Moving Telepresence Out of the Conference Room

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ABSTRACT

In this paper, we describe a project to create technology-rich spaces for informal collaboration that can be linked together using telepresence technologies. We discuss our approach, equipping spaces with very flexible, large, high-resolution displays and promoting their use for informal collaboration. We then present work in progress to add high quality telepresence to these systems and evaluate their use, with a special emphasis on their sustainability impacts.

General Terms

Design, Human Factors

Keywords

Telepresence, community displays, collaboration spaces.

1. INTRODUCTION

Across many sectors, there is a growing interest in using high quality audio in video conferencing in highly designed conferencing environments to create a highly realistic analog to face-to-face meetings among geographically distributed participants. These systems have been dubbed "Telepresence" systems, appropriating Buxton's [Buxton92] term for creating a shared sense of social presence among distributed group participants. While the recent round of telepresence systems have enjoyed acclaim for their performance in conference settings, there has been little corresponding innovation in the same high-quality collaboration tools outside of meeting settings. For organizations that have widely adopted telepresence systems, this means that the support for meetings -- often talking about doing work -- likely outpaces support for other types of formal and informal communication that are critical to accomplishing work. We believe that the challenge ahead for telepresence technologies is to identify ways to provide the same sense of social presence in workplace communication outside of the conference room that is currently provided by telepresence installations in the conference room.

A key challenge of extending the reach of telepresence systems is creating spaces and systems that are hubs of informal, collocated collaboration that can easily be augmented with high quality remote conferencing capabilities. These collaboration spaces exist somewhere between the formal discussion setting of a meeting room and the personal knowledge environment, where work gets done, but often very privately. In many organizations, hallways and lounges fill this kind of role, providing a setting for informal encounters and where team member can gather for extended work sessions, without a tightly scheduled beginning and end, similar to the way indviduals work in radical collocation settings [Teasley02]. Unlike personal offices and conference rooms, these spaces for informal communication often lack technology support for collaboration, either collocated or remote. Extending telepresence into these environments requires thinking about support the collocated collaboration that occurs in these spaces as well as participation by remote participants.

Through the Virtual Space Interaction Testbed (VISIT) project at the University of Michigan School of Information, we are developing and evaluating systems that can bring telepresence-quality interactions to a wider variety of activity contexts. The project focuses on the ways that advanced cyberinfrastructure can be applied in everyday work contexts to create immersive knowledge environments for conducting individual and shared work. In the sections that follow, we will provide an overview of the VISIT project, highlighting the ways we have augmented a variety of physical spaces with advanced cyberinfrastructure, describing applications of these spaces, reporting on experiments in high quality conferencing and introducing our approach to evaluation that includes an assessment of environmental sustainability.

2. SYSTEMS AND SPACES

Many of the systems deployed as part of the VISIT project are based on tiled displays running the Scalable Adaptive Graphics Environment (SAGE) [DeFanti09, Jeong05].

These tiled displays are both physically large and very high resolution. For example, a typical display consists of twelve thirty-inch LCD monitors, arranged in a three by four matrix, creating a fifty million pixel logical display that is over six feet wide and seven feet high. Using the SAGE middleware, multiple users can control this display simultaneously, running native applications on the cluster that powers the display, streaming video or still images from remote data repositories, streaming live audio and video of remote participants, dragging and dropping images from their own laptops in a simple user interface application or wirelessly projecting their laptops using VNC. This ability to flexibly display different types of visual content makes these platforms very flexible, allowing their use to be highly tailored to a user's specific needs, ranging from creating a public information display to posting images of work in progress (such as an electronic poster board) to engaging in very high resolution collaborative visualization of complex data.

One of our goals for VISIT was to provide a set of lightweight visual collaboration capabilities that would allow users to seamlessly shift between collocated and remote sharing. SAGE provides this facility through a mechanism called Visualcasting [Renambot09]. Visualcasting lets a SAGE user share the audio and visual data associated with a particular application with multiple other SAGE displays by replicating and transmitting the pixel and audio streams. By basing our VISIT systems on SAGE, we are able to first focus on the interaction techniques and social practices that help collocated users informally collaborate over shared artifacts and then quickly add telepresence capabilities by linking multiple displays together through combined high-quality audio, video and content conferencing.

