Concepts of Interaction with Projected Displays Using Gestures

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1   Introduction

In recent years, projection has been increasingly regarded as a new means for ubiquitous visual output. Different projector models have been developed to project on arbitrary surfaces, for example the *Everywhere Displays* (ED) projector [1] or the *Fluid Beam* system [2]. Using such projectors, the environment can be turned into a continuous output interface, on which visual information can be displayed. In order to give users the opportunity to interact with these projected displays in a natural way, new concepts of user interaction have to be developed and evaluated.

The main goal of the presented work is a transfer of the interaction space from the conventional desktop space to the real world, where the projected displays are located. This requires a development of novel interaction methods taking into account the particular features of projected displays. For this purpose, appropriate interaction devices and techniques have to be identified and, if necessary, special user interfaces have to be created.

2   Hardware and Software Setup

The projected displays which we are working with are realized using the *Fluid Beam* system [2]. It is a system for distortion-free projection on suitable surfaces in an instrumented room. The hardware consists of a projector and a digital camera fitted into a steerable unit with two degrees of freedom (see fig. 1 left). In this way, the *Fluid Beam* unit can be rotated horizontally and vertically, and thus it can be directed at almost any surface in the room. The *Fluid Beam* software corrects image distortion due to oblique projection, so that it is possible to display information on any suitable flat surface. Using this technique, a virtual layer covering the surfaces in the room is provided, on which virtual displays can be created and moved, which leads to the development of a *display continuum.*

Fig. 1. Hardware setup: steerable projector and camera unit of the Fluid Beam system (left); Wii Remote interaction device (center); the three rotation axes of the Wii Remote (right)

Our approach of enabling interaction in the real world is based on gestures. One possibility to recognize hand gestures, beside computer vision techniques, is the use of acceleration sensors attached to the user's hand. Such sensors are integrated e.g. in instrumented gloves like the CyberGlove[3] or the WInspect Glove[4]. A popular alternative to capture acceleration data from the user's hand is offered by the recently released remote controlling device of the Nintendo Wii gaming console, the so-called Wii Remote (see fig. 1 center). Beside its motion sensing capabilities through the use of accelerometer technology, the Wii Remote provides further input modalities like buttons and an infrared camera. It is also capable of giving feedback to the user in the form of sound, vibration or flashing lights. Moreover, the Wii Remote is an affordable hardware that allows the development and testing of gesture-based interaction. The presented concepts can however be transferred to instrumented gloves like e.g. the WInspect Glove mentioned above.

3   Interaction Concepts

The *Fluid Beam* system offers the possibility to create projected displays, to adjust their size, their positions and the displayed content or to move them over the surfaces in the environment to some desired locations. In the initial version of the system, these functions are supported by a 3D interface showing a model of the environment, in which the projected displays can be manipulated indirectly by their correspondents [3]. In order to transfer the interaction space into the real world, we propose a concept of using the display continuum offered by the Fluid Beam system for direct interaction with the projected displays.

3.1   Ambient Cursor

As a pendant to the mouse cursor on a desktop, we developed the *ambient cursor*, which is an arrow projected in the environment indicating the position currently aimed at for interaction (see fig. 2 left and right). This ambient cursor can be

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[3] http://www.cyberglovesystems.com
[4] http://www.wearitatwork.com/Clothing-I-O-Devices.199.0.html

moved along the surfaces of the room and thus for example steered to a location where the user wants to create a new projected display.
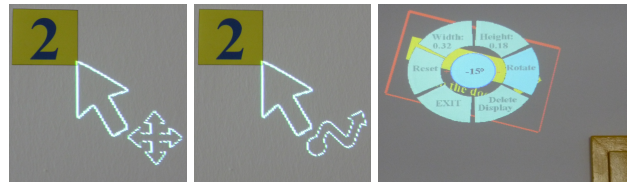

