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Collaborative Interface for Disaster Simulation

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Abstract

We introduce a disaster simulation system with a unique user interface technology. The goal of this system is to support collaborative planning of disaster measures, and disaster education for citizens. While several digital simulation tools are available for damage prediction and evaluation of disaster prevention plans, they are limited to use on traditional computers and displays, and rarely used in collaborative scenes and discussions. To address this issue, we have designed and developed a tabletop tangible user interface for disaster simulation.

The first part of this paper describes the design, implementation and basic functions of our system and reports our preliminary user observations and their feedback. The results show that our system can effectively support collaborative emergency planning tasks by a group of users and that users can easily learn how to use our system.

The second part of our research is to apply this simulation system to a group work-based disaster education method called DIG (Disaster Imagination Game), which is recently getting popular in Japan. We study the common instruction methods and tools used in current DIG sessions in Japan, and identify the needs of a system with both the functionality of computer-based simulation and the ease of operations of physical input devices such as pens. In order to support this need, we integrated the digital pen function into this simulation system and evaluate its effectiveness based on the scenario of DIG. The results show that this system has potential to be used by wide range of people and to support collaborative disaster education.

Keyword: *disaster simulation, user interface*

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1. Introduction

When planning disaster measures that minimize the damage from a hazard, simulations are useful for assessing the impact of a plan. The reality is, however, that we often see people use a paper map spread out on a table to assess the situation and discuss what actions to take. While Geographic Information Systems (GIS) and simulation tools are available for examination and evaluation of disaster reduction plans, they are limited to use on the traditional computer and display, and hard to use in such collaborative planning sessions. To address this issue, we developed a disaster simulation system with a unique user interface.

2. System Overview

The Tangible Disaster Simulation System is a collaborative simulation tool for disaster measures based on disaster and evacuation simulations (Figure 1).

2.1 Our Approach

The goal of this system is to realize a disaster simulation system that integrates the functionality of computer-based simulation with the ease of operations of physical input devices. We focus on the Tangible User Interface (TUI) [3], a new user interface in which a person interacts with digital information by using physical objects. Our expectation is that TUI is more suitable for collaboration than GUI (Graphical User Interface), because 1) it makes possible for users to directly control parameters on the map, and 2) it can handle multiple inputs simultaneously. We also expect that the physicality of the TUI model helps novices to learn how to use the system more easily and more quickly than GUI.

2.2 Implementation

This system is implemented upon the Sensetable system[5], one of the TUI platforms, which can wirelessly detect physical tags' locations and orientations. A video projector is installed to project digital maps onto the table. Anoto [1] paper covers the table to support inputs both by digital pens and physical objects with tags. Input data is sent to the computer in real time and projected back onto the tabletop surface. At the back end, a scenario-based disaster simulator [4] runs as a simulation engine. This system can simulate hazards (e.g. Tsunami, earthquake) and the evacuation behavior of residents and visualize the results as an animation. In addition, a touchscreen is installed for the control of map view; another display is for showing the simulation results as charts and numbers.

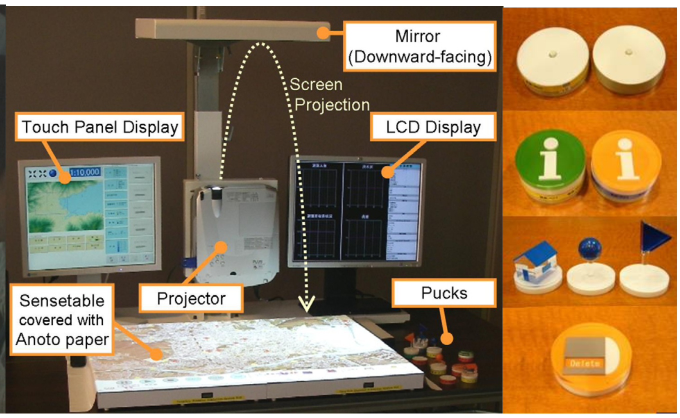

Figure 1: System in use. **Figure 2. System architecture(left) and pucks(right).**

3. Disaster Planning Scenario

This system allows multiple users to directly input parameters such as the scale of a disaster (e.g. tidal waves), the timing of evacuation orders, the locations and capacities of shelters, etc. Then, this system simulates and visualizes the effects of the disaster as well as the process of evacuation of people, under inputted conditions. Users can examine how much damage a disaster will cause and possible measures for reducing that damage estimate.

3.1 Input Plans

A digital map is displayed on the table, and users can physically move the location of the icons on the map by attaching video-projected icons to pucks on the table. Figure 3 shows the screenshot of the tabletop display. Each icon has a parameter that can be set by a rotating operation of the puck (e.g. the capacity of a shelter, the radius of a speaker-audible area). This system can handle multiple inputs on the map simultaneously.

