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# Awareness Agents: A Distributed System for Group Awareness

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## 1. Introduction

We are investigating the use of distributed knowledge to gather group awareness information. In a typical workgroup, an individual's presence information is known in bits and pieces by several agents including co-workers, software agents (e.g., email clients who know about the last time message was read/sent), and sensor agents (e.g., motion detecting light switches). Utilizing that fact, we have built awareness agents who gather and process the presence information for each of the group members. They do this by compiling volunteered information (e.g., a user manually setting her status) as well as sending inquiries to other agents and processing their replies.

## 2. Awareness

For knowledge workers, collaboration is key to successful completion of projects where expertise is often needed in multiple fields. The knowledge workers often find experts among themselves and collaborate to complete the projects. Group awareness greatly aids those collaboration efforts by offering an easy avenue for setting up informal face-to-face meetings. The notion of group awareness has been defined and used in many CSCW (computer-supported cooperative work) and HCI (human-computer interaction) applications. In this paper, we follow many others by defining group awareness as simply the physical availability of group members in the work area. While non-physical availability (e.g., available on a cellular phone) may also be useful in many circumstances, we focus on providing means to aid face-to-face communication.

Automatically inferring the presence and availability of a person is a difficult problem. Previous awareness applications have gathered information using video data (Dourish, 1992), system status (Huang, 2003), or some other source of cues, but using a single source of information for presence and availability does not give the complete picture. Moreover, in an actual group setting, much of the presence

information is gathered by asking other people who may have that information. For example, if Ann is looking for Betty, and Betty is not immediately visible, Ann might ask Charlie where Betty might be. Taking this one step further, if one could ask email clients and light switches the same question, he would have a more complete picture of presence information.

This is taking the model of instant messengers (IMs). IMs aid communication among users by passing messages and showing each user's status. Our system is a much more intelligent version where (1) perceptual agents and software agents, in addition to people in the group, contribute awareness information, (2) awareness agents handle natural language input from users and input from perceptual devices to extract the meaning from them, (3) each awareness agent acts as like a personal assistant and keeps all awareness information, and (4) each user's awareness agent mediates communication, thereby allowing communication to continue when users are not available.

In the next sections, we explain our system of awareness agents who gather distributed presence information from several types of agents within the group. The next section describes a scenario using our awareness agents, and the following section explains how different types of agents act in that scenario.

## 3. Scenario

Ann wants to know whether Betty would be available to meet this afternoon. Ann looks at her Awareness desktop client and notices that Betty has set her status as "away". Ann types "Where is Betty?". Ann's awareness agent parses the message and sends a query to Betty's awareness agent. Betty's awareness agent promptly responds with the recent messages it has received. Ann sees the following messages appear on her client: 1. (30 minutes ago) Charlie saw Betty at a seminar downstairs, 2. (25 minutes ago) Face detection agent saw Betty at her desk, 3. (12 minutes

ago) David asked about Betty's whereabouts, 4. (10 minutes ago) Betty's calendar says Betty is scheduled to be at a meeting until 2:00 p.m. From these messages, Ann infers that Betty's probably occupied until 2 and wonders whether to send her an email.

At the same time, Betty's awareness agent broadcasts a query "Does anyone know where Betty is?", and a minute later, Eva replies "I see Betty in Prof. X's office. When she gets out, I can tell her that Ann is looking for her." Eva's awareness agent passes this to Ann's awareness agent, and Ann relaxes in her office preparing for the impromptu meeting with Betty.

## 4. Agents

In this section, we explain the different types of agents working together in the above scenario.

### 4.1 Awareness Agents

There is one awareness agent acting on behalf of each person in the group. An awareness agent is a virtual assistant who keeps all presence information about the person it represents and communicates that information to the other awareness agents. When Ann wants to know about Betty, Ann's awareness agent sends an inquiry to Betty's awareness agent, who answers with any information it has, and also sends a broadcast inquiry to all other agents (including perceptual agents, discussed in a later section). If any of the agents respond, the information is channeled through Betty's awareness agent, who updates its presence data. We designed the system such that one's presence information is kept only by the awareness agent representing that person. This will allow, in the future, filtering outgoing communication based on privacy preferences.

### 4.2 People as Information Agents

Another rich source of awareness information is directly from one's friends and colleagues. To allow people to contribute information about one's availability, we have designed our system to include people in the group as another type of agents. Gathering information from them is equivalent to (1) asking the question "has anyone seen Ann today?" and (2) broadcasting an electronic message "I saw Betty on the way to school. She said she should be here by noon." As seen in the scenario, communication among the people agents is mediated by the awareness agents representing each person.

### 4.3 Face and Motion Detection

The third type of an agent is a perceptual agent. In our system, we have implemented a computer vision agent that de-



Figure 1. Desktop User Interface

fects faces and motion blobs using a low-resolution camera (e.g., a webcam). We have set up individual face/motion detection software for several users at their desktops. We have also set up motion detection software for a lab area so that several motion blobs can be detected and accounted for. For the desktop face detector, it can tell whether someone is sitting at her desk. For the lab motion detector, it can provide locations of motion blobs, and the group members looking at the information can make their own inference about who might be where.

### 4.4 Bluetooth

For users who have Bluetooth-enabled mobile phones, we support an additional source of awareness information: automatic location sensing within the laboratory. The mobile-phone awareness client (see section 6), a Java MIDP application, also doubles as a source of awareness, by perpetually scanning for nearby bluetooth devices. When it detects one of the various bluetooth beacons we have deployed in a number of spaces throughout our laboratory, it updates the user's awareness agent the user's current whereabouts. Although this is a coarse metric due to the range of bluetooth's signal (around 30-150 meters), we have found that the walls in our building attenuate the signal sufficiently to make it useful for finding users' general whereabouts.



Figure 2. Manually setting status



Figure 3. Natural Language Query

## 5. User Interface

The desktop user interface (see Figure 1) to the awareness agent is a GUI containing four sections: a drop-down menu for manually setting status, a buddy list window for viewing other people's statuses, a text field for posting a query or a reply to a query, and a text box for viewing the log of the current dialog.

In any UI, giving the user control is very important. Modeling after many instant messenger clients, our system provides each user with a pull-down menu for selecting her status as "available", "busy", "away", and "hidden" (see Figure 3).

The buddy list window displays all group members and their statuses using icons. Clicking on a buddy will display more detailed information about their availability including the messages that other agents have posted (see Figure ??).

All message passing between users and awareness agents is done via natural language. Our system currently does very simple parsing of natural language queries. In the future, full parsing of queries and replies will be implemented for natural user interaction. The example (see Figure ??) shows a simple sentence "where is Alice?" which gets parsed and send a status query to Alice's awareness agent.

The bottom window shows the log of any messages be-

tween the client and the awareness agents. When the user posts a query, all conversations among the agents about that query is displayed in the loggin window. This allows each user to take in information from all messages and make her own inference about presence and availability.

## 6. Mobile Phone Interface

In addition to the desktop user interface, the awareness agent also has an interface for mobile devices (see Figure 4). The mobile interface offers the same functionality as the desktop interface but due to limited screen real estate, the GUI is arranged differently. Each of the four sections in the desktop GUI is represented as a separate screen, and a user switches between screens depending on what he wants from his awareness agent.

## 7. Conclusion

The awareness agents gather distributed knowledge to present a more complete package of awareness information to the users. This system has been successfully launched in our group and promises to be a useful and usable application for fostering collaboration.



Figure 4. Mobile Phone Interface

## 8. Acknowledgements

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## References

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