A Design on Gestural User Interaction Techniques for Tiled Displays Using Kinects

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Abstract. With increased popularity of large tiled displays, a range of user interaction techniques have been explored in HCI, but gesture-based interaction mechanisms for tiled displays are still under investigation. This paper presents the design and implementation of gestural interaction techniques using Kinect sensors, designed for supporting natural user interaction for tiled display system. In particular, the Kinect interaction manager aggregates user skeleton data from the sensors, analyzes positions and changing user postures to recognize user gestures and triggers the Kinect handler to generate gestural interaction events that can be used for tiled display applications. We have built two tiled display applications with this interaction mechanism and it shows promising results in terms of user experience and performance.

Keywords: Tiled Display, Natural User Interaction, Gestural Interface, Kinect sensors.

1 Introduction

Nowadays public display devices tend to become increasingly large and high-resolution as the cost of display hardware has fallen and consumers prefer high-quality images. However, current public displays (composed of a single large display or tiled displays) are primarily used for information delivery. With the fast growth of emerging technology, multiple user interaction with contents on large public displays has received more growing attention. Large and scalable high-resolution tiled displays have been used in scientific visualization and analysis of multidimensional complex data sets allowing visual detection of patterns that increases user performance. Now they are used in many other application domains such as virtual reality, game and digital signage. However human-computer interaction on tiled displays is challenging as it leads to more physical user movements.

Clearly, tiled display user interaction is not well supported by traditional desktop computer interfaces such as mouse and keyboard due to the screen size and resolution. Typically the tiled display is too wide so that users cannot perceive all

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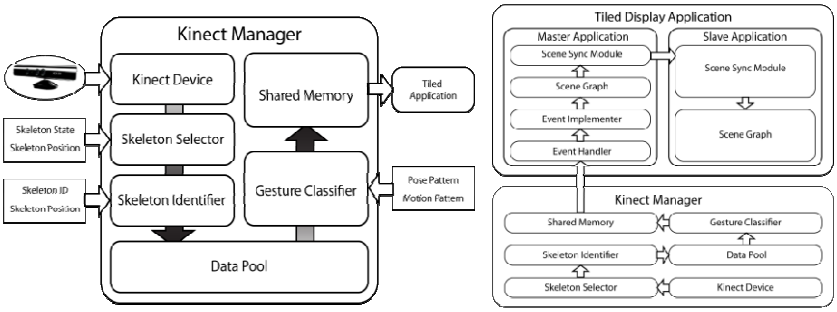

Fig. 1. The overall system architecture design

contents at a glance. It is also inconvenient to keep track of a mouse cursor and to move the cursor across the large screen [1]. Hence it is necessary to develop new input mechanisms for more natural user interaction from any point and distance on the tiled display. While a variety of interaction techniques for tiled display have been investigated in HCI [2, 3, 4], gestural user interaction mechanisms have not yet been thoroughly explored. In this research, we therefore exploit gestural user interaction techniques using Kinect sensors which address the mobility requirement but also provide natural user interaction with the tiled display system.

The current research and development of tiled display interfaces is widely ranged including physical movement, laser-pointer, multi-touch, mobile device, 3D gyro mouse, motion sensor based interface like Nintendo Wii remote controller and vision-based gesture interface like Microsoft Kinect [2,3,4]. However, there is no single user interface standard for the tiled display existed yet and there are several systematic challenges needed to be addressed. One challenge is how to help users interact with the contents (such as navigating the virtual world or selecting, moving, scaling, and rotating objects) on the large tiled display viewing from a distance.

In this paper, we present the design and implementation of the Kinect gestural user interaction system using Kinect sensors on the tiled display. This system is designed to support natural user interaction for a high-resolution and scalable tiled display by the Kinect Manager and the Event Implementer for the tiled display application module.

