MouseHaus Table, a Physical Interface for Urban Design

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ABSTRACT
MouseHaus Table is a computationally enhanced physical environment that supports collaborative urban design discussion. The system consists of a custom-made table with a rear projection screen, a video camera, projector and a simple pedestrian simulation program. MouseHaus Table provides a physical interface that enables participants who have no previous computer experience to interact with a pedestrian simulation program.

KEYWORDS: tangible user interface, pedestrian simulation, urban design, collaboration.

INTRODUCTION
Providing urban information for public participation may improve the quality of the design process and enable the community to express design criteria and alternatives that designers might not anticipate. Interactive simulation can offer powerful tools to facilitate this discussion. MouseHaus Table provides a multi-user environment with a simple pedestrian movement simulation program to engage discussion in the urban design context.

The MouseHaus Table physical interface, which uses ordinary objects in the design process, is a proof of concept prototype of a tangible user interface for collaborative design. Users show objects (for example, pieces of colored paper) of their choice under the camera and objects’ properties (for example, color) are recorded. The system allows these registered objects to represent urban elements when constructing a layout for simulation. MouseHaus Table bridges physical object manipulation, group activity, and computer simulation of pedestrian behavior. A preliminary user study showed that greater group interaction resulted when using the MouseHaus table with paper and scissors as input devices compared with using MouseHaus Table with a mouse input.

SCENARIO
The State Department of Transportation is in the very early planning stages for a multi-modal transportation center. The College of Architecture and Urban Planning has been asked to hold a design charrette to generate ideas for this plan. A visioning session, with a public presentation and exhibition, is planned to engage community members in discussing the neighborhood development.

Figure 1 Interaction in the MouseHaus Table

We provide a visioning tool, MouseHaus Table, to help collaborative stakeholders evaluate the pedestrian behavior of alternative street layouts. Stakeholders use scissors to cut out paper rectangles which represent the buildings or parks and then place them on the MouseHaus Table to create a street layout (Figure 1). The embedded simulation program in the MouseHaus Table then provides pedestrian movement feedback using the street layout. When a specific street layout is arranged and activated, the pedestrian agents start to appear on the table. These pedestrian agents perform behaviors such as moving between the buildings or resting in the parks. Stakeholders can discuss the arrangement of the different urban elements on the table. Certain layout designs may affect the pattern of pedestrian movement and impact density points in the urban space. The system can save these patterns for later discussion. Stakeholders may rearrange the street layout to produce the preferred movement pattern and density level for the urban space.

SYSTEM ARCHITECTURE
The hardware setup for MouseHaus Table consists of a custom-made table with a rear projection screen, a video camera and projector (Figure 2). We implemented the system with common and inexpensive computer peripherals.
that can easily be made available for use at any community meeting.

MouseHaus Table is a physical interface for the MouseHaus pedestrian simulation program, which is implemented in Java by Therakomen [3]. The physical interface is driven by an image processing program employing Java Media Framework to capture and analyze an image. We wrote a Java application to capture individual frames from the real-time camera stream and process the image. The image processing program has two parts: a Physical Objects Register and an Object Detector.

The Physical Object Register uses color to distinguish objects one from another. Users must put the objects that they want to use to represent urban elements under the video camera to complete the registration process. After registration, when users place previously registered objects on the table, the Object Detector will scan the image, get the colored objects, and interpret them as urban elements. The location and dimension information of the urban elements will be recorded and translated into a street layout in the MouseHaus simulation program.

DISCUSSION

A vision-based tabletop workspace has been an appealing topic for HCI researchers since the early DigitalDesk [5] application. Projects such as Envisionment and Discovery Collaboratory (EDC) [1], Urp [4], and Illuminating Clay [2], further applied tabletop digital media into an urban design or landscape planning context. Unlike other tangible user interface projects that depend on pre-configured gadgets, MouseHaus Table attempts to implement an interface using ordinary objects.

Table 1 Number of layout changes made by different participants.

<table>
<thead>
<tr>
<th>ID</th>
<th>Paper-Scissors Trial</th>
<th>Mouse Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
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<tr>
<td>B</td>
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</tr>
<tr>
<td>C</td>
<td>7</td>
<td>7</td>
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</tbody>
</table>

In a preliminary study we found that participants generated more verbal discussion and gesture interaction using the paper-scissors interface than a mouse interface to the MouseHaus simulation. They participated more fully in the paper-scissors sessions. For example, participant A did not engage in any layout arrangement in M2 (the mouse interface trial no. 2), and M3, but changed the layout 9 times in P1 (the paper-scissors interface trial no. 1), 9 times in P2, and 7 times in P3.

These preliminary data suggests that the MouseHaus Table, or more generally, applying computer augmented physical objects into a collaborative design process, has the potential to enhance interaction.

The current mechanism for MouseHaus Table has the limitation of using only color to differentiate objects, and the system is sensitive to lighting conditions. We plan to implement a better calibrating process to improve the performance of MouseHaus Table. Other future work includes testing the paper-scissors and mouse interfaces and investigating group dynamics. The interface test will have two independent variables, each with two levels: interface types (Paper-Scissors vs. Mouse) and urban element inputs (pre-defined shapes vs. free shape). For the group dynamic part, we plan on developing an interactive coding system to investigate the pattern of using a tangible interface in group interactions. The findings will be useful in incorporating tangible interfaces into group collaboration.

ACKNOWLEDGEMENT

This research was supported in part by the National Science Foundation under Grant No. EIA-0121326. The views contained in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

REFERENCES