Gesture Design and Feasibility in Emergency Response Environments

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ABSTRACT
Emergency response planning is a complicated process, with different forms of communication and information being exchanged amongst emergency response personnel during the course of an emergency. This information and communication exchange, led to the development of our multi-surface emergency response-planning prototype, to address communication and information sharing during emergency response situations. In this paper, we briefly describe the emergency response planning domain and how it informed the design of our prototype. We also discuss our preliminary findings on gesture design and feasibility of multi-surface interactions in the emergency response domain.

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Multi-surface environments; gestures; cross-device interaction; mobile devices; emergency response environments;

ACM Classification Keywords
H.5. 2 [Information interfaces and presentation]: User Interfaces— Input Devices and Strategies; Interaction Styles.

INTRODUCTION

When dealing with either real life emergencies, simulations or the planning of emergencies, Emergency Operation Centres (EOC) use numerous information sources. These information sources can come from sources that use their own unique protocols for information exchange. For example, during an emergency, a chain-of-command communication system is used by emergency response personnel to exchange information (e.g. firefighters, police, HAZMAT, EMS, armed forces), journalists (print, television and radio) utilize fact-checked information prior to broadcast, and citizens can live-tweet, post updates, or send emails.

Figure 1. The ePlan Multi-Surface Emergency Response Environment.

These different information sources have a significant impact in the workflow of emergency response personnel in the EOC. For example, traffic cameras can be live-streamed into the EOC, while tweets can arrive via text. The different information sources can appear on different screens in an EOC, which is typically driven by keyboard and mouse-based interactions with several large screens. EOC personnel continually need to examine up-to-date information on these screens and quickly determine its importance to an ongoing emergency, and in many situations, information is also shared amongst the EOC personnel, who are a group consisting of different backgrounds (e.g. firefighter, police).

Multi-surface environments, environments that utilize numerous different interactive devices (e.g. tablets, wall displays, and digital tabletops) provide an environment amenable for emergency response planning. Using concepts such as private and public spaces, and interactions that are possible with multi-surface environments (e.g. flicking, pouring), tasks such as information separation and segmentation for information triage in emergency planning is possible. In this paper, we present our ePlan multi-surface prototype, where iPads are used as personal workspaces from which EOC personnel can privately communicate with colleagues, a digital tabletop can be utilized as a collaboration and cooperation area, and a large high-resolution wall display aggregates information from traffic cameras, incident cameras, news feeds from local and national sources, along with live Twitter feed. We also discuss the challenges presented when implementing gestures and multi-surface interactions for EOC personnel.

RELATED WORK

Emergency response planning is comprised by many important tasks, from detecting and monitoring the emergency to the deployment of resources and communication management [1][6]. Even though this domain has been explored from the perspective of several different technologies, common rules on interactions to improve collaboration are scarce as the UI is heavily impacted by the domain and system's purpose, as highlighted by Bortolaso et al. Just co-locating people around a device does not mean that the collaboration will be improved since the tradeoff between simplicity and functionality must be evaluated multiple times during system's development.

uEmergency is a forest fire simulation system running on a very large-scale interactive tabletop [2]. This tabletop's dimensions (381x203cm) allow several users to collaborate using the system concurrently while considering personal space (local and private workspace) and a global space (shared among all users and synchronized through a button). Users can interact with the system using a digital pen or touch gestures. It's possible to translate and resize the map using gestures with one and two fingers, respectively; to perform annotations dragging and dropping markers from a menu into the map; and changing the simulation's time point through a slider available on each personal workspace. Since all users are sharing a very large-scale tabletop, collaboration is improved through visual cues from each user's actions.

Besides digital pen and touch gestures, physical tokens are also used in planning disaster systems on tabletops [3]. They act as input, changing simulation parameters according to their physical position above the tabletop, and provide feedback through images projected on them. The manipulation of physical tokens to interact with emergency systems has reduced the learning curve of these systems.

The research space of multi-surface environments is very well explored and significant research has been done in exploring the different ways in which interactions can take place [5][7][8].

The collaborative nature of the activities related to emergency response planning and the presence of multiple and heterogeneous devices in a room provide an opportunity for study and experimentation of different types of gesture-based interactions in the emergency response domain, described in this work by ePlan Multi-Surface.

EMERGENCY RESPONSE PLANNING

Working in collaboration with an emergency response simulation software company, C4i Consultants Inc.[1] (C4i), located in Calgary, Alberta, Canada, we designed the ePlan Multisurface Emergency Response Environment. It's a proof-of-concept environment designed based on our partner's specification for training purposes and, as shown in Figure 1, it consists of a large high-resolution wall display, digital tabletop and multiple iPads. The system was built using C4i's desktop software ePlan to drive the emergency simulation, as well as MSE-API [4], which provides communication between devices and multi-surface interactions. After discussions with C4i, researching multi-surface environments and based on their experience on emergency response, we decided to select a subset from the gesture set available in prior work [5] and implemented in MSE-API. To highlight the role of gestures and interactions in the prototype, we will describe the typical usage scenario in the context of an emergency response-planning scenario used by our industry partner:

Step 1: Emergency Alert Issued.