We have set up several of these systems in different types of spaces. One of the first deployments outside of our lab was in an Atmospheric, Oceanic and Space Sciences department. This system is located in a highly visible seminar room in the department and was visible from the hallway through large windows looking into the space. In addition to the tiled display, the space contained several other types of technology to support collaborative work including several graphics workstations, a small area for posting paper maps that are updated every 30 minutes using a high resolution plotter and a large conference table (see Figure 1). Faculty and students also bring their own laptops into the facility to add to the technology already in the room.

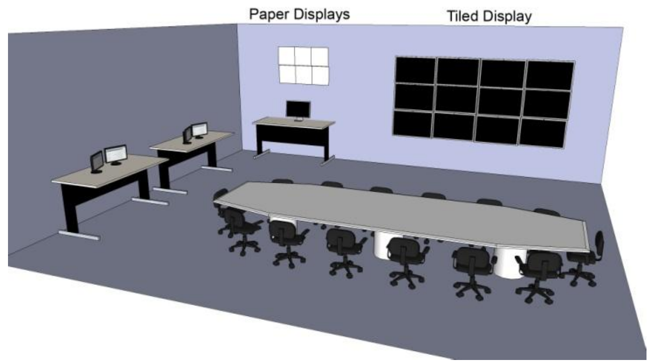

Figure 1: Classroom layout with the tiled display, paper displays, workstations, and student seating.

Despite having a conference table, this suite serves a very different purpose than most conference rooms. Instead of discussing work in progress, users of this space typically use the available technology to conduct data intensive analyses – doing work, rather than discussing it. The tiled display provides a visual canvas for "pinning up" related images and exploring how they relate, often by overlaying or spatially arranging different images in a meaningful way.

Another type of deployment has focused on adding a large, shared display to an open-plan work area to create a natural hub for collaboration and shared work. We renovated a doctoral student work area, replacing private cubicles with a much more open arrangement that includes pods of desks and a small lounge area adjacent to a large department break area. This lounge area (see Figure 2) includes a pair of couches, a coffee table and a large display that is open for community use.

Figure 2: Tiled display deployment in an open plan environment

In creating this informal space, our goal was to create a natural space for individuals to work together so that we can effectively deploy telepresence capabilities that would link this space with similar spaces on campus or allow participation from users working remotely. Without a space like this that affords group work, small group collaboration occurs elsewhere or in less predictable settings, making it difficult to support remote participation via telepresence.

Identifying and equipping these designed spaces for different types of collaboration is key to our approach for moving telepresence out of the conference room because it allows us to influence where collaboration happens in physical space, much in the way that the availability of conference rooms shape where much formal discussion takes place. However, nice couches and large displays alone to not make people use these spaces to their full potential. In the next section, we will discuss some of the applications of these spaces that promote both sociability and focused work.

3. APPLICATIONS

Tiled displays like the ones we deployed as part of the VISIT project have long been used to support high resolution and scientific visualization. While visualization was a major focus of the atmospheric sciences installation, it was less of a focal use for the open-plan work area installation. In addition to using the display for focused work, we also wanted the system to enhance the sociability of the common space by providing a platform for posting and sharing visual artifacts or obtaining certain information that was relevant to the community that occupies the space. After the system's installation, a considerable pa rt of our work focused on developing applications that met this goal. For example, we developed several lightweight widgets that provided a display of community-related Twitter feeds, weather information and bus arrival information. We also created mechanisms for users to post messages, pictures and slideshows of Flickr photo sets to the tiled display, in essence creating a lightweight bulletin board application that allows users to post information they want to share or that spurs discussion, similar to MessyBoard [Fass02],

In addition to these community awareness applications, we also provided ways to incorporate the display into informal meetings or into users' workflows. In order to support small meetings, users are able to "project' their laptops onto the display wirelessly, using a VNC connection to the display. This turns the system into a multi-user projection system, supporting the fluid sharing of information on different laptops without the need to negotiate the exchange of a laptop cable. This feature, combined with the general ability to post images and movies on the display provides individuals working together with a number of lightweight mechanisms for sharing their work, either in the context of an ongoing discussion or just to provide a high level of awareness about what they are working on.

