

DIGTable: A Tabletop Simulation System for Disaster Education

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Abstract

We introduce DIGTable, an interactive disaster simulation system for disaster education. This system incorporates a tabletop tangible user interface and a digital pen input to provide a wide range of users with a collaborative and easy-to-use learning environment. Users can interact with the map or GIS (Geographical Information System) data to learn more about their towns. Likewise, through natural interaction with the physical tools on the table, users can explore disaster evacuation scenarios based on simulation.

1. Introduction

The Disaster Imagination Game (DIG) is a new instruction method for disaster education in Japan[2]. A typical DIG session includes three sets of exercises for a group of people. First, the participants are asked to recognize the existing disaster-prevention facilities in their city and the land features and characteristics. Second, they are placed in a disaster situation and asked to predict its damage and learn about possible repercussions. Finally, they are encouraged to discuss what kinds of actions they should take in such circumstances.

The DIG method is gaining popularity in Japan which is a highly active geological region with a high threat of tsunamis and earthquakes. Recently, several local communities have begun to host DIG sessions for its citizens to educate them. Generally, in a current DIG session, participants do not use computers but instead use traditional physical tools such as a pen and Post-its (Figure 1). Using these tools, participants contribute to a DIG session, and thereby gain a deep realization of the potential disasters. The use of these kinds of tools is considered very powerful because every person can easily use them to participate in the tasks, regardless of his or her level of computer literacy. They can develop a sense of engagement through the interaction with their own hands.

On the other hand, it has also been pointed out that there are no means to check the effectiveness of the disaster measures or evacuation plans discussed during DIG. Although there is an increased need for the introduction of information technology in order to maximize the effectiveness of DIGs, there is also strong concern about the utilization of a graphical user interface. DIG tools should be targeted at those unfamiliar with personal computers.



Figure 1. Scene of Disaster Imagination Game and traditional tools

In order to address this issue, we propose the DIGTable, a disaster simulation system that integrates the functionality of computer-based simulation with the ease of operation of physical input devices. This system allows a group of people to view digital maps, write directly on these maps, and manipulate simulation functions by using small physical pieces on the map.

2. DIGTable Overview

The DIGTable is an interactive disaster simulation system for disaster education. This system incorporates a tabletop tangible user interface [4] and a digital pen input to provide a wide range of users with a collaborative and easy-to-use learning environment. Users can physically interact with the map or GIS (Geographical Information System) data to learn more about their towns.

In addition, the DIGTable allows multiple users to directly input parameters for disaster and evacuation simulations on a projected map. The system simulates and visualizes the disaster and the evacuation of people to shelters by using advanced simulator software [5] that simulates hazards, evacuation, and information distribution.

Inspired by the Urp system [7], we positively tried to adopt tangible user interfaces to our system with expectation that tangible tools would be easy to understand and also suitable for use in collaborative works. At the same time, we incorporate a pen interface since we identified the needs of pen input through the study of traditional DIG sessions.

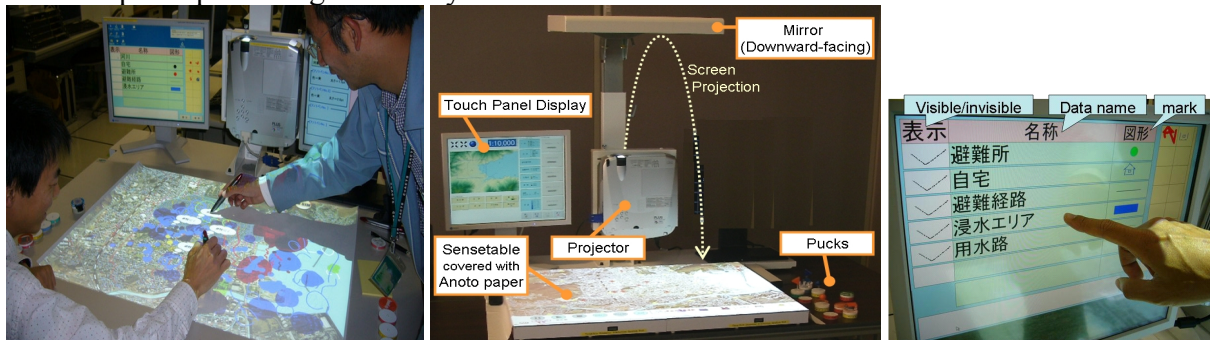


Figure 2. DIGTable in use. Figure 3. Prototype setting(left), and touch panel display for data labeling(right).

3. Implementation

This system is based on a tabletop interface, which can wirelessly detect multiple remote tag locations using electro-magnetic sensing technology such as Sensetable [6]. A “puck” has three tags inside so that the table can detect its location and rotation angle on the table. A video projector and a mirror are installed to project digital maps and simulation results onto the surface of the sensing table. Anoto [1][3] paper covers the surface of the table so that users can draw directly on the screen by digital pens as well. The digital pen is a ballpoint pen with an embedded camera that reads the dot pattern printed on the paper to digitally track the stroke.

Tracked stroke data is sent to the computer using Bluetooth in real-time, transformed into graphical images, and projected to the tabletop. There is also a touch sensing display that allows users to label input data.

2.1. Create a disaster prevention map

As a first step of a DIG session, participants collaborate in making a disaster prevention map. The goal of this task is to understand the town's structure, check important facilities such as places of refuge, and identify potentially dangerous areas in their town. Based on commercially available digital map data, this system can display many geographic objects including buildings, rivers, road networks, and landmarks, as well as disaster prevention facilities.