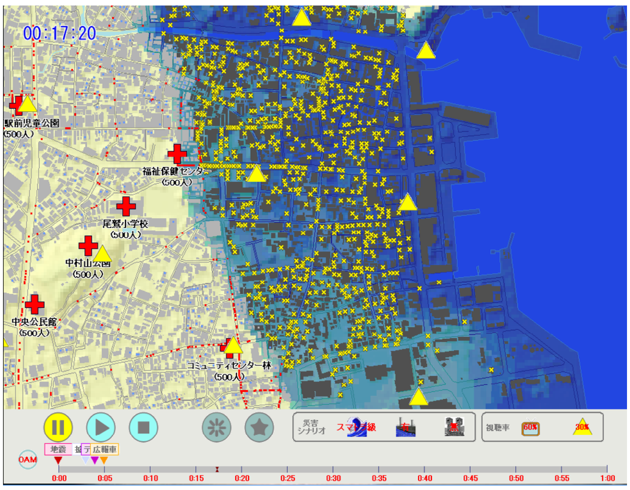

Figure 3: Screen image on the tabletop surface. **Figure 4. Interaction with pucks.**

3.2 Simulation Mode

During simulation, this system visualizes locations of people moving into shelters or refuge areas. Small dots show the current locations of people. Evacuation routes are searched dynamically according to simulated disaster state and road conditions. As the simulation progresses, how high and how far tidal waves have come can be also shown with the gradation of blue color.

A couple of pucks are color-coded and assigned to monitor the status of a specific point. When a user places a colored puck onto a shelter, a chart indicating the number of people who have arrived at that shelter appears in the puck color on the chart display. In the same way, the immersion level of a tidal wave can be monitored by putting one of these pucks onto any point on the map.

In addition, numerical data of estimated damage is displayed on the chart screen for further detailed analysis. This data includes human damage (i.e. the estimated number of dead and injured), building losses, and evacuation-related data (e.g. average time for evacuation, etc.).

3.3 Preliminary Evaluation

We demonstrated this system to visitors, including professionals in the disaster control domain. We have informally observed their use of this system in order to preliminarily assess whether our interface achieves its aims.

We have seen that most user groups enjoy and make full use of the capabilities of spatially multiplexed and direct inputs. For example, a user designated a restricted area as he and other persons were monitoring the water levels nearby. Another group was interested in investigating a combination of shelter capacities by using two pucks simultaneously. Users commented that they could easily recognize hazardous areas and evacuation plan flaws because the system visually represented simulation results on the map.

Quite a few people noted that this interface could be very effective as a collaborative learning tool for citizens as well. This system has great potential to make learning processes more enjoyable for participants because of its interactivity. In the next section, we introduce some other functions to support disaster education.

4. Disaster Education Scenario

"Disaster Imagination Game (DIG)" is a new instruction method of disaster education [2], which is getting popular in Japan. DIG is a group task in which participants (5-10 people in one group) check the structure and the existing disaster-prevention facilities in their city, imagine the situation when a disaster strikes and discuss what kinds of actions they should take in such cases.

Participants use a paper map, color markers, and stickers in a DIG session. The use of these kinds of tools is considered very powerful because every person in the group can easily use such tools and join the task, regardless of his/her level of computer literacy. On the other hand, there is an increasing need of introducing information technology to increase the effectiveness of DIG, but a strong concern is the usability issue. The supporting tool should be targeted at novice group members, many of whom are not used to personal computers.

4.1 Create Town Maps

As a first step of a DIG session, participants make markings onto their town's base map. The goal of this task is to understand the town's structure, check important facilities such as refuge places, and know potentially dangerous areas in their town.

With our system, participants can draw lines and figures freely and directly on the digital maps with a digital pen(Figure 5). The drawings and memos made by users are registered to the GIS database, and the system can display maps and in any scale inputted.

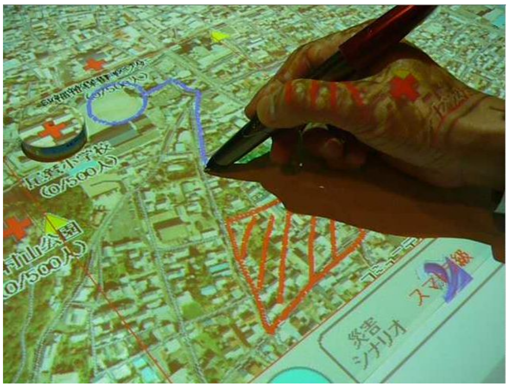

Figure 5. Drawing with a digital pen.

Figure 6. Evacuation simulation.

4.2 Simulate disasters and examine feasibility of evacuation scenario

This system provides an evacuation simulation function for a specific person.

A user can input the location of his or her house by placing a house-shaped physical piece on the map. Goal point, one of the shelters, can be set in the same way with another piece, and then an optimal shortest route will be displayed. (Figure 6-left). Other conditions (e.g. trigger to start evacuation, how long you need to get ready to evacuate, etc.) can be selected as well. After the simulation starts, a person image appears and moves toward the specified destination along the evacuation route. Users can examine the safe evacuation plan from their own home to the refuge area, as though it were a game (Figure 6-right).

5. Conclusion

We present the Tangible Disaster Simulation System, a disaster simulation system with a tabletop tangible user interface and a digital pen function. Preliminary observation and feedback from users who interacted with our system show that our approach can effectively support collaborative planning tasks and group-work based disaster education. In the future, we plan to enhance this system to deal with other kinds of disasters and measures.

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