Whole Body Large Wall Display Interfaces

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Abstract
This video demonstrates an application that uses a body-centric approach to support interaction with very large wall displays. The design is centered on a virtual body model that represents the users in the context of the workspace, relative to one another as well as to the display(s). This concept of *body-centric interaction* serves both as a design philosophy and an implementation approach and is both general and powerful. Our approach is general because if the model is detailed enough, a broad range of interaction techniques can be implemented. It is powerful because it opens up an entire class of new interaction techniques: those that depend on properties of a user's body, such as arm or hand pointing direction, head direction, or body location or orientation. The video highlights some of the body-centric interaction techniques that we believe are of value based on how people use their bodies in the everyday world.

Keywords
Large displays, interaction techniques, whole body interaction

ACM Classification Keywords
H.5.2. [User Interfaces]: Input devices and strategies

General Terms
Design

Introduction

Very large wall displays offer a format well suited to specific tasks, including brainstorming, lecturing, scheduling, and long-term coordination. While it is known that these displays hold great promise, it is also clear that the traditional methods of computer interaction, mouse and keyboard, are not well suited to these larger devices. It is necessary that we develop new interaction techniques appropriate for larger wall displays and the specific tasks that they support. We show work-in-progress that explores the design space of interaction techniques for large wall displays. Specifically, it shows an implementation of a *body-centric* interaction approach, where a virtual model of the users' state is maintained by the system and used for supporting interaction. A number of techniques based on this approach are demonstrated.

There is good reason to believe that a body-centric interaction approach is well suited to interaction with large wall displays. While computing systems must offer functionality in addition to what is possible in the physical world in order to be of value, it has been argued that interaction approaches supported by these computing systems should nevertheless be grounded in reality. Jacob et al. [2] defined a framework for *reality-based interfaces*, and argued that reality in interfaces should only be sacrificed when there are clear benefits, such as expressive power or efficiency. Related to this, Klemmer et al. made an argument for the importance of bodies in interaction [3]. They argue that our bodies should play as important a role in our virtual interactions as they do in our physical world interactions. Klemmer et al. investigated several themes, including *thinking-through-doing* and *visibility*, that highlight how our bodies can serve to enhance the interactive experience in different ways.

figure 1. Users collaborating with the prototype system.

Existing work has explored the role that bodies can play in interaction. Significant early work by Krueger et al. explored the use of body shadows in interactive art installations [4]. Shadows have also been investigated by other researchers for the purpose of supporting awareness in mainstream applications [1,5,6]. What past work has not done is look beyond one specific user embodiment (i.e. the shadow) to consider how the entire body can be leveraged to support interaction in a consistent, unified manner. This is the goal of our work in body-centric interaction.

Body-Centric Interaction

Body-centric interaction supports user interaction with virtual data so that natural body affordances are utilized to their maximum potential. In order to leverage the body in this way, the system must maintain at all times a computational model of the user's body and any relevant contextual objects (e.g.

displays, tables, tools, collaborators). The higher the resolution and more accurate the model is, the more effective it will be in supporting interaction.

The architecture of a body-centered interaction technique can be broken into three components. The first component is *sensing*, whereby raw data is captured from the environment. This data can be of any type, or a combination of types. This can include visual spectrum or infrared imagery captured from cameras, tracker data from a magnetic (e.g. Polhemus) or optical (e.g. Vicon) tracking system, or data from touch sensitive surfaces. The second component is *modelling*, where the sensing data is analyzed and a virtual model of the scene (i.e. users and context) is constructed. The computational operations performed in this stage, as well as the quality of the output models, depend on the sensing approaches used. The third component, *interaction*, is where the model is used to support interaction techniques. This component incorporates both the rendering of the interaction and the behaviour associated with it. An important aspect of this process is that the interaction technique is oblivious to the tracking approaches used. The implementation of the interaction technique simply queries the model of the users and the scene. The particulars of sensing are abstracted away, and indeed can be changed without the need to redesign or re-implement the interaction.

Implemented Techniques

This video demonstrates a suite of techniques that have been implemented following the body-centric interaction approach. These were integrated into an application that supports geographic visualization, exploration, and annotation. We give a short description of each of the techniques.

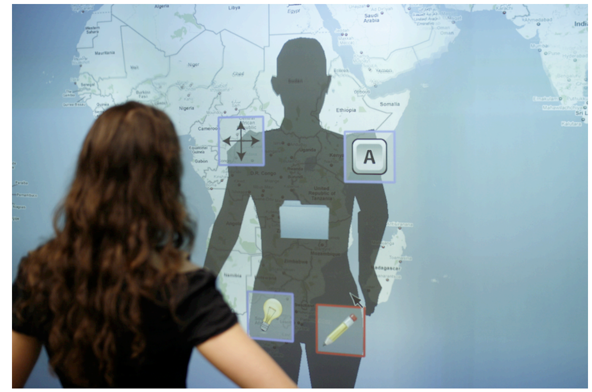

figure 2. A user selects a tool from her right hip.

Shadow Reaching

The application includes an improved version of the *shadow reaching* technique described by Shoemaker et al. [5]. The current implementation is more powerful because it makes use of a much richer 3-dimensional body model and because user interaction is abstracted away from the details of sensing. This allows us to switch easily between different sensing modalities. A similar abstraction of the rendering component supports a variety of different shadow visualizations.

Body-Based Tools

We introduce *body-based tools*. This is a technique whereby virtual tools are stored at physical points on the user's body. To select a tool or enter a tool mode, the user points at a particular part of the body in order to make a selection (Fig. 2). This technique leverages the power of human proprioception. Furthermore, by keeping the tools local to each user we solve the recognized problems of accessing small menus or toolbars on a large screen and of managing multiple instances of personal toolbars in collaborative settings.

Body-Centric Data Storage
This manages access to personal data in a shared application. The metaphor used is that a user's personal data is all stored in the user's own stomach. The user can use his or her hands to "dig" through the data store in order to access any desired data, and pull it out into the shared workspace. This technique shares many of the strengths of body-based tools.

Collaboration-Aware Body Shadows
Large wall displays are commonly used for collaborative tasks, and as such collaboration should be explicitly supported. We modify the behaviour of the shadows in the basic "shadow reaching" technique using the system's knowledge of where users are in the workspace. Based on proximity and orientation, the system infers whether or not multiple users are collaborating. If users appear to be collaborating the system constrains their shadows to be mutually consistent in order to minimize the risk of shadow conflict and user confusion. This is achieved by switching from the normal perspective rendering of shadows, which works well for a single user, to an orthographic projection that suits multiple users.

Collaboration-Aware Privacy Protocols
Because a large wall display is an environment in which both private and public data can be manipulated, it is desirable to have protocols to enforce privacy. Our system implements a protocol that leverages natural sharing cues from the physical world. In order for a user to share private data with a second user, the owner of the data must physically hand it to the second user. This protocol relies on the universal notion of personal space and invasion of that space, and it integrates privacy implicitly into the action of sharing.

Conclusions
Our ongoing work explores how a model of the users of a large wall display system can be leveraged in order to support rich physical-based interaction. We believe that body-centric physical-based interaction techniques hold great promise for supporting natural and powerful interactions with virtual environments, and that a body model-centric approach is effective in isolating the *sensing* and *interaction* elements of the process. We expect to present a full investigation of the body-centric interaction approach, and related system, in the near future.

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