Supporting Collaboration in a Context-Aware Office Computing Environment

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Introduction

Our research seeks to design an office that better supports knowledge workers—business professionals who interpret and transform information [1]. Successful knowledge workers manage multiple tasks, collaborate effectively among several colleagues and clients, and manipulate information that is most relevant to their current task by leveraging the spatial organization of their work area [2,3,5]. The diversity of these work practices and the complexity of implementing flexible computing tools make it difficult to meet all the workers' needs.

In typical office environments, knowledge workers use a variety of tools and information sources, including desktop and laptop computers, whiteboards, and desks. Information sources are frequently distributed throughout the office environment, both within and beyond the individual office walls. Although these tools and information sources contribute to a comprehensive understanding of the various activities in progress, it is entirely up to the worker to make sense of this information, synthesize the disparate pieces of information, and act appropriately on that information.

Fig. 1. The Kimura system in an office environment, including the focal monitor and peripheral displays.

Context description	Context type	Effect in activity representation (montage)
Location (availability) of user's colleagues	Physical	Colleague availability notification cue
Presence of multiple individuals in the user's office	Physical	Presence, size, and opacity of montages on electronic whiteboard
Email messages	Virtual	Colleague availability notification cue

Table 1. The kinds of physical- and virtual-context information collected by the Kimura system to support collaboration.

We are working to augment and combine these independent tools into an integrated, pervasive computing system called Kimura [4, 6]. Kimura monitors a user's interactions with the computer, an electronic whiteboard, and a variety of networked peripheral devices and data sources. The system also draws from several physical sensors distributed throughout the office. This combination of virtual and physical context drives the creation of *montages* representing work activities on a wall-size peripheral display—the electronic whiteboard (see Figure 1). The whiteboard lets users monitor each ongoing work activity, transition smoothly between activities, access a wide variety of contextual information designed to facilitate collaboration, and maintain awareness about relevant activity changes. Additionally, the interactivity provided by the electronic whiteboard allows the user to informally annotate and spatially organize the montages.

Supporting Collaboration

Our first prototype of the Kimura system is focused primarily on supporting single-user computing practices such as multitasking and maintaining task awareness. However, the public display characteristics of the electronic whiteboard and the versatility of the system's physical and virtual context acquisition infrastructure allowed us to implement several basic behaviors to facilitate collaboration between the user and his or her colleagues (see Table 1).

Kimura's physical sensor network is designed to detect the arrival and departure of known individuals in the augmented office environment, in public areas of the office, and near peripheral devices (that is, next to the printer). This information allows the system to determine the general whereabouts and activity of Kimura's user when he or she is not directly interacting with the desktop or electronic whiteboard. It also lets

the system determine the general location of colleagues and infer when they might be available for collaboration, or when they have joined the user in the augmented office for an informal meeting.

Kimura also acquires virtual context through an email monitoring system, helping track the user's interaction with colleagues during a particular work activity. The system monitors all email messages that the user sends and associates each mail recipient with the active working context. It also adds the recipient to a list of individuals with whom the user might be trying to connect, and instructs the location-monitoring component to actively monitor the availability of that individual by watching for their presence in public areas of the office.

The context information gathered by the Kimura system is currently used to modify the display of the montages on the electronic whiteboard. To indicate the availability of a colleague, the system adds a notification cue–a thumbnail image of the colleague–to the appropriate montage. When the system detects what might be the beginning of an informal meeting, the montages on the electronic whiteboard associated with the office visitor(s) become more prominent and accessible in anticipation of a discussion about one of those work activities.

Future Work

Although our current prototype exhibits some support for office collaboration, we recognize the importance of further fostering communication and teamwork. We are particularly interested in expanding the interactive functionality of Kimura's electronic whiteboard in order to give users more control over the display and organization of the montages and to provide more useful tools for informal meetings and presentations. These divergent uses of the electronic whiteboard suggest important research issues regarding the role of the electronic whiteboard as both a personal and semi-public display in an individual office space.

We are also interested in exploring the cooperative work implications of linking two or more instances of Kimura. We envision an office environment in which multiple work colleagues each have their own Kimura system. We would like to understand the interaction issues raised as colleagues collaborate over working contexts. These issues might include topics such as privacy, information access and visibility on the electronic whiteboard, and synchronization of shared information.

Expectations for the Workshop

We anticipate that the issues that we have identified are not unique to our system or the environment in which we plan to deploy and test it. We feel that this workshop will allow us a unique opportunity to present our work and discuss these and other salient issues with others engaged in similar research efforts.

Authors' Backgrounds

Stephen Voida is a PhD student in the college of computing at the Georgia Institute of Technology. His research interests include augmented environments, ubiquitous computing, and technology in the workplace. He has an MS in HCI from Georgia Tech and a BS in computer science from Arizona State University. He is a member of both the Augmented Environments and Everyday Computing labs and is affiliated with the GVU Center.

Elizabeth D. Mynatt is an Associate Professor in the College of Computing and the Associate Director of the GVU Center at the Georgia Institute of Technology. She directs the research program in Everyday Computing, examining the implications of having computation continuously available in many aspects of everyday life. She previously worked for three years at Xerox PARC with Mark Weiser. Her research explored how to augment everyday places and objects with computational capabilities.

Blair MacIntyre is an assistant professor in the College of Computing and the GVU Center at the Georgia Institute of Technology. His research interests include understanding how to create highly interactive augmented reality environments, especially those that use personal displays (that is, displays worn or carried by the user, such as see-through head-worn displays) to directly augment a user's perception of their environment. His research covers a broad spectrum of topics in this area, with the goal of gaining a complete understanding of how to design and build such systems.

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