TOWARDS AN INSTANT COLLABORATION ENVIRONMENT: Designing Ambient Interfaces for Social Awareness and Collaboration

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Abstract. For geographically separated designers, moving into collaboration is sometimes distracting because it requires complex negotiation between colleagues. This research explores the practicability of moving from social awareness of remote colleagues into physical collaboration in an instant but unobtrusive way. A framework of "Instant Collaboration" has been proposed with characteristics identified, and a demonstrational prototype is implemented to examine the computability and usability of the proposed framework.

1. Introduction

1.1. BACKGROUND

With modern technology, design teams nowadays are often located in many different locations and connect together by network. Social awareness, in this case, provides an opportunity for these teams to be connected with each other in a sentimental manner. In co-located design teams, colleagues work individually while physically close to each other to maintain such group awareness. In this kind of situation, the spatial structure of a personal design environment is usually semi-public, which means there is a public channel for designers to be aware of and communicate with the others outside. With such a channel, designers will not be disturbed while they are working, and when needed, they can move to collaboration with others immediately and naturally. Such a channel is crucial in a distributed collaboration environment with its awareness characteristics.

1.2. EXPLORATIONS

Previous researches have explored ways such as ambient awareness display (Prinz, 1999; Gross, 2003; Edward et al., 2004) to reproduce such a channel to keep distributed colleagues aware of each other. However, most relevant researches, while focusing on the display itself, do not discuss how it can be integrated in the distributed design environment, to reproduce the easiness and immediacy of moving to collaboration with others whereas in the architectural design domain, the sense or awareness of such display or interface is important and effective in a better design collaboration environment. Therefore, the scope of our paper will aim at the design issues and strategies of ambient interfaces described above and argue with its integration in design spatially.

The goal of this research is to understand the possibility and practicability of immediately moving from ambient awareness to collaboration in a physical, non-distracting manner. A prototype system that augments collaboration facility on to ambient interfaces of a personal design environment is designed to verify the practicability of moving into collaboration after ambient awareness in an immediate but smooth way.

2. Media Review

Previous researches were categorized into: (a) Ambient Awareness Interfaces, (b) Instant Messaging + Ambient Interfaces, and (c) Physical Shared Workspace. We'll discuss each as follows:

2.1. AMBIENT AWARENESS INTERFACES

For mediating social awareness within distributed colleagues, at earlier times, Media Spaces (Bly et al., 1993) were designed to broadcast real time video-captured images in each space as social cues. However, such video-mediated awareness could raise the problem of distraction and privacy invasion (Edward et al., 2004). Different from Media Spaces, Ambient Display (Wisneski et al., 1998) assumes that while one is focusing on his foreground task, he has at the same time the ability to receive minor information from the environment such as temperature, weather condition, light, and sound through background awareness. Such assumption has led works that try to use environmental subtle changes as cues for social awareness to avoid the problem by using video-mediated awareness, and to deliver awareness information in a calm and unobtrusive way. Examples are Gellersen and Michael Beigl (1999) that use sound as remote status indication, and the work from the TOWER (Schaefer et al., 2001) has explored various ways for remote events or awareness indication, by emitting bubbles from a fish tank, winding of a propeller

to make wind, or hand-raising of a robot. The Hello.Wall (Streitz, 2003) uses different light patterns as a way to deliver awareness information to passersby in a calm and elegant way. Besides, Röcker et al. (2004) identified a set of requirements for supporting awareness in a distributed team, and Gross (2003) has offered guidelines for designing ambient interfaces. All of these works have provided a basis for designing ambient interfaces for our research.

2.2. INSTANT MESSAGING + AMBIENT INTERFACES

IM (Instant Messaging; such as ICQ, MSN, or Yahoo! Messenger), has gradually been adopted by companies and enterprises for its support of informal collaboration (Nardi et al., 2000). By being aware of the status of other colleagues on the BuddyList, awareness among colleagues could easily be maintained. Furthermore, by simply clicking on names on the BuddyList, colleagues could make an instant conversation or even start a collaboration session through shared whiteboards or instant games. IM has the facility both of mediating social awareness, and triggering specific groupware for different purposes of collaboration instantly. Nevertheless, IM is a computer software that is designed for computer users and has its own computer interface context constraining within screens and keyboards/mouse interfaces.

