Gesture Interaction for Wall-Sized Touchscreen Display

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Abstract
In order to improve the user experience in a large touchscreen, this research introduces gesture interaction into wall-sized touchscreen. According to the distance between user and display, we create two interaction modes for touch and body gesture respectively. Challenges encountered and prospects for further improvement are also investigated.

Author Keywords
Public display; large display; touchscreen; gesture interaction

ACM Classification Keywords
H.5.2 User Interfaces

Introduction
While keeping the consistency of users' experience with their private touchscreen devices, a wall-sized touchscreen can vastly enhance the immersion in virtual reality [5]. However, as touchscreens become larger, there are problems such as: user cannot have an overall view while being closed to a large display; long-range gestures require excessive movements; some parts of the screen is not easy to reach, etc. Since body gesture interaction has been widely discussed as a suitable solution for large interactive displays [6], we decide to introduce gesture interaction

into a wall-sized touchscreen. Similar to our study, Bragdon et al [2] explored a combination of touch and body gesture interactions for a public display. But they did not discuss the problems of large touchscreen since they only used a normal-sized LCD in their installation.

This research solves some existing problems of large touchscreen display by presenting two different interaction modes based on the distance between user and screen. We also discuss the prospects and challenges of utilizing both touch and gesture interaction in a single installation.

Existing Problems of Wall-Sized Touchscreen

Our previous work ported a 3D mapping application [4] onto wall-sized touchscreen display [8]. While utilizing the wall-sized touchscreen, we found out a few problems of large touchscreen:

- In general, investigating places of interest is the primary task in a 3D mapping service. However, when touching the screen under a wall-sized display, it is not easy to have an overview of the whole scene, making it not intuitive to navigate the view such as panning or zooming. In our previous work, we used single static view to cover the whole scene, which contained only few city blocks. But once the scene cover larger areas, view navigation will be necessary.
- Since the display is several meters wide, users may have to walk when they drag-and-drop. Meanwhile, as large display is usually a combination of several LCD cells, the bezels between them could block a long range drag-and-drop gesture.
- Under certain circumstances, menu selections may require excessive movement. For example, users may have to walk from one side of the display to another only for a button then go back to the original place.
- As a large display is generally taller than people, it is uncomfortable for certain users to reach the upper part of the display and even impossible for some young users or users on wheelchairs.

Solution

To address the existing problems, we decide to further discuss the distance between user and screen. Vogel and Balakrishnan [7] explored the relationship between implicit and explicit interaction by setting up four interactive zones for their installation. Hawkey et al [3] the near/far conditions of co-located users interacting with a large display. Inspired by these researches, we create two interaction modes according to the distance between user and screen (figure 1): 'Near-Mode' for touch interaction; 'Far-Mode' for gesture interaction.

- Near-mode (figure 2) is used for touch-based interaction including tapping (e.g. clicking hotspot icons for pop-up information); typing (e.g. entering keywords for searching); short range dragging (e.g. dragging scroll bars in pop-up windows).
- Far-mode (figure 3) can detect user's gesture using Kinect. Keeping certain distance from the display, users can have an overall view of the scene, which is a clear advantage for 3D navigation. By simply moving arms, users are able to reach menus everywhere on the screen or drag-and-drop across the display. Besides, with the help of gesture interaction, even some young or disable users can easily interact with the application.

We do not set a specific boundary to divide these two modes. Instead, we add a window to show the depth

Figure 2. Clicking a hotspot for pop-up window in near-mode.

Figure 3. Gesture interaction in far-mode.

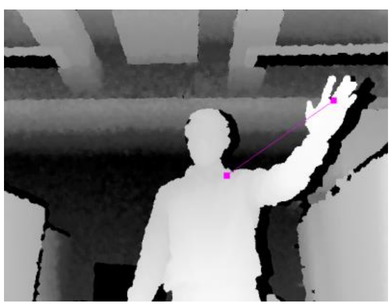

Figure 4. Depth image generated by Kinect, also showing the relative distance between the first tracked point and active tracking point.

image generated by Kinect, also indicating the hand tracking by the application (figure 4). Whenever a user is tracked, far-mode would be activated. Since the practical ranging limit of Kinect sensor is about 1.2 to 3.5 m, when touching the screen in near-mode, it is less likely to trigger far-mode by mistake. One user is served at a time starting from far-mode. After finishing the tasks in far-mode, user would be prompted to touch the screen for further interaction. If needed, user can step back to activate far-mode again.