To support individual workflows, we provided occupants of the space with a set of utilities that allowed them to integrate the tiled display into their workflows. These utilities allow students and faculty to render large images from statistics and analysis programs (i.e. Mathematic) on the tiled display, allowing them to produce very large graphs or models on their individual workstations that they can then view at a large size and high resolution on the tiled display.

While these applications cover a broad range of uses and vary from single user to full community use cases, we deliberately avoided creating a formal policy about how the display would be used. Instead, we allowed the users of the space to negotiate the different uses of the display and to ultimately control what content is posted and how it is laid out. In giving control to the community, the collaboration space and the systems that reside in it are maximally tailorable to their needs.

4. ON TO TELEPRESENCE

While much of our systems deployment effort has been focused on creating areas in our physical plant that are conducive to informal collaboration, we have also been conducting experiments on how to create a telepresence-caliber conferencing experience on tiled displays. Using the Visualcasting capabilities provided by SAGE, sharing uncompressed, low-latency high definition videos between tiled displays is very straightforward, provided that there is sufficient bandwidth (10 Gb/s) connecting the displays. Our focus has been to understand the optimal practices for microphone, camera and speaker placement in order to create a realistic conferencing environment. For instance, by placing small, high definition video cameras in the seams of the tiled displays, we are able to achieve an excellent approximation of physical size and eye contact (see Figure 3).

Figure 3: Lifesize, HD video conferencing on a tiled display

Due to the greater color depth and lack of compression artifacts in the uncompressed HD video, we believe these systems will be well suited to capturing active environments with lots of people, such as hallways and lounges, unlike more mainstream telepresence codecs, which often suffer from quality degradation from excessive motion artifacts in “busy” settings.

A greater challenge is these more public and informal settings is the proper tuning of audio in order to prevent excessive noise or picking up sensitive conversations. As a result, a current focus is on microphone and speaker systems that are highly directional and can create semi-private audio zones in a larger open space.

5. GREENING EVALUATION

As we have deployed these systems into production, we have become very conscious of the potential environmental impact of large, shared displays that require a considerable amount of computational power to run. In addition to more traditional aspects of evaluation, we are currently examining ways to quantify the environmental and sustainability implications of these displays and of telepresence technologies more generally. While these large-scale collaborations systems often look inefficient on the surface, some preliminary analyses suggest that they may actually have a huge positive impact. As an illustration, some of the infrastructure that supports the VISIT Project was re-purposed to host a set of national training programs in computational science and engineering. Initial estimates show that the use of VISIT technology eliminated 30,498 air miles and produced an energy savings of over 25,000 kWh across the 100+ participants, or a 30% reduction in air travel and energy use compared to convening a meeting at a single site. These numbers are still very preliminary, largely because we do not yet have a good handle on how to precisely measure the aggregate energy use of telepresence technologies across all of the relevant infrastructure and at all of the participating sites. However, we feel that understanding the sustainability aspects of telepresence systems is critical to a complete evaluation of their usefulness.

6. CONCLUSION

In this position paper we have presented our efforts to move telepresence out of the conference room and into the many parts of an organization where real work happens. Our approach to this problem has been to nurture the development of physical spaces for collaboration that are less formal than the meeting rooms (a place for talking *about* work) and are more public than individuals’ private workspaces. We believe that creating these spaces and promoting their use in everyday practice creates natural hubs of communication that are good targets for deploying telepresence technologies to support a wide range of collaborative work. To make the depoloyment of teleprsence technologies easier, we have deployed a number of tiled display systems that can be used for collocated collaboration but that can easily be linked together to share artifacts and high quality, uncompressed audio and video between sites.

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