Buddy Bugs (McPhail, 2002) makes the presence of MSN physical by mapping it into the physical movement of a bug on the leaf. And by touching the bugs, it triggers IM chat windows of the remote teammates. Similarly, Flexible Displays (Elliot and Greenberg, 2004) allows the users to push ambient buttons to trigger a different application window to start a further interaction. Both Buddy Bugs and Flexible Displays have provided an immediate yet smooth way from ambient awareness to collaboration. However, they are designed for computer users cooperating with Instant Messaging Systems or other application software.

2.3. PHYSICAL SHARED WORKSPACES

Physical Shared Workspaces refer to groupware systems that provide a physical environment for collaboration. Similar to Clearboard, GroupSketch and GroupDraw (Greenberg et al., 1992), supply a platform that can do freehand drawing for annotation. ClearBoard (Ishii et al., 1993), uses a metaphor of see-through glass. From the sketch board the team workers can gaze at the image of the other parties and furnish the ‘‘task-oriented awareness’’ (Prinz, 1999) in real time. Escritoire (Ashdown, 2003) uses the tablet pen as an interface for the users to manipulate and share the digital documents that are projected on the table. Those researches give the insight to the issues of the undergoing collaboration and make it possible to supply an interface of novel collaborative way. However, all these researches concentrate on the interaction during the collaboration and the task-oriented

awareness. There are few concerning the team member's interaction before and after and the issues on social awareness.

On the way to building an environment that supports immediate but smooth moving from ambient awareness to collaboration, we were inspired by (b) to integrate awareness information and collaborative media into one infrastructure. And based on researches from (c), we were inspired to design collaboration media as part of ambience. We have also identified several principles for designing unobtrusive ambient interfaces from Gross (2003) and Röcker et al. (2004), and works outlined in (a). Besides, our researches have also been affected by visionary computing concepts such as Ubiquitous Computing (Weiser, 1991) and Ambient Computing (Streitz, 2004).

3. Towards an Instant Collaboration Environment

We hypothesize that our framework, when fully implemented, could make colleagues aware of others as possible candidates for collaboration when they are working separately in their personal design environment. And, when needed, immediately move into collaboration with them with minimal distraction. We call the environment with such capability "Instant Collaboration Environment". We borrowed the word "Instant" from "Instant Messaging", but different from IM, our environment is developed under the concept of Ambient Computing, which is to make the computing services available to users through the physical environment rather than computers.

3.1. METHODOLOGY

The nature of our problem is scenario-oriented, which is still not a well-established field even in cognitive psychology. For achieving the aforementioned goal, the first step is to observe and analyze the interactive behaviours. With such analysis, we can identify the characteristics of instant collaboration and key steps co-located colleagues moving from social awareness into collaboration with each other in an instant fashion, to help frame an integrated conceptual framework for the hypothesis of this research. Furthermore, we can apply computational techniques describes afterwards on to such framework to testify the computability and usability of our framework. By refining the framework, the relationship between ambient interfaces and other entities can be understood and explained in the sense of domain.

3.2. CHARACTERISTICS OF INSTANT COLLABORATION

We chose the design studio of Graduate Institute of Architecture at National Chiao-Tung University as the spot for observation and graduate students of Design group are being observed. Through two adjacent students, we observed their daily

interaction in the hope that we could summarize a pattern of their mutual interaction by the ways their instant collaboration flow, the elements how they achieve instant collaboration. We have analyzed and identified some characteristics that must be provided with for instant collaboration in physical environment. The characteristics are shown as follow:

3.2.1. Continuous awareness. One can keep their social awareness of the remote colleague all the time, and by continuous awareness, updating and forming the motivation for collaboration.

3.2.2. Notification. When the remote colleague needs to invite or terminate the cooperation, one can be notified and respond immediately.

3.2.3. Ease-of-use. Using a simple or intuitive way, one reacts with the remote colleague.

3.2.4. Request and response. Without much tedious and complicated negotiation for inviting collaboration, one can react by simple request and another will respond.

3.2.5. Fluid transition. When one tries to shift from social awareness to a collaboration mode, the process is just a smooth transition.

3.2.6. On-time collaborative media. When one tries to cooperate with the remote colleague, he can get the on-time collaborative media as long as he asks for.

3.3. A FRAMEWORK FOR INSTANT COLLABORATION

With the characteristics described above, five interactive phrases are: (i) awareness phase, (ii) initialization phase, (iii) negotiation phase, (iv) collaboration phase, and 5) termination phase. A framework based on these phrases are shown in Figure 1.