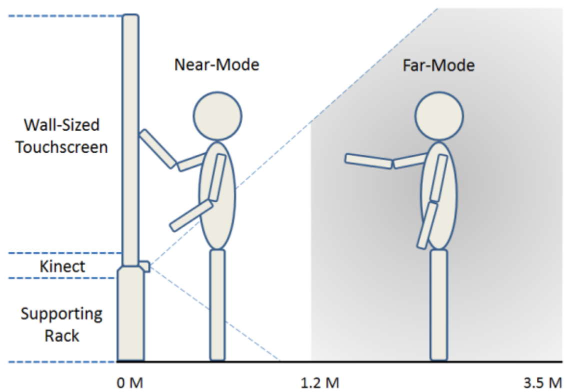

Figure 1. Creating two interaction modes based on distance.

Implementation

The installation is based on our previous wall-sized touchscreen dubbed 'UBI-wall' [8], with six 55 inches MultiTaction LCD cells in a 3×2 tiled array, resulting in a display of total size of 373×143 cm. The whole installation is elevated by a 75 cm tall supporting rack, connected to a single computer (Intel® CoreTM i7-3770 CPU @ 3.40 GHz × 8; 16 GB RAM; GeForce GTX 670 2 GB × 3). A Microsoft Kinect sensor is also placed in the middle of the supporting rack, right below the bottom of the display (figure 1).

Using the RealXtend Tundra SDK [1], we built a plugin for OpenNI, an API framework for natural interactive devices. With the depth and gesture data offered by Kinect, we are able to achieve the following functions:

3D navigation

Generally, view navigation is the primary task in a 3D mapping service, which is why we chose 'wave' gesture (like saying hello to the installation) to activate 3D navigation. Once a hand is tracked, the scene camera could be panned vertically or horizontally as the hand moving up/down or left/right. Pushing and pulling indicate zoom-in and zoom-out. The application marks down the first point where the hand is tracked, then calculates the relative distance between the active tracking point and the first point (figure 4). In case the movements are too sensitive, we set a threshold for this parameter. Once greater than the threshold, the relative distance is linear correlative with the camera moving speed. User can wave again or put down the arm to deactivate tracking.

Main menu selection

In near-mode, users can interact with small-sized touch interfaces for different hotspots in the scene (figure 2). However, the application needs a main menu for overall functions such as searching, filtering, helping and setting etc. In this case, we build a large-sized menu in far-mode, activated by the 'pick' gesture. User can move the arm forward then backward to pick up a hand-shaped cursor. Once the cursor stays on top of a button for 2 seconds, the button would be clicked.

Drag-and-drop function

For keeping the consistency, drag-and-drop function shares the same gesture as menu selection. For example, when users want to drag an item into the shopping cart, they can pick up the hand-shaped cursor by 'pick' gesture and move the cursor on top of the item. After staying for 2 seconds, the item could follow your movement to reach the shopping cart, where to stay another 2 second to drop the item into.

Assisting young or disable users

With the help of gesture interaction, some young or disable users can also freely explore the scene and manage limited interactions. So far, the application requires both touch and gesture interaction for full functions. In the future, we plan to add a mode for special users, by adjusting the whole application to gesture-based, allowing them to have the full control of all modules only with gesture interaction.

Discussion

This approach shows an encouraging result of complementing the wall-sized touchscreen installation with gesture interaction. The biggest challenge encountered in this study is utilizing both touch and gesture interaction in a single installation. To overcome the challenge, we set up near and far modes for touch and gesture interactions separately. Solving the existing problems of large touchscreen, our method offers better user experience in a wall-sized touchscreen display. In the future, multi-user scenario in a large touchscreen should be further explored. Also, real-world user evaluations can be made, in order to better discuss how distance between user and screen can affect user's perception during the interaction.

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