In the first stage, emergency response planners, in particular, the emergency response operation controller receives different information (text, email, and phone) from various sources (fire, emergency medical services, and police) about an emergency. The EOC then determines the type of emergency that is occurring and issues a state of emergency to a city or municipality, if necessary. During this time, the EOC is continually analyzing and receiving information on both their personal iPads, as well analyzing the situation on the large wall display that highlights information such as live camera traffic cameras and Twitter feeds. The EOC is often interrupted or simultaneously performing tasks due to the evolving nature of an emergency.

Step 2: Response Representatives Assemble.

After the alert has been issued, the response representatives assemble in the ePlan multi-surface emergency response environment. These representatives include the fire department, emergency medical services (EMS), law enforcement agencies, hazard materials unit (depending on the severity of the situation), among others. Each representative maintains their own personal iPad containing relevant information that is either shared at their discretion or used in their own assessment for allocating resources for the emergency. To share their information, a representative is able to use multi-surface interactions such as flick to send to the wall display, allowing all representatives to see updated information, the tabletop to assist in collaborative emergency response planning with other representatives (pouring from the iPad to the tabletop also performs the same function) or to other iPads, to facilitate communication between different representatives. These interactions are typically done in parallel with planning or analysis tasks in the environment, and notifications are used that visually prompt representatives of new data. The multi-surface interactions also serve as a visual prompt for representatives of new or updated emergency information.

[1] http://www.c4ic.com/

Figure 2. User performing "flick" gesture on iPad's screen to send content from tablet to tablet (left); tablet to tabletop (center); and tablet to wall display (right).

Step 3: Emergency Response Planning.

During the emergency response planning session(s), which last until the end of an emergency situation, numerous types of interactions occur. This session is the most critical component of emergency response planning, as significant coordination and planning is done. In ePlan multi-surface, emergency response, personnel are continually collaborating and consuming new information rapidly using iPads, while also simultaneously trying to keep track and manage the emergency through the wall display and digital tabletop. At the end of an emergency response situation, a report is typically generated that summarizes the emergency and the contributions of the emergency response personnel.

INTERACTIONS AND GESTURES IN EPLAN PROTOTYPE

Touch-based gestures on ePlan Multi-Surface are used for content transfer to support EOC personnel during emergency planning scenarios. These gestures are based on a device's type (iPad, digital tabletop, and wall display), its physical position and relative position to other devices, different gestures and interactions might be performed. These include the following

1. Pulling content from another device

Considering the case an EMS specialist wants to analyze part of the global situation, presented on wall display, in his iPad. He orients his iPad towards the wall display and perform a pull gesture using one finger from the top to the center of the screen. The content will then be copied from the wall display into his mobile device.

2. Pouring content from tablet into tabletop

During emergency planning activities, users collaborate among each other by sharing analysis (annotations) made privately in their devices. On ePlan Multi-Surface it's possible to make content made on one's device globally available: a user share his annotations by placing his iPad above the tabletop and "pouring" its content into tabletop's screen, as shown in Figure 2. The content will then be displayed on wall display and available for everyone's analysis.

3. Sending content through flick gestures

A common situation in emergency planning is one specialist informing others or discussing about a given aspect of the emergency – for example, firefighters informing an evacuation plan to the police. Since ePlan users can interact with their own devices in a local fashion, it's possible to share information with specific users through flick gestures on tablet's screen. It's possible to perform tablet-tablet, tablet-tabletop and tablet-wall display content transfer through such gestures, as shown in Figure 3. MSEAPI identifies who should receive the content according to sender's position and orientation.

Figure 3. User "pouring" content over tabletop

GESTURE DESIGN AND FEASIBILITY

Building upon prior work of multi-surface interactions and gestures [5], the goal of building ePlan multi-surface was to examine multi-surface gestures in the context of emergency response planning. In the oil and gas domain we observed that multi-surface gestures and interactions still require a significant amount of work to be adopted, and adoption barriers, such as learnability, still need to be overcome.

In our preliminary work presented here, design sessions, feedback and informal discussion has suggested similar findings to [1]. We believe this reflects not just the nature of how we've considered multi-surface interactions and gestures, but the literature for the space as well. One important aspect of gesture design, especially in the context of multi-surface environments, is that the focus has primarily been on using gestures to transfer content. There has been a noticeable shift away from the GUI based techniques as the technology of devices has evolved. With more information being available from devices (e.g. gyroscope, accelerometer) to essentially mimic or create "natural" interactions (e.g. pick and drop, pouring, etc), this seems like a logical research track to follow. However, in the case of emergency response planning, this shift seems to be at the expense of the user, as appears to be both more efficient and feasible for emergency response personnel to not use such gestures in the traditional sense of replacement, but merely augmenting their tasks.

Another interesting implication of gesture design and interactions from a multi-surface perspective, is their grounding. For the most part, we have introduced gestures that were designed or inspired by prior work, and have seen that in practical, real-world settings, the results are less than ideal. This seems to suggest, that gesture and interaction design should first begin in grounded domains before being examined and tested more generically, as is much of the case in the gesture design literature.

For us, in the context of multi-surface environments and emergency response planning, this opens a number of interesting questions, that we'd like to explore in future work, which are the following:

- What are alternative ways to designing gestures in a multi-surface context, especially when they are so new?
- How can we leverage or augment traditional techniques (e.g. 2D interfaces) in the design of multi-surface gestures and interactions?
- Are multi-surface interactions and gestures truly feasible or faster for domains such as emergency response planning?

Also, as future work, we intend to evaluate the environment prototype in a training situation with our partner, since to run a test during a real emergency would carry great risk for the ones involved.

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