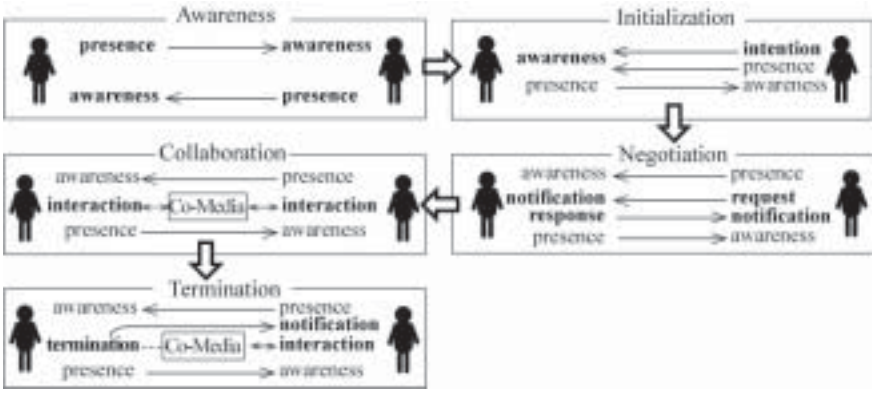

Figure 1. A framework for instant collaboration.

Five phrases of our framework are described in detail as follows:

3.3.1. Awareness phase. This phase is when colleagues focus on their foreground task, and keep an eye on presence of remote colleagues through background

awareness. Remote presence must be represented by environmental subtle cues to be identified, and should not be obtrusive and distracting. The presence of the people should be implicitly recognized by the system.

3.3.1. Initialization phase. When a colleague reveals an intention to contact a remote colleague, the system should instantly provide him with a negotiation channel. The user's intention for collaboration should be explicitly but naturally recognized by the system, and when recognized, the system should inform the user as feedback. Also, the system should make the remote colleague aware of the intention from local side, to have a mental preparation for moving into the next phase for negotiation.

3.3.3. Negotiation phase. The negotiation between colleagues should be simple and direct. When an invitation of collaboration has been sent, the remote should instantly be notified. Moreover, the system should offer a channel for remote colleagues for rapid response, for example, through simply accepting or rejecting the invitation. At the same time, while waiting for response, the system should also provide a way to suspend the invitation and the awareness information of waiting for response.

3.3.4. Collaboration phase. When a remote colleague accepts an invitation, the system should instantly trigger the requested physical shared workspace in each environment and make them connected. Transition to physical shared workspace should not take long or be too complicated for the user. Besides, the collaborative interface should be simple or intuitive.

3.3.5. Termination phase. During the collaboration, the system should provide a way for the user to terminate the session. And after the termination, the remote colleague should be notified that one is leaving the session immediately.

4. Implementation

To examine the computability and usability of our framework, we have implemented a prototype system in two separated personal design environments in our studio. We focus on the design of ambient interfaces, along with guidelines provided by Gross (2003) and Röcker et al. (2004). We have mainly designed three ambient interfaces: (i) Ambient Awareness Display for displaying patterns indicating remote status for maintaining social awareness, (ii) Ambient Communication Interface for instant negotiation in between colleagues to initiate, request, respond, and terminate a collaboration, and (iii) Ambient Collaboration Interface as a dynamic physical shared workspace which emerges only when entering collaboration phase. Here we have implemented two collaborative services as examples to validate that the system is able to trigger more than one collaborative service.

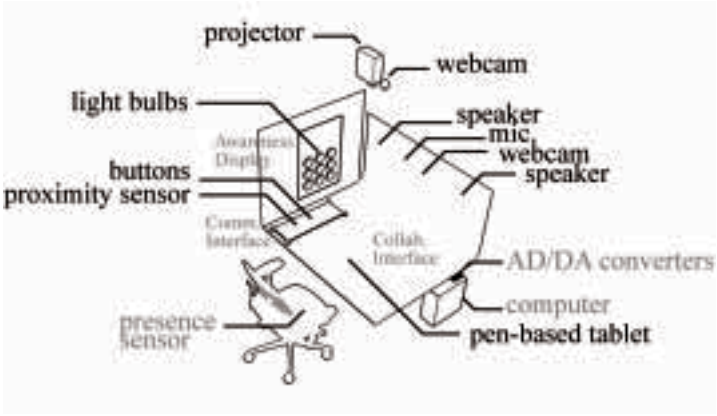

Figure 2. The schematic diagram of our prototype system and its embedded components.

