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Research on Public, Community, and Situated Displays at MERL Cambridge

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Abstract

In this position paper, I discuss aspects of the research program at MERL Cambridge in public situated displays and interactions. We are working on a number of key enabling technologies including smart projective displays, multi-user touch, and computer vision for face detection. We have developed an initial concept demonstration for retail environments that includes an integration of some of these technologies. As we continue to develop technologies and tools, a key question at this point in our research program is to determine a strategy for addressing the social and evaluative aspects of public interactive spaces.

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ABSTRACT

In this position paper, I discuss aspects of the research program at MERL Cambridge in public situated displays and interactions. We are working on a number of key enabling technologies including smart projective displays, multi-user touch, and computer vision for face detection. We have developed an initial concept demonstration for retail environments that includes an integration of some of these technologies. As we continue to develop technologies and tools, a key question at this point in our research program is to determine a strategy for addressing the social and evaluative aspects of public interactive spaces.

Keywords

Projectors, touch interaction, computer vision, face recognition

INTRODUCTION

The two laboratories at MERL Cambridge have an extensive research program in technologies and systems relevant to public situated displays. First, we are working on advanced technologies for projectors including smart projectors that can sense their orientation and correct for distortion [4], easily configured multi-projector mosaics for large and/or brighter displays [5], and "shader lamps" that allow projection onto non-planar surfaces and objects [6]. Second, we are working on interactive touch technologies that enable simultaneous multi-user touch events. For touch surfaces outfitted with antenna arrays and receivers, this technology also affords identification of who is touching where [2]. In the general case, we have shown how capacitive sensing can be used to afford interaction with physical displays and artefacts [3]. Third, we have a strong program in computer vision in which we have developed methods for detecting faces and determining when people are directly facing a given camera position [7]. Such technology can be used to determine when people are present and/ or looking at a certain target area and could trigger events for new forms of public interaction.

Recently we completed a concept prototype of an interactive projective display in a retail environment space. (See Figures 1-6). The demo incorporated 13 projectors in a room to simulate part of a floor space in a shoe store. We modeled the physical space itself to enable a seamless, continuous display across corners and shelves in the room with no distortion. A multimedia presentation including engaging audio and graphical animation was created that was tuned to the physical characteristics of the space. Interaction was enabled by placing simple capacitive touch sensors at key points in the physical space. After playing a multimedia message about the product line, the display entered a state with a message that said "Touch shoe for more information." Shoe shelves outfitted with touch sensors were highlighted using a virtual spotlight technique compatible with conventional projectors. Users then could pick up a shoe (actually, just putting a hand close to a shelf was sufficient), and a presentation about that specific shoe would be shown.

In what follows I will describe aspects of this interactive retail space demonstration and identify ongoing research issues. Needless to say, it is impossible to appreciate the impact of a situated interactive multimedia presentation in print alone, but we will be able to identify some of the technical issues. I'll then touch on some of our other research and how it might fit into this general program. The focus of MERL Cambridge to date has been on the enabling technologies. We welcome interactions with other researchers focused on social and evaluative aspects.

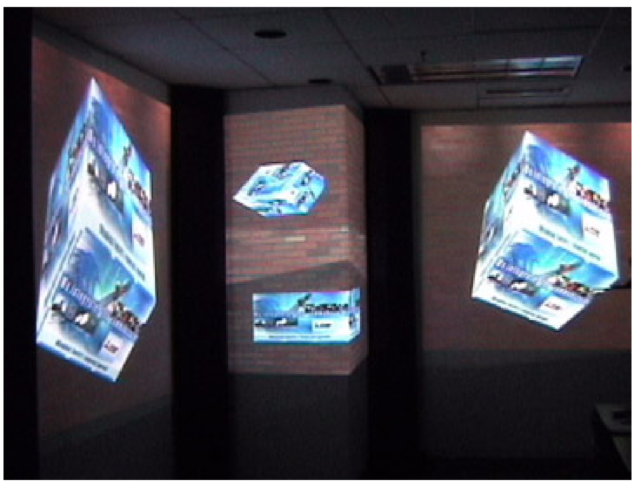
INTERACTIVE RETAIL SHOE STORE

Our demonstration of an interactive retail space incorporates use of multiple projectors that integrates content from a common source, multimedia content that is created with the physical aspects of the space in mind, and interactive touch sensors placed in key physical positions in the environment.

Situated Projective Displays

For usage of projectors to expand in the ways suggested by our demonstration, a number of innovations are required. First, distortion problems need to be easily and automatically corrected so that projectors can be flexibly placed in the environment. One problem is that the customers will often occlude the displays on which we are hoping to project. One solution is to project onto these surfaces from

Figure 1: An evocative scene being displayed with multiple projectors across a nonplanar surface.



igure 2: A change of that scene showing brick wall texture and a syncronized 3D display of a rotating cube.

Figure 3: Display shelves with a multimedia presentation designed for the space.

igure 4: A close up of the display shelves that have been equipped with capacitive sensors.

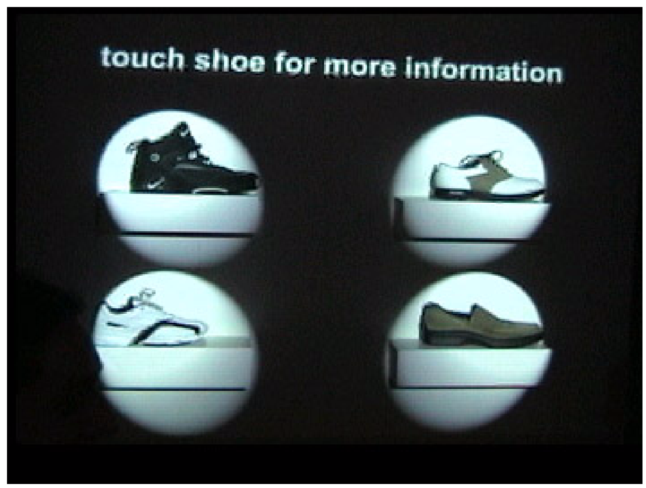


Figure 5: At the end of the multimedia presentation loop, individual shelves are spotlit with a message to encourage interaction.