2 Design and Implementation

Fig. 1 shows the overall architectural design of the Kinect gesture-based user interaction system for the tiled display. This system design is divided into two components: the Kinect Manager and the tiled display application module consisting of the Event Implementer. The Kinect Manager processes user skeleton data aggregating from Kinect sensors to recognize meaningful user gesture data (such as swipe, wave, walk, etc) and to generate gesture types and event messages for the tiled display applications. This mechanism enables sharing user gestural controls to interact with any tiled display applications.

Fig. 2. The snapshot of user's navigating and catching insects in the Insect Safari (left) and selecting and manipulating images in the ImageWorld (right)

Microsoft's Kinect sensor consists of RGB camera, depth sensor (IR projector and camera) and multi-array microphone configuration. Kinect SDK library provides the color image, grayscale depth image, and the users' skeleton information (twenty-one points in 3D coordinates) using RGB camera and depth sensor through two-dimensional face recognition and three-dimensional depth value.

In the Kinect manager, each Kinect adapter collects raw user skeleton data obtained from the Kinect device. The Skeleton Selector analyzes raw data received from the Kinect adapter to classify the valid data and the Skeleton Identifier assigns the identification number for the valid skeleton data. Then, these data are accumulated in the Data Pool. The Gesture Classifier recognizes the position of user skeletons and the pattern of changing user posture. For example, when a user moves knees high above the ground, "walk-in-place" gesture is recognized. Finally, such recognized gestures are stored in the shared memory to be used as inputs to the tiled display application.

The gesture types and events are then used by the Event Handler to generate events in the master's tiled display application. Only the necessary gesture information is processed and sent to the Event Implementer of the tiled display application. The event implementer is defined to suit the characteristics of each tiled display application to handle the event of the user's gesture. A separate event implementer is used for each tiled display application depending on the user's gesture interaction design. For example, "Swing-Right-Hand" gesture recognized by the Kinect Manager can be processed to throwing a ball in the baseball game or wielding a fist in the fighting game.

Fig. 2 shows the photograph of user's standing in front of the tiled display and interacting with the application using hand and body gestures without the need for any interface devices. This tiled display system has a high quality resolution of 2456x12288 pixels (42.5 M pixels). In the Insect Safari (on the left image of Fig. 1), the player's "walking-in-place" and "twisting shoulder" gestures are used for 3D navigation in the virtual world and "swiping-hand" or "shaking-hand" gestures for catching flying or ground insects. In the ImageWorld (on the right image of Fig. 1), the users can freely move their hands in mid-air to select images directly by "pushing" gesture and then translate, rotate and scale the images by two-hands "sliding", "turning", "pinch-and-stretch" gestures.

3 Conclusions

In this paper, we presented the design and implementation of gesture-based user interaction techniques using Kinect sensors designed for supporting natural user interaction on a scalable high-resolution tiled display. Unlike other user interaction technologies, this gesture-based user interaction mechanism allows users to freely interact with the tiled display applications without having to use separate input devices. We developed two applications built using this interaction method, demonstrating the possibility of using various kinds of gestural user interactions for the tiled display. The proposed method meets the scalability of tiled display system while allowing multiple users to interact with tiled display applications in a certain distance from the screen. Thus, we expect that it will contribute to increase the utilization of tiled display system.

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References

1. Robertson, G., Czerwinski, M., Baudisch, P., Meyers, B., Robbins, D., Smith, G., Tan, D.: The Large-Display User Experience, pp. 2–9. IEEE CG&A (2005)
2. Badillo, B., Bowman, D.A., McConnel, W., Ni, T., Silva, M.: Literature Survey on Interaction Techniques for Large Displays. Technical Report TR-06-21, Computer Science, Virginia Tech. (2006)
3. Daniel, D., Hagen, T.-M.S., Bjorndalen, J.M., Anshus, O.J.: Gesture-Based, Touch-Free Multi-User Gaming on Wall-Sized, High-Resolution Tiled Displays. Journal of Virtual Reality and Broadcasting 5(10) (2008)
4. Davis, J., Chen, X.: Lumipoint: Multi-user laser-based interaction on large tiled displays, Displays 2002, vol. 23, pp. 205–211. Elsevier (2002)