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Three Modes of Multi-Surface Interaction and Visualization

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TR2006-025 April 2006

Abstract

Today, with the availability of new interactive walls and tabletop technologies, the number of multi-display interactive visualization rooms of all sizes and of many usages is on the rise. The application scenarios are expanding well beyond the personal or ad hoc group settings. In this position paper, we examine these environments according to how they share content, visualize data, and allow for manipultaion of the UI between and among multiple interactive surfaces including tables and walls. We term this partitioning Modes of Multi-surface Visualization and Interaction, or MVI. Three modes of MVI are briefly analysed and illustrated that will form the basis for our future research at large.

Information Visualization and Interaction Techniques for Collaboration Across Multiple Displays Workshop (CHI)

Three Modes of Multi-Surface Interaction and Visualization

Figure 1. Examples of multi-surface interactive environments. From left to right: (a) Parsons Brinckerhoff PB CAVE (Computer Analysis and Visualization Environment) for urban design [8], (b) document triage [1], (c) ad hoc group meeting[6], (d) NYPD Real-Time Crime Center[7].

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Today, with the availability of new interactive walls and tabletop technologies, the number of multi-display interactive visualization rooms of all sizes and of many usages is on the rise. The application scenarios are expanding well beyond the personal or ad hoc group settings. In this position paper, we examine these environments according to how they share content, visualize data, and allow for manipulation of the UI between and among multiple interactive surfaces including tables and walls. We term this partitioning Modes of Multi-surface Visualization and Interaction, or MVI. Three modes of MVI are briefly analysed and illustrated that will form the basis for our future research at large.

To appear in Information Visualization and Interaction Techniques for Collaboration across Multiple Displays. Workshop associated with ACM CHI 2006, April 22–27, 2006, Montreal, Canada.

Keywords

Multi-display interactive spaces, groupware

ACM Classification Keywords

H.5.2 [**User Interfaces**]: Interaction styles

Introduction

Interactive multi-surface environments come in diversely varied settings, and can be applicable in many application domains and spaces, as the examples shown in Figure 1. In an interactive environment with multiple display surfaces, input interaction and output visualization are both equally important and challenging. By using the term *multi-surface*, instead of multi-display, we emphasize the nature of many of today's interactive walls, tables, Tablet PCs, desktop displays, laptops and PDAs that often can be interacted upon in addition to be merely the visual display. Multi-surface interactive environments range from common multi-monitor desktops, to ad hoc meeting rooms with walk-in and walk-up displays, to large "extreme collaboration" spaces. Although many research projects [2,3,4,6,10], including our own [5], have studied user interfaces, human computer interaction techniques, CSCW techniques, and system-level services (such as application relocation, input redirection and file sharing) for multi-surface interactive environments, many key issues still remain to be addressed. For example, new research problems arise in new types of multi-surface interactive environments such as disparate input capabilities and co-located simultaneous collaborative visualization of large amount of information.

Based on our past three years of research on multi-touch multi-user surfaces (see www.merl.com/projects/dspace for more information), we are currently working on the design of a new multi-surface interactive space (see Figure 2), partially funded by ARDA/ARIVA. In addition, we have also visited and worked externally with some of the new interactive spaces that are being designed and constructed, most notably (1) PB CAVE (PB Computer Analysis and Visualization Environment) for urban design [8] that has been constructed in PB's New York City office, and planned for other U.S. cities as well, and (2) the NYPD Real-Time Crime Center (RTCC) [7], both shown in Figure 1. PB CAVE is a large room with multiple plasma displays, desktop computers, a large projected wall all used in concert for 2D and/or 3D urban design visualization and analysis; it is used for group visualization and discussion between people from PB and its clients. For example, visualization and information management of damaged infrastructure is one of PB's key businesses for public and private clients. They have installed an interactive tabletop for experimental visualization and interaction with their wall display. NYPD RTCC is newly opened on July 14, 2005. The center is a large auditorium sized room with many rows of numerous detective desktop computers and a 10 feet tall, 27 feet wide data wall, with over 14 million pixels of resolution, as shown in the rightmost image in Figure 1. It allows NYPD detectives to collaboratively view and analyze information.

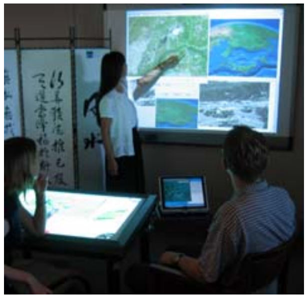

Figure 2. An example of MERL's multi-surface setup.