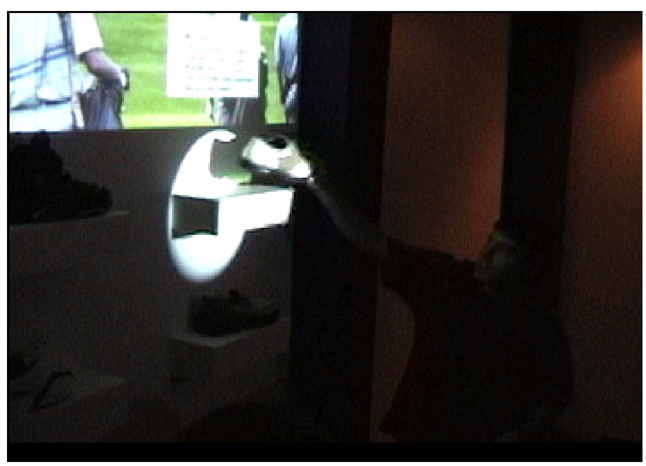


Figure 6: A customer touching a shoe, which triggers an interactive display with more information for that shoe.

fairly acute angles with ceiling or floor-mounted projectors. This raises the issue of geometric distortion. We have overcome this problem by prewarping the image data so that it ends up looking correct on the display. We have also developed technologies using cameras to analyze a projected checkerboard pattern (on planar surfaces) so that projectors can quickly and automatically be calibrated [4]. For non-planar surfaces, we build a geometric model of the space and calibrate by clicking with the mouse pointer on key points as they are projected onto the environment [6].

In order to create larger display areas as well as to add brightness so that front-projected displays are visible in a well-lit room, it is possible to use multiple projectors to display a single content source. If the projected displays overlap, the images from each projector must be "stitched" together to create a single seamless display. We have developed a system for automating such multi-projector mosaics [5]. In addition to automatically discovering the warping and blending required of each projector, the images must also be synchronized in time. We have built initial software to support such synchronization. Research on better tools for such content creation and distributed display is ongoing. Note that the use of multiple projectors with overlap helps to overcome the shadowing problems mentioned above.

In addition to projection on planar surfaces such as walls and floors, we have also developed a technology called Shader Lamps that allows projection onto arbitrary three-dimensional objects [6]. Shader lamps can project texture and other object details onto white three-dimensional objects. This can create the illusion of different materials and lighting conditions, as well as display intricate details. In addition, image animation can be used to yield the perception of apparent motion. Use of Shader Lamps requires the acquisition of a three-dimensional model and the creation of content to project onto that model. In the retail shoe store demonstration we used Shader Lamps to create an undistorted image over a space that included a corner projecting out into the room. (See Figures 1 and 2.) Research issues here include tools for easy acquisition of 3D models, integration with tools for content creation for use with multiple projectors, and display methods so that interactions as well as portions of the visual scene can be distributed across multiple projectors and computers.

Interaction through proximity detection

Since all of these systems we are proposing use video projection, the content displayed can change from moment to moment. This opens the possibility of creating highly interactive displays that respond automatically to consumers. Such systems require inexpensive sensors that serve to generate input events that trigger appropriate responses.

In the retail shoe store demo, we have utilized “Sensing Shelves” that incorporate capacitive proximity sensors to determine when a person has touched or nearly touched a particular piece of merchandise. The underlying technology has been demonstrated in other projects at MERL, notably the buffer phone [3]. Issues here include the development of integrated device toolkits and development tools that are designed to work with them. Deployments require communication between sensors in the environment and one or more host computers. The interactions in physical spaces afforded by such sensors have only begun to be explored, and much work is needed to determine creative uses of such input devices and evaluate their effectiveness.

FUTURE WORK

In future work, we envision that cameras might be mounted on shelves or (virtual) signage and that vision algorithms could determine when consumers are facing a particular direction. We have developed face detection technology at MERL Cambridge that includes frontal as well as profile views [7]. Such technology could also be used to analyze crowdedness in particular floor locations and trigger an event that might attempt to draw people to another location.

We also have two ongoing projects involving multi-user touch surfaces and computing tables [2][8]. With collaborators at the University of Manchester and Imperial College, we are beginning to investigate opportunistic browsing in communities through interactive computing tables in public spaces [1].

A related project with potential in public situated displays is in the area of rapid serial visual presentation (RSVP) [9]. At MERL we are building on earlier work [10] to explore how presentation and interaction techniques involving rapid sequences of images might be used for consumers to browse and find information. In a public environment, this suggests a highly interactive “page flipping” sort of interaction to support the tasks of getting an overview of a product line and/or searching for a particular item.

CONCLUSION

The demonstration and underlying technologies just described are indicative of the great potential for public interactive displays in retail environments. Our plan is to continue to explore technologies, interactive designs, and toolkits that can enable new forms of situated interactions of this kind. We are also investigating enhancements to existing projector product lines that would be required to support these scenarios. However, to date our laboratories have not articulated a plan to evaluate the effectiveness of these and other interactive public displays. How would the public actually react to such a display? Would behaviors be affected by the size and demographics of the crowd or other factors? Would interaction differences exist across age, sex, or other demographic factors? What presentation parameters might overcome inhibition of public interaction, assuming there would be some? We are actively seeking discussions and collaborations with other researchers to articulate theories that might explain such phenomena and construct a program for evaluation.

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