

Multi-Display Environments for Co-located Collaboration

Kori M. Inkpen

EDGE Lab

Dalhousie University

6050 University Ave., Halifax, NS Canada

inkpen@cs.dal.ca

Regan L. Mandryk

EDGE Lab

Simon Fraser University

Dept. of Computer Science, Burnaby, BC Canada

rlmandry@cs.sfu.ca

INTRODUCTION

The falling cost of displays coupled with the multitude of technologies available means that we often have access to several display devices during our daily interactions. While this increased availability of displays opens up many new opportunities, seamless interaction with these displays and management of information across them is not trivial. At the heart of this problem is the fact that most of our computer interactions have stemmed from the one-person/one-display perspective.

WORKSHOP GOALS

This workshop is timely given the recent emergence of both research projects and commercial technologies that facilitate interaction in Distributed Display Environments (DDEs). We are very interested in this topic, particularly from the perspective of supporting co-located collaboration. Below is a discussion of our insights related to the workshop goals.

New Interaction Research

The possibilities for new interaction research for DDEs are endless. We are interested in exploring techniques that let us easily move information between displays, and interact with it on any given display. Given our interest in the use of DDEs for collaboration, we are also interested in the multi-user aspects of DDEs, both from the perspective of interaction techniques and the necessity for managing both private and public displays.

Passive Information Display

Although this isn't our primary interest, we understand that there has been a proliferation in the use of passive information for active user participation and peripheral information for notification in our computing systems. Given that this information is often moved to a secondary display, it is an important issue for discussion in the workshop. Our interest in this topic is in how these peripheral information displays scale when there are multiple users, and/or the displays are large and public.

Evaluation

Evaluation of single-user DDE's will require extension of many of our standard HCI evaluation strategies. However, evaluation of multi-user DDE's will be extremely challenging. In general, evaluation of co-located

collaborative interactions with technology is difficult. Human's face-to-face interactions are extremely rich and complex. Trying to determine whether technology has added value to those interactions without consequent harm was an important point raised at a recent workshop on evaluation of co-located collaboration [4]. Typical challenges include what task(s) to examine, what behaviours to observe, and how to quantify collaboration and measure its effectiveness. Developing appropriate methodologies as a community (through workshops such as this) is essential to building a valid body of research. One approach is to understand how novel DDE technologies impact a single user first, extending the investigation to multi-user environments once the former is quantified. We have taken this approach with a DDE project that is described later in this paper.

Broader Implications

An important broader implication to consider is display technologies that will be available in the future. Some research advances in this area, albeit important for current environments, will become irrelevant as display technologies advance. We may not have to worry about the bezels between multiple monitors because we will have displays of any size or shape. We may not need to worry about how to move information in and out of a high resolution area on a large display because the whole display itself will be capable of high resolution. While these advances will alleviate some of the current problems, they will also introduce a host of new problems. For example, interacting with the 3840 x 2400 resolution display in our lab is problematic because at that resolution you can't read the text on icons, login screens, etc. Many standard interaction styles will become more cumbersome as users move between dramatically different display sizes with varying resolutions. By thinking ahead to these issues, we can better plan interactions that will scale with future DDEs.

AUTHORS' PREVIOUS WORK

The main research goal of the EDGE Lab is computer support for co-located collaboration. We have investigated many variations of display environments and their impact on co-located environments, which has provided us strong insights into small group collaboration and mechanisms, such as DDEs, to effectively support collaboration.

A main focus of our research has been in the area of Shared Display Groupware. This has included understanding how multiple users interact with desktop [8, 10], tabletop [7], and wall displays. Much of this work can also inform the design of DDEs. In a recent project we have attempted to generalize our findings into a framework of display factors (such as display-angle, display-size, number or displays, proximity), and identify how these factors impact co-located collaboration. [2].

Another main thread of our research has been the exploration of co-located collaboration across handheld devices. Multiple users, each with a handheld computer that acts as a portal into a shared information space, can be described as a DDE. We have examined ways to structure a collaborative activity to encourage interaction between participants, despite the use of small, personal devices [1]. We have also explored ways to help foster a shared understanding between users during a collaborative activity by supporting shared annotations across devices [6]. This project also focused heavily on appropriate methodologies to evaluate collaboration with small mobile devices.

