi-Fi and a web browser. This paper also details the results of field experiments and describes the importance of the "service usability" concept in making those technologies truly practical.

Keywords: Disaster · Resilience · Information sharing · Mobile device · Digital signage

1 Introduction

In disaster situations, it is important to share "information" such as safety confirmation and public transportation notices. The East Japan Earthquake in 2011 disconnected the Internet in many areas by destroying facilities and/or flow control of the public communication network. A report on the earthquake noted that 78.5 % of evacuees carried their own mobile devices, and at the train stations in urban areas, many tried to get disaster information from digital signage displays.

This paper describes how to design a communication service for disaster situations by utilizing mobile devices and digital signage. The contribution of this work to HCI research is to provide use cases in the design, development, and testing of services for disaster situations and to provide other countries which will experience disasters with design principles for future services.

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2 Web-Based Implementation

One problem with applications for disaster situations is that native applications cannot be downloaded if the Internet is disconnected. To support evacuation centers without Internet access, our multi-device collaboration technology realizes resilient information sharing that allows evacuees to share disaster information among devices with an HTML5 browser by connecting to a local Wi-Fi router and launching the browser. To support evacuees at the train station, our technology allows digital signage terminals to provide disaster information to evacuees' mobile devices via local Wi-Fi connections and any HTML5 browser. The advantage is that no software installation is needed, as our proposal is completely web-based using HTML5. Our web-based implementation brings the other advantage of ease in developing and maintaining the application regardless of the operating system. For example, we do not need to develop both Android versions and iOS versions.

3 Resilient Information Sharing

Technologies for use in disaster situations must be very resilient to support changes in the environment. For example, many people may enter and leave an evacuation center frequently. This means that the number of mobile devices connected to Wi-Fi in the evacuation center changes frequently. Our resilient information sharing platform (See Fig. 1) can accept such a situation as it uses a javascript-based decentralized

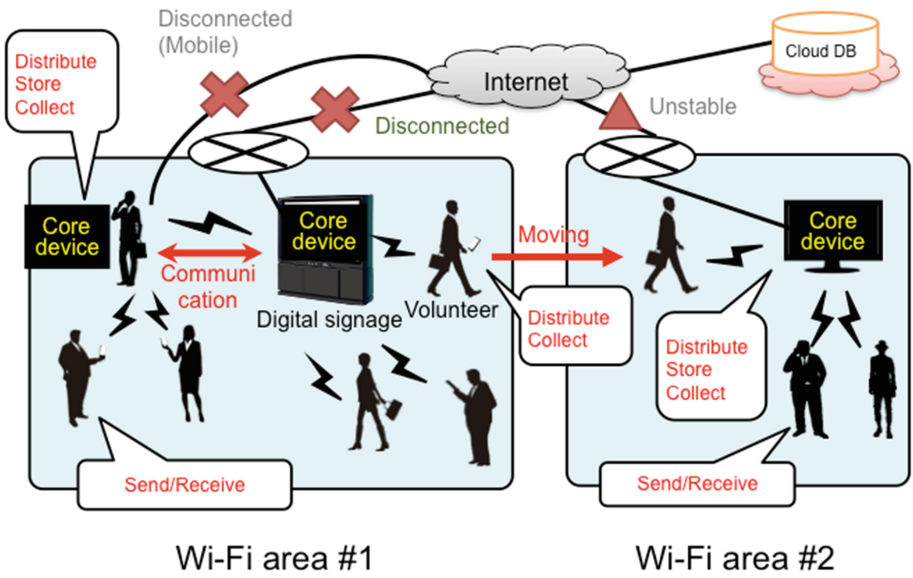

Fig. 1. Resilient information sharing platform. This can accept frequent device joining to or leaving as it uses a javascript-based decentralized cooperation control program on each device. A few core devices collect, store and distribute information from non-core devices. Human movement between Wi-Fi areas #1 and #2 enable information sharing.

cooperation control program on each device to collect, store, and distribute information among devices.

The resilient information sharing platform has a great advantage in terms of implementation. The system is available even if the Internet is disconnected. This is realized by using local Wi-Fi links and a delay tolerant network (DTN) technology, (most existing alternatives assume the existence or recovery of Internet connections [1, 2, 6]). The DTN technology uses the inter-center movement of humans to realize information sharing rather than Internet connections [3].

4 Applications

We developed three applications for disaster situations, all of which work on the resilient information sharing platform; safety confirmation, evacuation navigation and signage-smartphone collaboration.

4.1 Safety Confirmation

Safety confirmation is rated most important by evacuees [5]. Our safety confirmation application makes it possible to share safety confirmation information among evacuation centers using DTN. Evacuees can discover safety confirmation of family or friends without visiting many evacuation centers.

Figure 2 shows how our safety confirmation application works. According to the real use of some disaster-relief applications in the past disasters, users (i.e., sufferers in the affected area) are quite eager to take actions to know other's conditions (and their posting messages) while they forget to inform others of their own conditions, which people outside the affected area really want to know. To collect sufferers' conditions more efficiently in a confused situation, the automatic registration of user's conditions is desired. An application server can know that users are alive from their actions. It is recommended the safety confirmation system should support automatic registration of