4.1. SYSTEM COMPONENTS

Our prototype system is comprised of the following key components in each space, as shown in Figure 2:

4.1.1. Ambient Awareness Display. A set of light bulbs are used as components for Ambient Awareness Display to present an abstract form of social awareness and notification.

4.1.2. Ambient Communication Interface. Ambient Communication Interface components include speaker, microphone, proximity sensors, buttons, and a projector. A Proximity Sensor is used to determine whether Ambient Communication Interface is being triggered by sensing the user's hand hovering over ambient communication interface as we hypothesized the cue of user's intention for contact. The microphone and speakers are used when the users ‘‘push-to-talk’’ as a complimentary way for negotiation. Buttons are for user pressing items. And a projector is needed to dynamically project items on Ambient Communication Interface or shared work surface on Ambient Collaboration Interface according to what the current phase is.

4.1.3. Ambient Collaboration Interface. Ambient Collaboration Interface is comprised of components to function in two collaboration media examples: *Shared Whiteboard* and *Social Space*. These include a *pen-based tablet, microphone, speakers, web cameras,* and *a projector.*

4.1.4. Presence Sensor. The Presence sensor is to indicate whether the person is available by sensing his presence.

4.1.5. AD/DA Converters. AD/DA Converters are needed as a bridge to communicate between the physical and cyber world. It includes a series of relays and an analog-digital conversion card. It can transform the analog signals from presence sensor, proximity sensor, and the button press into digital form for further

processing in computer. And transform the digital signal from remote computer into analog signal to change patterns in ambient awareness display.

4.1.6. Computing Unit. A Computer with internet connection is required to mediate and transfer awareness information and notification between colleagues by connecting with each component, and to activate or de-activate different ambient interfaces in different phases. It is both a server and a client in network architecture.

4.2. SYSTEM ARCHITECTURE

The system is triggered by a computing unit that is listening to remote signals or data from either sensors or buttons embedded in the environment. When a signal is received, computing units will be activated and interpret the received data. This will trigger a further instant collaborative phase with different results (Fig 3).

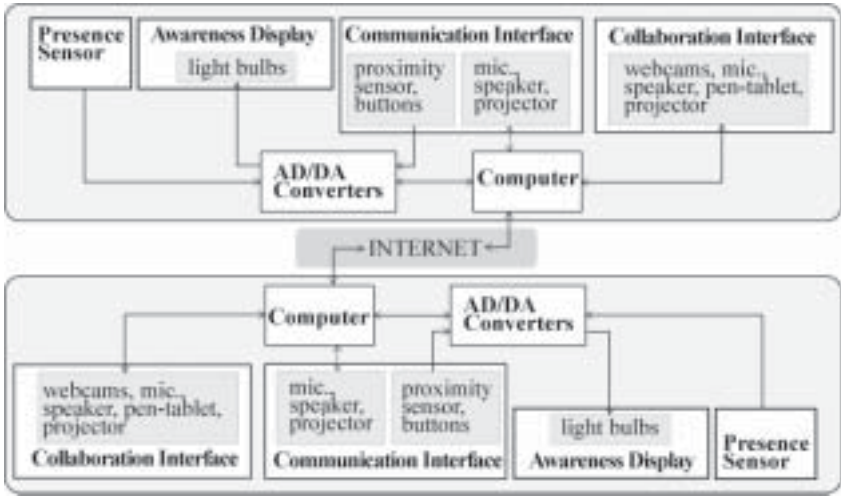

Figure 3. System architecture of our prototype system.

We have implemented two example collaborative services: Shared Whiteboard and Social Space using Flash MX Communication Server with RTMP (Real-Time Messaging Protocol). We have developed a Client+Server system in Visual Basic to communicate with each components and the remote computer through TCP/IP. We have integrated the Flash documents with Visual Basic through the Flash.ocx component. Figures 4 and 5 show the embedded components and the making of the ambient interfaces.

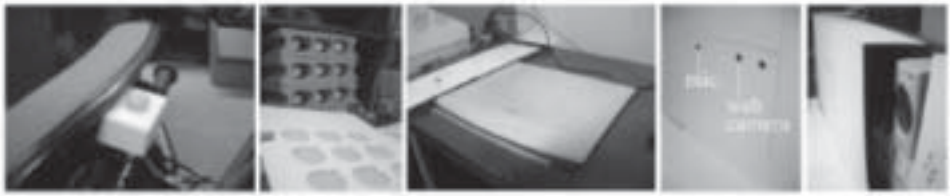

Figure 4. Embedded Components (from left to right): (1) presence sensor (2) light bulbs (3) pen-based tablet (4) web camera and microphone (5) speakers.

