inSpace Projector: An Accessible Display System for Meeting Environments

Aras Bilgen, W. Keith Edwards
Georgia Institute of Technology
85 5th St. NW Atlanta, GA 30332
{abilgen, keith}@cc.gatech.edu

1. Background

Device-centric technologies are increasingly populating many areas, meeting environments being one. Such a proliferation may lead to complication because the number of devices to manage goes up; further, complexity may increase due to the required connections among devices, since some functionality is only available when devices are used in conjunction with each other.

As new forms of technology enter the meeting environments, some of the affordances that help people understand the technologies are being lost. For example, consider getting the control of a projector for a presentation. The VGA cable points very clearly to the owner and the explicit handing of the cord to the next presenter speaks the message “I am done”. While new wireless network technologies such as WiFi or Bluetooth have their own advantages in reducing cable clutter and improving coverage, they lack the social and physical cues that help people cope with the challenges of meeting technologies.

There have been previous attempts in making meeting technologies more accessible. One such attempt is MeetingMachine [1], a portable projector that offers physical discovery and meeting collaboration features. Our system is different that it is not targeted towards providing the mobile and adhoc meetings with the adequate tools, but for making the deployed infrastructure easy to use in the meetings.

Another project that deals with meeting environments is the Stanford Interactive Workspaces.[2] The project offers a comprehensive, general end-to-end component system, capable of prototyping solutions for problems from very different domains. However, we are not planning to provide a full infrastructure, but instead just one minimal bit that would make the other components in the system much more useful than before.

We believe that it is essential that new, network-based meeting technologies make use of some of the features and affordances provided by "old style" interaction that relies on physical connections. In light of this, we are looking at small technologies that fluidly support a single aspect of meetings in a smart environment. Our work focuses on creating a lightweight display system that allows meeting participants to harness the power of display surfaces situated in a smart meeting environment. Our aim is to create a system that preserves the desirable social and physical affordances of the old technology while delivering means to control the new, more advanced technology.

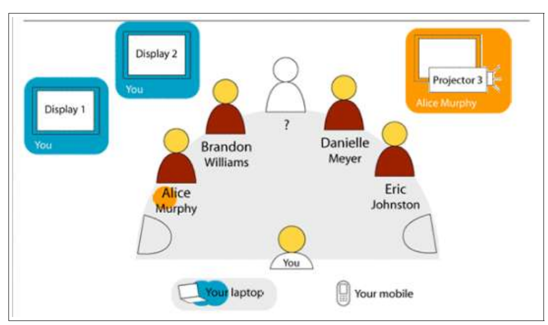
2. inSpace Projector

The inSpace projector is a network projection system that allows meeting participants to present their screens on multiple display surfaces simultaneously. Users install the client software on their devices and switch between different displays through a simple spatial interface.

Our system does not impose a rigid access control scheme on the use of displays; rather, it provides cues that support and accommodate socially negotiated access control. Rather than adopt a heavy-weight access control system, we follow a model similar to that with current VGA projectors. Anyone can "grab the cord" from anyone else, and social protocols dictate whether or not this is appropriate. When a display is requested, the person currently on the display is put off, the new user is introduced and the display is then given to the new user. Possible accidental requests are taken into account when the UI for the system was designed, and are properly guarded against. In our prototype, the users click the projector icon and click again on the bubble that appears by the projector. Note that the access control is not stricter than that of a regular projector – anyone who has the intention to pull the VGA cable from the presenter can feel at home with our system.

Location data is used for exclusive access to the displays in the room. Our system has to make sure that the requesting parties are physically in the room in order to grant them the right to grab a display. We achieve this through our room infrastructure detailed in the implementation section.

The displays are used through a spatial UI representing all the assets in the room. These assets can be wall displays, laptops belonging to different users, projectors, cell phones etc. The users are also represented with avatars in the UI. All these items are placed in the UI with enough accuracy to mirror their relative positions in real world. Users can then click on a display to request it. This approach eliminates the need to name the displays explicitly to access them. Instead of lists or combo boxes, users point to the “screen over there” to use it. For example, if a user wants to project on a display between two participants who sit across her, that display is also located between those two people's avatars in the UI. To aid visual recognition, the displays in the UI are color coded and the physical displays are tagged with the respective colors.



The spatial UI for the displays

We also wanted to preserve some of the walk-up-and-use properties of physical whiteboards that are often lost in digital displays. Therefore, our system has support for regular screens as well as pen-based touch screens. Users can walk up to the supporting display and annotate directly on the screen. The annotater can write while the presenting user is updating the view, she can choose to freeze the screen and write on it, or she can write on a separate panel overlaid on the screen, creating a virtual whiteboard. The users can capture the annotations on the board.