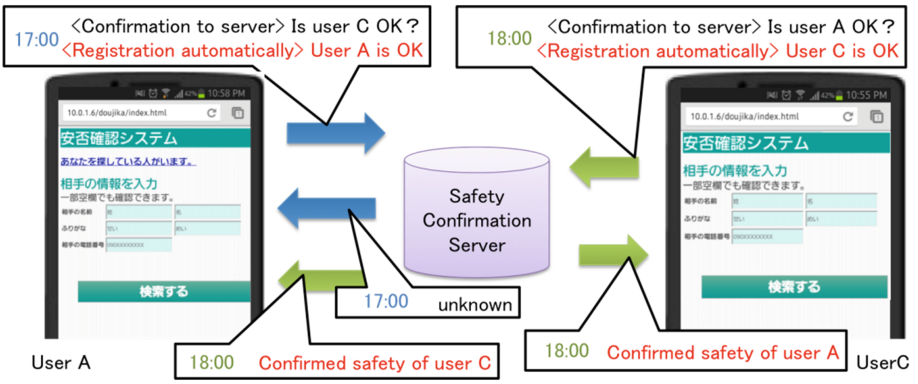

Fig. 2. Safety confirmation application. In this application, self-safety information will be sent to the server with the search query of the retrieval.

user's conditions in conjunction with user's other actions to the system and service. The actions that trigger automatic registration include retrieval of other user's messages. In this case, self-safety information will be sent to the server with the search query of the retrieval.

4.2 Evacuation Navigation

Evacuation is one of most important actions just after a disaster occurred [4]. Our evacuation navigation application uses collaborating digital signage terminals to provide the direction and distance to the nearest evacuation center (See Fig. 3). Evacuees can evacuate with a downloaded map to the nearest evacuation center and can know the updated information such as a change of the center to evacuate according to the changing disaster situation from a digital signage terminal in front of the shop as well as the information of distance and direction to the evacuation center.

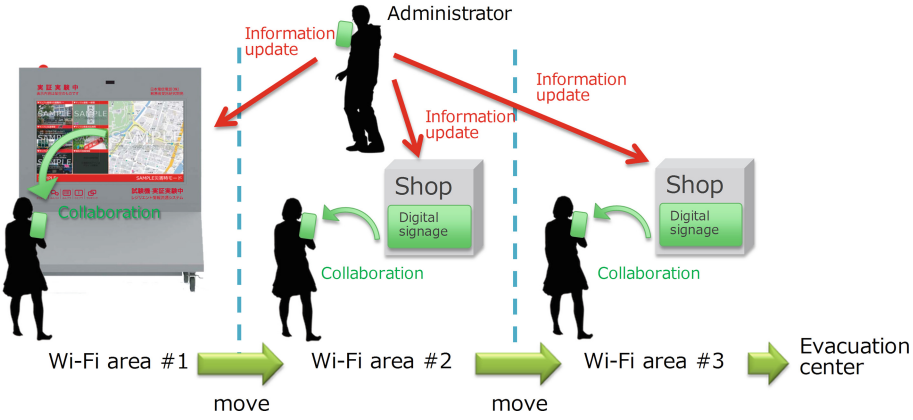

Fig. 3. Evacuation navigation application. Evacuees can evacuate with a navigation shown on each screen of digital signage displays. The navigation can change according to the changing disaster situation such as an evacuation center change.

4.3 Signage-Smartphone Collaboration

The signage-smartphone collaboration application makes it possible for evacuees to download information from digital signage terminals to their own smartphone interactively. For example, they can obtain a route to the nearest evacuation center from the current train station (See Fig. 4). This collaboration is achieved by real-time mutual communication (WebSocket/WebRTC) between a digital signage terminal and smartphones.

Fig. 4. Signage-smartphone collaboration. Evacuees can download a map or route to the nearest evacuation center via local Wi-Fi.

5 Experiments

To evaluate the feasibility of these three applications, we conducted experiments at a shopping arcade (See Figs. 5, 6, 7 and 8).

Fig. 5. Experiments of the safety confirmation application at a shopping arcade

Fig. 6. Experiments of the evacuation navigation application at a shopping arcade

(a)

(b)

(c)

(d)

Fig. 7. Information displayed on many types of digital signage or a smartphone. (a): Downloadable information on a digital signage screen. (b): A distance and direction to the nearest evacuation center on a digital signage device in front of a shop. (c): Information of change of the center to evacuate. (d): A downloaded route map on a smartphone.

Fig. 8. Experiments of the signage-smartphone collaboration at a shopping arcade

About 100 subjects experienced our technology in each application and answered questionnaires about their experiences. Experiments of the safety confirmation application were conducted by many subject pairs under an assumed friend name which is written on the given sheet. As a result, 86 % of the subjects could confirm friend's safety and the rest failed due to a mistake in registration of his/her own name. In experiments of the evacuation navigation application, we confirmed that updated information of the change of center to evacuate was correctly displayed on each type of signage screen according to the given disaster scenario. A main part of experiments of the signage-smartphone collaboration was whether subjects could connect to Wi-Fi and download necessary disaster information onto their own smartphone or not. As a result, 90.5 % of the subjects could download the information by themselves for the first time and 96.2 % could do for the second time. These results were positive for our applications but three significant issues must be resolved to make the applications more practical.

6 Service Usability

We propose the novel concept "service usability" to make the applications more practical, which consists of service affordance, network connection usability, and intuitive user interface. Service affordance is critical in alerting users to the existence of the service because most people do not know that they can download information from a signage terminal to their own device. The network connection usability is essential as most people will give up if the Wi-Fi connection is difficult to make. The intuitive user interface is important since in a disaster situation many users will be novices. These

three issues identify the importance of service usability as service usability includes more issues than simply those related to the interface.

7 Conclusion

The contribution of this report is to provide use cases of the development and field-testing of completely web-based communication technologies for disaster situations without any Internet connection. This paper presents the following four design principles for developing applications for disaster situations. Following them will yield applications that are truly practical.

- Utilize mobile devices and digital signage terminals
- Employ web-based implementation
- Match changes in the situations
- Improve usability as a total service

Future work includes improving the proposed technologies by applying the service usability concept.

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