

Interfaces for Managing Information in Distributed Display Environments

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INTRODUCTION

Interactive workspaces are distributed display environments where users can seamlessly manage information across displays. A key element of interactive workspaces is that they are comprised of multiple, independent devices linked through sophisticated software and hardware infrastructures. While system level support for these workspaces exists [6], users need effective interfaces to manage information in these workspaces. Through the creation of interfaces which enable users to better manage information across devices such as laptops, tablet PCs, and large screens, the use of interactive workspaces could dramatically improve how users perform collaborative work. Our research focuses on designing and evaluating interfaces to support application relocation and input redirection tasks, two frequent and common tasks in interactive workspaces.

EXISTING APPROACHES

In [4] researchers extended the multi-display desktop interaction model to support virtual paths among devices in the workspace. In their system, a user moves his cursor off the edge of one display to relocate the cursor to the display physically closest to the crossed edge. In [5] and others, users manipulate text-based lists of devices and applications to perform relocation and redirection tasks. In our iconic interface, users manipulate a 2D map of the workspace allowing relocation and redirection tasks between any two devices, regardless of the devices' physical location and without having to mentally map textual identifiers to physical devices and applications. Further, our interface is the first to support an interaction design which allows users to coalesce both relocation and redirection tasks into a single interaction.

ARIS

ARIS (Application Relocator for an Interactive Space) [1] is our iconic interface for managing information in interactive workspaces. ARIS provides a spatial representation of a workspace using a 2D, fold-out view which provides iconic representations of applications, devices and other salient physical features of the workspace (e.g. tables, doors, etc). To relocate applications and redirect input users directly interact with these representations. ARIS was specifically designed to execute on tablet PCs, laptops, desktops and large screens while allowing the use of stylus, touch and mouse input mechanisms.

Design and Implementation

To design ARIS, we followed an iterative design process which involved developing and evaluating a series of prototypes. Through the iterative design process we learned many lessons for creating usable interfaces. Among the lessons learned, we discovered the use of new metrics, such as head turns and physical movement, to evaluate interfaces for interactive workspaces. The outcome of this process was the creation of a usable interface for performing relocation and redirection tasks in interactive workspaces. ARIS is implemented to execute on an existing infrastructure [6] as well as a single PC driving multiple displays. In addition, ARIS can easily be ported to other existing interactive workspace infrastructures.

Evaluation

Our most recent work [2] empirically compares the use of our iconic interface, ARIS, to a text-based [3, 5] and virtual paths interface [4, 7] for relocating applications and redirecting input. Our results show ARIS is more effective than a text-based interface and almost as effective as a virtual paths interface. These results have two important implications. First, since text-based interfaces are common in interactive workspaces, the use of an iconic interface enables relocation and redirection tasks to be performed more effectively than today. Second, our results indicate that an iconic interface imposes only a small additional cost to the user beyond that of a virtual paths interface while supporting additional functionality, e.g. the use of stylus or touch-input to relocate applications.

Ongoing Work

We are enhancing ARIS to better support a larger number of devices (screens) and applications. In addition, we are incorporating activity awareness into ARIS's iconic representation through visualizations of collaborators' activities. We believe these visualizations will help users collaborate more effectively on shared activities.

In addition to improving ARIS, we are exploring the creation of groupware tools which provide users adjustable levels of ownership for both devices and applications in interactive workspaces. These tools will enable users to specify access models to allow for control over how and who can interact with their applications and devices. For example, supporting a situation where a user relocates an application from their local device to a large, shared screen while providing control to prevent other users from accessing the application. A major challenge in creating these tools will be the design of interaction and presentation models that transcend traditional single user, single display environments.

Finally, a long term goal is to evaluate the effectiveness of interactive workspaces for enhancing different collaborative activities across various task domains. By comparing the use of an interactive workspace to traditional collaborative environments, we hope to acquire both qualitative and quantitative evidence to support the perceived benefits of using interactive workspaces in collaborative work.

CONTRIBUTION TO WORKSHOP GOALS

We have outlined below how our experience can contribute to the workshop goals:

Outlining promising areas of interaction research. We have created an interface for supporting relocation and redirection tasks in interactive workspaces. Through this process we uncovered new challenges in building interfaces for interactive workspaces. These challenges include designing an interface which supports heterogeneous input mechanisms, devices of varied form factors and devices which can be brought into and taken away from the workspace. These challenges were determined through observation and analysis of activities users were performing in our interactive workspace laboratory. We believe the new opportunities for research in interactive workspaces can be determined through a similar process. As a next step, we need to develop a taxonomy of the activities supported in interactive workspaces, the interaction tasks these activities contain, and how well each task is currently supported. This taxonomy will allow us to outline promising new opportunities for research in interactive workspaces.

Passive information in interfaces. As discussed above, we are actively conducting research into incorporating activity awareness into the ARIS interface. Through visualizations

that summarize co-located collaborator's actions, users may be able to assess the activities and the engagement level of their collaborators. A challenge that still remains is determining the appropriate level of detail to provide in these visualizations. At the workshop we hope to discuss methods for determining the appropriate levels of detail for visualization of activity awareness.

Evaluation. In [1] we found that measuring head turns and physical movement are new metrics by which to evaluate the usability of interactive workspace interfaces. In addition, our experience shows the design space in this area is quite large. Potential evaluation factors in these workspaces can include selection of the experimental task, configuration of the environment, input mechanisms tested, individual or collaborative tasks, physical location of users, and more. The experimental design of an evaluation in these workspaces can become overly difficult to manage. As researchers in this field, we need to develop guidelines that help fellow researchers balance external validity with what can reasonably be accomplished in a single study.

Broader implications of multiple display environments for HCI. The advancement of interactive workspaces is opening new opportunities for researchers in social sciences, computer supported collaborative work, education and more. For example, observing the workspace's effect on group dynamics, providing an environment to investigate new cooperative work applications, and using these workspaces to support group based learning.

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