Fig. 2. Projected ambient cursor: in continuous gesture mode (left) and discrete gesture mode (center); projected menu while manipulating display rotation (right)

3.2 Gesture Interaction

When using the acceleration-sensing capabilities of the Wii Remote, we distinguish between two types of gestures: *continuous gestures* and *discrete gestures*. In continuous gesture mode, the acceleration output of the Wii Remote is immediately mapped to system output, e.g. movement of the ambient cursor or a display. In our application, continuous gestures consist in rotating the Wii Remote around one of its three axes (see fig. 1 right). They are especially suitable for triggering continuous functions like movement, in-/decreasing of numbers or rotation. Discrete gestures, on the other hand, are used to trigger command functions like the creation of a display or the opening of a menu. They consist in symbolical "air drawings" and are recognized using the wiigee toolkit[5]. In contrast to continuous gestures, the function triggered by a discrete gesture is not invoked until the gesture is completely finished. In order to indicate the current gesture interaction mode, additional symbols are added to the arrow of the ambient cursor (see fig. 2 left and right). The user can switch between the two modes using the buttons of the Wii Remote.

3.3 Interaction Context and Focus

In order to achieve an easy to use interaction concept, the set of used gestures and buttons has to be kept as limited as possible. This results in function overloading, when the same gesture or button input can refer to different system commands. In this case, interaction context plays an important role, as it helps resolving the ambiguities. Especially in the case of discrete gesture interaction, the context can be taken into account in order to limit the number of possible interpretations of the received acceleration data and thus reduce the probability of recognition errors of the wiigee toolkit.

As, in the presented application, there can be several objects with which the user

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[5] gesture recognition library: `http://www.wiigee.org/`

can interact (e.g. ambient cursor and different projected displays), it must be possible to switch the interaction focus between the possible interaction objects. This focus switching function is triggered by a discrete gesture and the user gets visual feedback indicating the currently focused object. A currently focused display is marked by a red border.

3.4 Projected Menus

As not every function required for the manipulation of projected displays can be supported only by gestures, several interaction menus are provided. For better usability, menus with a constant number of items are designed as pie-menus (see fig. 2 right) and these with a changing number of items as lists. Menus can be opened using gestures, which are interpreted according to the current interaction context.

3.5 Interaction Between Stationary Screens and Display Continuum

In order to be able to define the content for a projected display (image, video or live stream), interaction with stationary desktops must be possible. This is realized by automatically switching the interaction focus from the display continuum to a stationary screen as soon as the ambient cursor reaches its border. Thus, it is possible to create virtual displays on a desktop and drag them to the display continuum, where they appear as projected displays (see fig. 3).
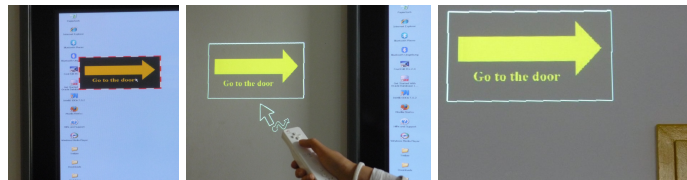

Fig. 3. Interaction with projected displays using a Wii Remote: virtual display created on a stationary screen (left); same display dragged out on the display continuum (center) and moved to a desired position beside the door (right)

References

1. Claudio Pinhanez. The Everywhere Displays Projector: A Device to Create Ubiquitous Graphical Interfaces. *Lecture Notes in Computer Science*, 2201:315–331, 2001.
2. Lübomira Spassova. Fluid Beam - A Steerable Projector and Camera Unit. In *Proceedings of the Doctoral Colloquium at the 8th IEEE International Symposium on Wearable Computers*, pages 56–58, Arlington, USA, October 2004.
3. Lübomira Spassova. Interacting with Projected Displays by Means of a 3D Interface and an Instrumented Bracelet. In *IEEE Symposium on 3D User Interfaces*, Charlotte, NC, USA, 2007.