The inSpace projector can serve in different configurations, satisfying different needs. The most common use is for replacing the singular control over the central projector found in most meetings, making it equally accessible to anyone in the room. The system is especially useful in situations where there are large numbers of display surfaces in a room, as it allows much more flexible pairing of users to displays, and its spatial interface is more intuitive than a scrolling list of display names. The color-coded projection surfaces in the UI help in making sure that the ownership is visible to everyone.

We came up with a number of new configurations to explore different modes that can be employed to create a meeting environment which allows new ways of interacting with displays. For example, along with its support for multiple displays and different screen sizes, it can serve to create an array of awareness pads, personal display devices dedicated to show screens broadcasted into a shared channel. This not only yields a display that the meeting participants can appropriate within their personal workspaces, it welcomes people who walk into the meeting with no technology. Should they be interested in seeing the shared material, they can pick a small tablet upon their arrival.

2.1 Implementation details

Our system consists of a set of computers driving the public displays and client software on each participant's devices. The computers driving the displays listen to incoming connections and switch to view the connected user's screen over a VNC connection.

The system supports a variety of device types with different screen sizes, both on the client and the display side. It uses Java WebStart to support cross-platform installation over the network. Users need only click on a link on a web page or simply copy the JNLP file from a thumb drive to install the client software.

For location and identification, we are combining two systems in our prototype meeting environment, a smart table and a shared metadata store. The table has embedded RFID readers that can detect the location of any tagged device on it. The shared metadata store is a collection of information pertinent to the current meeting. Besides storing files, presentations and notes, it holds identification and ownership information.

When a device is detected, the table announces its location on a notification service. The device information is then used to find out the owner of the device. Using these two pieces of information, we put the users' avatars pulled from their profiles in the shared metadata store in a position in the UI that reflects their physical position with respect to others in the room.

The displays are located using a similar approach. Clients automatically discover displays in the room using a Bonjour service. The displays announce their relative locations to the clients using a notification service. Their icons are then situated on the same screen showing the relative locations of the participants.

In summary, the inSpace projector aims to lower the barrier to participation in a collaborative environment by providing easy access to display surfaces. It allows users to use projectors and screens with a few clicks instead of cable shuffling and a series of special button presses on the laptop. The system empowers the laptop users by providing untethered access to various display technologies and makes it easy to move images from one screen to another. It also embraces the deviceless by offering them a lightweight awareness.

3. Future Work

Another area of interest for us is the way people engage with the shared displays. So far, we have focused our efforts on how people connect freely to the displays and negotiate turn taking. We would like to look further into how users utilize interactive wall displays and whether current interactivity offered by such displays meet the needs of the meeting participants. Moreover, wall displays, with their generally large size, afford new collaboration opportunities such as tiling screens of multiple users on one big continuous screen or creating collages spanning the whole room.

Currently, the client software is running on Mac OS X, Linux and Windows XP machines. We are interested in making it compatible with handheld operating systems such as Maemo, Palm OS and Windows Mobile.

The inSpace projector preserves the useful affordances from physical connections and respects the social norms associated with those physical affordances. We hope that acknowledging the importance of social cues and providing visibility will prevent the problems of complicated control, since we are trying to maintain the best features of the "old world" of technology along with the new.

4. References

[1] Barton, J. J., Hsieh, T., and Johanson, B. The MeetingMachine: Interactive Workspace Support for Nomadic Users. Proceedings of the Fifth IEEE Workshop on Mobile Computing Systems & Applications, 2003.

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[3] Igarashi, T., Edwards, W. K., LaMarca, A., and Mynatt, E. D. An Architecture for Pen-based Interaction on Electronic Whiteboards.

[4] Kortuem, G. and Kray, C. HCI issues of dispersed public displays. Ubicomp 2005 Distributed Display Environments Workshop.

5. Biography

Aras Bilgen is a human centered computing PhD student in Georgia Institute of Technology. Under Dr. Keith Edwards' supervision, he is involved with ubiquitous computing research, focusing on infrastructures and systems enabling collaboration. He received his B.S. in Computer Engineering from Bilkent University, Turkey in 2005. He also spent a year in UC Irvine as an exchange student and a summer in InfoLab at Lancaster University, UK as a visiting student.

Keith Edwards is an Associate Professor at the Georgia Tech College of Computing, where his research interests include ubiquitous computing, technologies to support computer-mediated collaboration, and improving the usability of networking and information security infrastructure. Prior to joining the Georgia Tech faculty in 2004, he was Principal Scientist and manager of the Ubiquitous Computing Area at the Palo Alto Research Center (PARC).