Users can make marks directly on digital maps with digital pens (Figure 4). The system treats drawn strokes not simply as a sketch on the map, but as GIS data. Therefore, the system can instantly reflect these data in simulations to be described. We designed each mark to be automatically distributed into one of three GIS data types: point data, line data, or polygon data. If the length of a stroke is smaller than the threshold value, the stroke data is converted into a "point." If the length of a stroke is larger than the threshold value and the distance between the origin and the end of the stroke is far enough apart, it becomes a "line." Otherwise, it is converted to a "polygon" and the system fills the region. All the data is sorted by color as well. It is possible to change pen color and thickness by touching a physical palette with a digital pen.

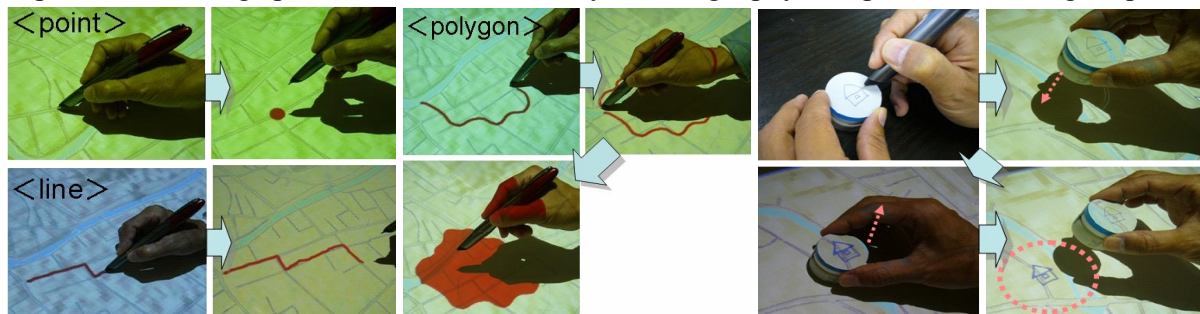


Figure 4. (from left) Inputting a point, a line, a polygon, and a stamp.

Users can associate a name with the input data with respect to each of the above-categorized groups, by selecting one of the names, a target data type, and color on the touch-sensing panel of the legend (Figure 3(right)). Once labeled, each data group is treated as a layer so that it can be set visible or invisible collectively.

We also implemented the so-called "stamp" function, taking simultaneous advantage of the digital pen function and the physical input objects. To create a new stamp, a user draws an icon on a small piece of Anoto paper attached to a "puck" by using a digital pen. When the stamp puck is placed on any point of the map, the sensing table detects the puck's location and angle. Then the system leaves a "digital copy" of the icon on the point, as though the icon is literally stamped (Figure 4 right).

2.1. Simulate disaster and evacuation scenarios

With a digital pen, the user can input an inundation area of 5, 10, 15, or 20 minutes after an earthquake by drawing the appropriate lines. The system then automatically inputs the tsunami data for the intervening time for smoother animation (Figure 5 left).

Users can input an evacuation plan in the following two ways. With TUI, a user can set the location of his or her house by placing a house-shaped physical piece on the map. The 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 5(TUI mode)). In the pen mode, users need to trace evacuation routes from their homes to a shelter. We implemented a route search algorithm that looks up the existing closest route to the handwritten figure on a real road map (Figure 5(Pen mode)). After the simulation starts, a person image appears and moves toward the specified destination along the evacuation route (Figure 5 right). In this way, users can examine their evacuation plans.

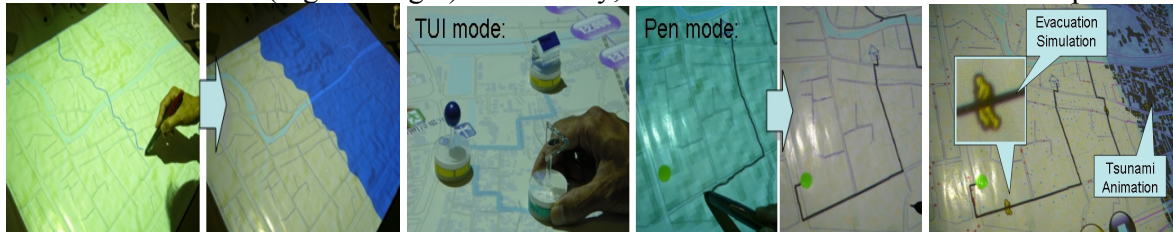


Figure 5. (from left) Create Tsunami data, set evacuation plans, and run a simulation.

4. User Experience

We have demonstrated this system to the visitors and colleagues in our company, and more than 20 people have interacted with the system so far. We informally observed the interaction and collected feedback from them. As we intended, we have seen that most users enjoy and make full use of the DIGTable without additional instructions. They also reported that they enjoyed the interaction with the DIGTable. We observed that users utilized “stamp” function to make their own “icons” for the disaster prevention map. For instance, a person repetitively drew a mark that meant “school” or “home”. A disaster education professional commented that the simulation function of this system would help users imagine and learn the temporal behavior of disasters, unlike the traditional tool (static paper map). Regarding future improvements, some of the participants complained that the shadow caused by their hands was too obtrusive especially during tracing routes with a pen. Another major comment was about data types. The participants sometimes wanted to more freely write letters, short lines and hatching as well.

6. Conclusion

We present the DIGTable, which is designed and developed to support the group work-based disaster education method, DIG. We studied the normative instruction methods and tools used in current DIG sessions in Japan, and designed a tabletop disaster simulation system.

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