Figure 5. The making of the ambient interfaces.

5. A Scenario Example

In this section, we show a scenario to demonstrate the use of our system.

Daniel and Chialin are members of a global virtual design team. Daniel works at his home in Taipei and Chialin works at a rented office room in Hsinchu.

- *Today, Daniel is sitting at his design desk and doing his designs. He knows that Chialin is at his design desk as he sees the Ambient Awareness Display which represents Chialin is displaying the pattern of presence.*
- *For a while, Daniel has come up with an idea and wants to share it with Chialin. Daniel moves his hand aside to the fringe of the design desk where Ambient Communication Interface is placed and a few items emerge: "[C-Room] [M-Space] [S-Board]". Daniel touches [S-Board]. Meanwhile, in Chialin's place, an ambient display which is representative of Daniel is flashing white lights to visually attract Chialin's attention, also "S-Board? [Accept/Reject]" is displayed aside the desk surface.*
- *Chialin slightly touches "[Accept]", and then both of their work surfaces have immediately become Shared Whiteboards.*
- *Daniel starts to sketch his idea and discuss with Chialin using the Shared Whiteboard.*

— *After the collaboration, Daniel touches [Terminate] aside his work surface, and then both sides' Shared Whiteboard fade away and their work surfaces turn back to their original.*

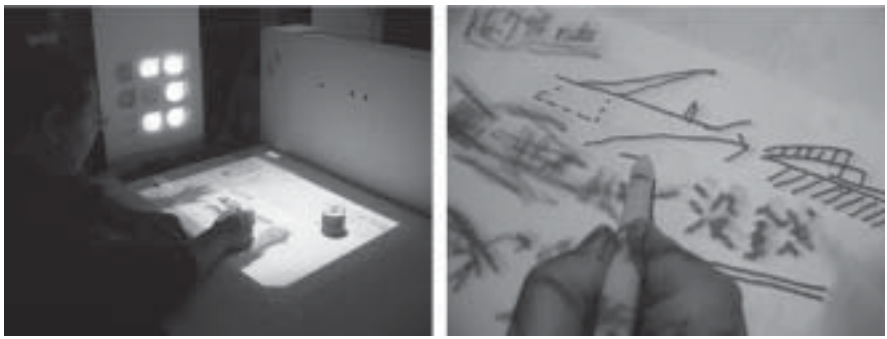

Figure 6. Remote collaboration with Shared Whiteboard on the move.

6. Conclusion and Discussion

This research has proposed a framework for instant collaboration and identified a few characteristics of instant collaboration as design requirements for designing an Instant Collaboration Environment. The framework has been implemented as a demonstrational prototype according to the design principles of ambient interfaces. In Instant Collaboration Environment, the ambient interfaces have become more than awareness information carrier, but an environmental agent that mediates social awareness and collaboration. It brings distributed colleagues into collaboration easily and unobtrusively by dynamically changing its ambient settings and system infrastructure. With the demonstration and lessons described in this paper, the instant collaboration environment is shown its possibility and computability for further investigation.

Different from the previous studies on ambient awareness displays, our ambient interfaces reflects an ''instantaneity'' property. The facility embedded into ambience could change immediately between phases of instant collaboration. By doing this, the interface arrangement will not necessarily be controlled by the physical layout, but dynamically by means of projection to adapt to an ambient interface layout. This ensures that users reach and interact with the interface at the very first time, and the designing of the input interface need not allocate a specified physical layout for every input. By way of adaptive projection, the location of interface can be shifted at any time, without changing the artifact or environment of interaction.

The prototype has integrated both ambient interfaces and system components for different interaction phases into one system infrastructure to enable users to shift instantly from social awareness to collaboration. The structure of the system

will change instantly to adapt different context according to the preset requirements. This also implies the practicability of an architectural space that can dynamically change its structure according to the user's needs and spatial context. The concept of dynamic architecture is not new in CSCW. However, it is worth mentioning when cooperating with the design of ambient interfaces. Although the work we have presented appears to be one example of our framework, we believe that by the use of wireless technologies (e.g. Bluetooth) and modulized ambient interfaces, there are the opportunities to extend the flexibility and extensibility of our approach.

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