We have also examined work related to single-user interactions with multiple-monitor systems. In a recent project we explored 'sticky widgets' for multiple monitor configurations. Sticky widgets utilize pseudo-haptics to prevent a users' cursor from crossing over to the other monitor when accessing widgets on the border between two monitors [5]. We are continuing to investigate smart system support for interaction in multi-monitor environments.

AUTHORS

Both authors have organized three CSCW workshops [3, 4, 9] that are very relevant to proposed Distributed Display Environments workshop. The first workshop was on co-located collaboration in general, the second was on tabletop displays, and the third was on evaluation of co-located collaboration

Dr. Kori Inkpen

Kori Inkpen is an Associate Professor in the Faculty of Computer Science at Dalhousie University. She is director of the EDGE Lab, which explores a wide body of research in the areas of HCI, CSCW, and Ubicomp. Kori has organized and participated in many workshops and is active in the CHI, CSCW, UIST and GI communities (published papers, reviewer, conference & organizing committees).

Regan Mandryk

Regan Mandryk is a Ph.D. student in the School of Computing Science at Simon Fraser University. Her research projects focus on using emerging technologies to facilitate social interactions between friends and strangers. Regan has co-organized workshops on ubiquitous play at previous UbiCOMP and Pervasive Computing conferences and workshops on co-located collaborative technologies at

three CSCW conferences. She was also a guest co-editor for a special issue on Ubiquitous Games in the journal *Personal and Ubiquitous Computing*.

ACKNOWLEDGMENTS

We thank Stacey Scott, Malcolm Rodgers, and the rest of the EDGE Lab team for their work on the many research projects discussed in this position statement. We would also like to thank NSERC, MERL, and Electronic Arts for funding this research.

REFERENCES

1. A. Danesh, K.M. Inkpen, F. Lau, K. Shu, and K.S. Booth. Geney: Designing a collaborative activity for the Palm handheld computer. In *Proceedings of CHI 2001*. Seattle, WA, April 2001.
2. K. Inkpen, K. Hawkey, M. Kellar, R. Mandryk, K. Parker, D. Reilly, S. Scott, and T. Whalen. *Display Factors Influencing Co-Located Collaboration*. Accepted for publication in *Proceedings of HCI International 2005*, Las Vegas, NV, July 2005.
3. K. Inkpen, R. Mandryk, S. Scott, S. Greenberg, and A. Zanella. *Shared Environments to Support Face-to-Face Collaboration*. Workshop at CSCW 2000, Philadelphia, PA, Dec. 2000.
4. K. Inkpen, R. Mandryk, J. Morris DiMicco, and S. Scott. *Methodologies for Evaluating Collaboration in Co-Located Environments*. Workshop at CSCW 2004, Chicago, IL, Nov. 2004.
5. R.L. Mandryk, M. Rodgers, and K.M. Inkpen. *Sticky Widgets: Pseudo-haptic Widget Enhancements for Multi-Monitor Displays*. Submitted as Late-Breaking Submission to CHI 2005, Portland OR, April 2005.
6. D. Reilly. *Not in Karlsplatz anymore: Navigating cities together*. In *Ubicomp 2004 Workshop on Ubicomp in the Urban Frontier*, Nottingham, England, Sept. 2004.
7. S.D. Scott, M.S.T. Carpendale, and K.M. Inkpen. *Territoriality in collaborative tabletop workspaces*. In *Proceedings CSCW 2004*, Chicago, IL, Nov. 2004.
8. S.D. Scott, R.L. Mandryk, and K.M. Inkpen. *Understanding children's collaborative interactions in shared environments*. *Journal of Computer Assisted Learning*, Special issue on Children and New Technology, Vol. 19, Issue 2 pp. 220-228. June 2003.
9. S. Scott, K. Grant, S. Carpendale, K. Inkpen, R. Mandryk, and T. Winograd. *Co-located Tabletop Collaboration: Technologies and Directions*. Workshop at CSCW2002, New Orleans, LA, Nov. 2002.
10. G.B.D. Shoemaker and K.M. Inkpen. *Single display privacyware: Augmenting public displays with private information*. In *Proceedings of CHI 2001*, Seattle, WA, April 2001.