Anaysis of Multi-surface environments

Four questions arise when designing a multi-surface visualization and interaction environment: (1) What is the intended application scenario (e.g., ad hoc meeting rooms, university cafes, business visualization, intelligence analysis environment, or an emergency monitoring and response center)? (2)What types of interaction techniques are required (e.g., cross-device pointing, shared control, direct-touch of all surfaces, re-direction of input)? (3)How tightly coupled do the visual elements on the separate display surfaces need to be (e.g., no relationship, simple file transfer between surfaces, a multi-view system where the data on two displays are synchronously co-related with a focused view and a context view of the same application, or the pixels on two surfaces must be updated in unison)? (4)What are the digital applications to be executed in this environment (legacy applications adapted to the new environment, or all applications will be newly developed)?

In analyzing the requirements of a new multi-surface interactive environment, a core set of visualization and interaction requirements has emerged: (1) Some applications are similar to traditional office meeting room scenarios: Shared files across surfaces, application redirection, co-pointing thus input redirection, mouse input across multiple devices and surface are needed. (2) A set of applications require the simultaneous visualization as well as interaction on the exact same set of visual data across two or more surfaces. For example, as a group analyzes a geospatial situation, the users need to manipulate (e.g., zoom in context, mark paths, annotate) maps that can be displayed on multiple surfaces (e.g., on the wall, a table and from someone's laptop), as shown in Figure 3. (3) Certain applications require multiple surfaces to visualize different perspectives or views of the same application or situation scenario, while the input control across the surfaces must be coordinated. For example, one application is the document triage application running on two displays as shown in the second image in Figure 1. Here as the user selects a document link on the large wall display, a detailed document will open up on his desktop [1]. Another application is an interactive 3D urban city design as shown in Figure 4. On the horizontal tabletop surface, an interactive "birds-eye" view of the city is rendered, and the building blocks, cameras can be moved around the city; while on the vertical wall display, a different camera view is displayed. User input interaction on the table affects the visual rendering on both the tabletop and on the wall.

Three MVIs

In this paper, we propose 3 modes of multi-surface visualization and interaction (3 MVIs): *Independent*, *Reflective*, and *Coordinated*. MVI-I: Independent - The displayed contents and the user inputs on the surfaces are not coupled or coordinated. Continuous input interactions on one surface are self-contained within that surface. When file transfer, content relocation, or application relocation occurs, it is an independent action; there is no visual indication of the action or its effects on the other surfaces. MVI-II: Reflective- The displayed contents and user inputs on multiple surfaces are tightly coupled. In essence all surfaces share both visual content (pixels) and user interactions. Actions on one surface are directly reflected on the other surfaces. See Figure 3. MVI-III: Coordinated Multi-View - The displayed contents and user inputs on multiple surfaces are interdependent, but not necessarily identical. In essence all surfaces share the same content (i.e., tightly coupled input coordination and visual data rendering), but the view points are varied. See Figure 4. Coordinated views have been studied in earlier single display systems [11], multi-surface systems present us with a much larger real estate of pixel space, as well as problems of potential contention of multi-user inputs from different or the same surface.

Acknowledgement

This study was partially supported by the Advanced Research and Development Activity (ARDA) and the

National Geospatial-intelligence Agency (NGA) under Contract Number HM1582-05-C-0028. The views, opinions, and findings contained in this report are those of the author(s) and should not be construed as an official Department of Defense position, policy, or decision, unless so designated by other official documentation.

Figure 3. MVI-II: Reflective. The 3 surfaces are running 3 instances of a layered map viewer application. Interactions on any surface are reflected across all surfaces. The lenses on all surfaces display the same layered geospatial data.

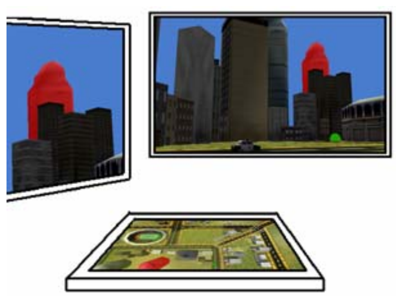

Figure 4. MVI-III: Coordinated Multi-View. The tabletop renders a “birds-eye” view of the city, while the walls render a “first-person” walk-through view.

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