Interaction Design for Selection and Manipulation on Immersive Touch Table Display Systems for 3D Geographic Visualization

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Monoscopic Touch Tables

With monoscopic rendering our stereoscopic vision lets us perceive the surface of the display, even when other depth cues render the objects below or in front of the surface. Natural and intuitive multi-touch interaction is achieved by mapping finger motion to object motion on the surface, as directly as possible. The user selects an object to manipulate by tapping on the object rendering itself with their finger or simply put their finger on it and drag the finger over the surface to manipulate its position. Many popular applications, for instance almost any map on a tablet, follow this principle.

This approach to multi-touch interaction can be formulated as these design principles:

- **touch interaction should be on the object interacted with**, and
- **dragging one or two fingers over an object should transform that object so that both fingers stay on the same position on its surface.**

We have realized the design principles above into a basic design. The user selects an object to manipulate by tapping on the object itself with their finger or simply put their finger on it and drag the finger over the surface to manipulate its position. When selected, the object also shows handles for scaling, another detail common in 3D applications, in particular modelling software. Interacting with the main handles will move those handles to follow the finger at a constant height. To manipulate height there are additional, separate handles that allow movement up and down, like a slider.

This study was funded by the Swedish Transport Administration and the LFV Air Navigation Services of Sweden through the project UTM CITY.

Stereoscopic, Immersive Touch Tables

With a stereoscopic display and rendering the touch screen itself is invisible to the user. If we do not want to force the user to keep the screen position in their mind during interaction but we still want tactile feedback and interaction only on top of visible objects, then we need to modify our design principles. It is no longer possible to interact by touching directly on the objects, located below the screen.

Thus, another surface must be given for interaction, on the surface of the touch table. We suggest, then, these new design principles:

- **each object that can be interacted with should provide an interaction surface, co-located with the touch screen, for the user to perform multi-touch interaction on,**
- **the interaction surface should be graphically rendered in a way that provides an intuitive link to the main object,** and
- **dragging one or two fingers over such a surface should transform that surface so that they stay on the same position on it, and the linked object should be transformed correspondingly.**

The new design is shown in the figure, with one rectangular surface allowing 2D translation with one finger, and four handles that allow for 2D scaling of the box with a single finger. In the design the interaction surface is a projection of the main object onto the touch screen, however not necessarily through an orthogonal projection. Also, the projection may contain all kinds of visual information about more complex objects than the cuboid of our example.

The pinch-to-zoom metaphor, that could be used on the interaction surface to provide uniform scaling, can instead be used to move the object in height. Think of this as pulling apart the two ends of a string that has its mid section tucked down a hole. Likewise, this *string-in-a-hole* metaphor can be applied on the handles to allow for vertical scaling.

In this poster we consider the interaction design for selection and manipulation through touch on the display of 3D geographic visualization—in our case the visualization of drone traffic over rural and urban areas—focusing on moving from a monoscopic to a more immersive, stereoscopic touch table, and how this move affects the interaction design. Moving to a stereoscopic display, for increased sense of immersion, the graphics no longer provide visual cues about the location of the screen. We argue that this motivates modification of the design principles, with an alternative interaction design.