Interaction Design of 2D/3D Map Navigation on Wall and Tabletop Displays

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ABSTRACT
We propose interaction design of a map navigation system that displays Google Maps on a tabletop display, and Google Earth and Google Street View on the wall display. In Google Maps on the table, we introduce the use of hand gestures to pan, rotate, and zoom for providing basic interaction. We also introduce a function that enables comparison of maps of different scales and locations. In Google Earth on the wall, the user can see the 3D world from a bird's-eye view by linking Google Maps and the proposed hang glider device, creating the sense of flying on Google Maps. Google Street View can be displayed on the wall and the user can move around it by using the finger gesture of walking on the table.

ACM Classification Keywords: H5.2 [Information interfaces and presentation]: User Interfaces. - Interaction styles, Input devices, and strategies; H5.1 [Information interfaces and presentation]: Multimedia Information Systems - Artificial, augmented, and virtual realities.

General terms: Design, Human Factors

Keywords: Gesture Operation, Wall Projection, Tabletop, Navigation

INTRODUCTION
Digital maps, such as Google Maps and Bing Maps, store large amount of geographic information and its scale can be adjusted easily. As a result of these becoming famous, convenience of the map has greatly improved. In addition, using 3D maps, such as Google Earth and Google Street View, enables user to get detailed information regarding the town scenery and 3D geographic information such as overview of buildings.

The field of study that aims at expanding workspaces and realizing efficient electronic work has been developed [1-2]. In this field, some studies focus on map applications utilizing large workspaces [3-4]. Ajaj et al. [5] provided a method to collaborate 2D map and 3D map using touch table and wall display. Forlines et al. [6] developed a collaborative system that controls the view of Google Earth on multi-displays. However, these methods require manipulation on the touch table to change the view of the 3D map view on the wall display. Ullmer et al. [7] developed "metaDESK" that presents the 3D map in a small monitor when the monitor is moved around the table displaying 2D map. This method also has a limitation that user cannot see the 3D map from any angle.

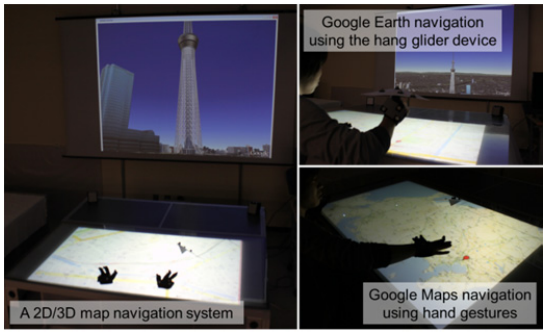


Figure 1: A 2D/3D map navigation system

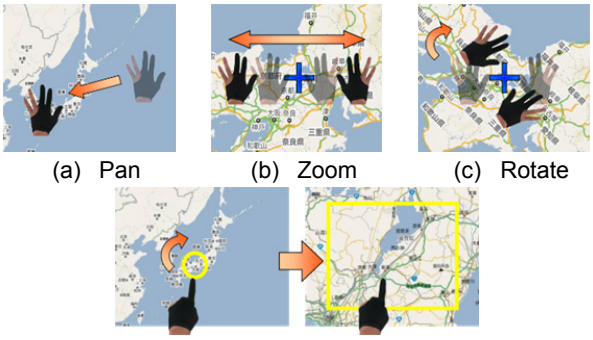
On the basis of these previous studies, we developed a 2D/3D map navigation system that displays Google Maps on the table, and Google Earth and Google Street View on the wall, as shown Figure 1. In this paper, we describe four interactions that aimed at realizing intuitive and efficient map navigation by introducing the use of hand gestures and a physical device as a real world metaphor.

INTERACTION DESIGN

Basic interaction for Google Maps navigation
The large Google Maps displayed on the table is controlled with hand gestures as shown in Figure 3. These gestures are detected by motion capture system.

We use hand gestures to pan, rotate, and zoom to provide basic interaction with the 2D map. These are similar to the hand gestures that are used in general tabletop systems. In addition, we provide a function that zooms a selected region on the 2D map by drawing a circle on it. This function was incorporated because when the user wants to see the specific region, he/she often is annoyed by having to zoom many times.

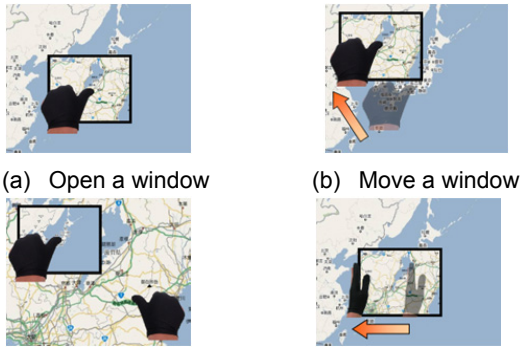
ITS 2011, November 13-16, Kobe, Japan.



(a) Pan (b) Zoom (c) Rotate

(d) Selecting zoom

Figure 2: Gesture commands for basic interaction



(a) Open a window (b) Move a window

(c) Replace maps (d) Close a window

Figure 3: Gesture commands for multi-window navigation

Multi-window navigation on the table

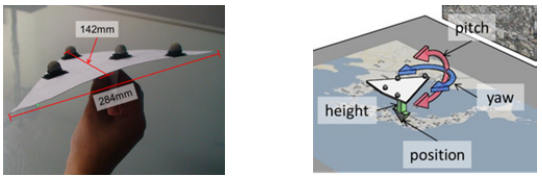
We introduced multi-window navigation in the 2D map, as shown in Figure 3, to enable users to compare maps of different scales and locations. The user can open sub-windows and move each sub-window with hand gestures. In addition, the user can replace the main map with a map of the sub-windows. These gestures are designed to use thumb mainly for ease of learning, but when closing sub-window, we employ a gesture of placing a palm vertical to the table and move it to prevent unexpected close.

Google Earth navigation using Google Maps and hang glider device

The user can handle Google Earth on the wall by using Google Maps on the table and a hang glider-like interactive device shown in Figure 4(a). Thanks to this device, the users are not required to memorize gestures for navigation, and can determine the view of Google Earth by intuition. As the hang glider device is moved around Google Maps, as shown in Figure 4(b), the bird's-eye view from the device is accordingly projected on the wall.

Google Street View navigation using hand gesture

The Google Earth displayed on the wall can be switched to Google Street View when the hang glider device is positioned on the location that has Street View data and the user make a gesture of sliding a bar that is displayed along the edge of the screen at that time. In Google Street View navigation, the user moves to the next location by the hand gesture that signifies that of walking on a road, i.e., touch



(a) Hang glider device (b) Operation using the device.

Figure 4: Hang glider device for Google Earth navigation

(a) Walk (b) Rotate

Figure 5: Gesture commands for Google Street View navigation

the table with a forefinger and a middle finger and move the fingers back and forth (Figure 5(a)). To rotate the direction of the view, picking in the air and moving it from side to side (Figure 5(b)).

CONCLUSION

In this paper, we introduced a map navigation system that links and handles Google Maps displayed on a table and Google Earth and Google Street View displayed on a wall. In this system, we realized interactions by using metaphors such as digital map as paper map, moving to a destination as walking on the road, and changing the viewport as flying through the 3D world by using hand gestures and a hang glider device. As a result, we accomplished intuitive map handling smooth accessing of multiple maps, and easy comparison of two or more maps.

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