FingerPrint: Supporting Social Awareness in a Translucent Sensor-Mediated Cue-Based Environment

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Abstract
We report on a pilot study that is part of an ongoing project which investigates social awareness support for project groups made of students who may choose to work at the university, at home or at part-time job offices. The study involved the design and early evaluation of a prototype which augments a cooperative application with various sensorial and computational *cues* about co-worker presence. The sensing devices were installed and annotated by the users themselves. Based on this experience and inspired by "technomethodology", we suggest implications for design of awareness support and context-enabled devices.

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INTRODUCTION
Obtaining and displaying information about co-worker presence and availability for cooperation are regarded as important features of cooperative systems and have been studied under the term "social awareness" within HCI and CSCW (e.g. [1,5,8]). As ubiquitous and pervasive computing grew influential it became common practice, when supporting such social awareness, to make use of sensorial information on physical user presence and to combine it with non-sensorial events that suggest presence, e.g. typing in a text editor, logging into a system, etc.

Similar interests in using sensors for presence detection can be found in "context-enabled" applications, which benefit from information on "*location, identity, activity and state of people, groups and objects"* [6]. Context-enabled applications that change their behavior depending on the context are referred to as "context-aware".

The Cue-Based Approach to Social Awareness
As an example of approaching the support of social awareness and as a starting point for the work described here, we will present the cue-based approach [1]. In a system employing the approach, each user has associated a number of *cues*: a sensor on a chair, an infrared motion-detector sensor, records of last time they touched the keyboard, last time they read mail, etc. Most such cues are *passive*, they require no explicit actions from the user to be activated or de-activated, while other cues require the user to explicitly set their presence information by e.g. typing on a telephone to set their status in the switchboard [8]. Every user can have their own collection of cues, depending on what kind of information they want to reveal to others, and cues can be added to the system dynamically.

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Once the cue information is collected and processed, a number of *outlets* can be installed for each user, or in common places such as a cafeteria. Examples can range from desktop windows that display the cue information of certain co-workers, to physical bulbs or balloons (cf. [5]), sign-in boards placed in common areas showing information to co-workers and to outsiders, etc.

Issues in Processing Social Awareness Information
Two issues arise when considering technical solutions for supporting social awareness or for enabling applications with "context". *First*, there is the issue of combining the possibly contradictory information coming from heterogeneous sources to indicate presence or absence of a co-worker. For example, a presence sensor might indicate movement at a co-worker desk, but the idle time reported by a 'finger' tool might indicate no activity in the last hour. How is a system supposed to interpret such contradictory information? One approach is to create a "context widget" for presence [6], which simply 'abstracts out' all sensor particularities along with the mechanism that combines information from various sensors and presents Boolean information on whether the person is present or not. This is inspired from the manner in which well-known input device widgets, pervasive in graphical user interface (GUI) toolkits, 'abstract out' the physical devices and their software drivers, and just present e.g. the coordinates of a pointing device, hiding details such as its type (mouse or a trackball) or its technology (optical or mechanical), etc.

Second, once co-worker presence awareness information has been gathered and processed, there is the issue of who should be notified about changes of such information, and how obtrusive should that notification be. In other words, social awareness support applications try to determine *what is of interest* at the respective moment. A number of models have been devised to represent “interest” (e.g. reaction-diffusion metaphor and spatial model, see [5] for details and references) yet none of them has yet achieved recognition in practice.

In attempting to address these issues, we conducted a pilot study in a graduate school that has no physical premises, but its courses are given within 2 universities in Stockholm. Our aim was to improve social awareness within course project groups made of students who worked at the various university locations, as well as in their homes. Our pilot study became the first iteration in a 3-year project related to awareness in such distributed student groups cooperating on course projects. In what follows we will detail on how our study was organized, then will present aspects of our design for awareness support, and their evaluation. Finally, we will close with a discussion on design in relation to awareness, “technomethodology” and context-enabled computing.

PILOT STUDY

The setting for our design and implementation involved a group of four students who wrote a literature review for one of the graduate school courses over a period of 10 days. Our aim was to design and implement a prototype of a shared workspace supporting the literature review task, enhanced with features for supporting social awareness.

The users participated in two design workshops, where initial design ideas were discussed, and where they had the opportunity to familiarize themselves to the cue concepts, less common input devices such as sensors, etc. In the first workshop users discussed various cues and outlets that they could use to convey and monitor presence. Several types of sensors were considered, as well as cues coming from e.g. the usage of the shared workspace, usage of general-purpose tools like the instant messaging system ICQ®, the “empty mailbox” cue, etc. As suggested in [1], each user made a priority list of their cue preferences, and these lists were used to prepare the system before the second workshop.

By the second workshop, a sensor kit was ready for each user, and a demonstration was given on how to install the sensors and how to connect them to rest of the system. Also, some final design discussions were held on the design of the shared workspace for literature review support.

After the prototype implementation was finished, users installed their sensors and started working on their task. Three users installed the sensors at home, and one at her part-time job. They could access the (WWW-based) literature review support system from any location. All users accessed it from at least two locations (university and home, etc). The users did not meet physically (one of them also went abroad for some days) but communicated via the chat included with the prototype, via e-mail and some via ICQ. The first author was occasionally logged into the system (and employed a reduced sensor kit) to serve with help in using the system and to spot and solve prototype problems.

To document prototype usage, users took pictures of their sensor installations. The first author visited one of the users at home and observed the usage during a two-hour session. The pilot study ended with evaluation interviews. Also, each student wrote a report as part of the graduate course.

Support for the Literature Review Task. Artifacts Created

The shared workspace includes basic support for creating and editing two types of artifacts: literature references and documents. Comments to reference and documents, as well as comments to comments are supported. Support also exists for users to become aware of the creation or modification of artifacts since their last login. Several views were supplied for easier examination of the reference list.

We will briefly outline the kinds of documents created by the users: to begin with, they created a document where they assigned various literature references to members of the group. When a user read a paper they started the discussion around that paper by creating a comment to the respective reference. A first literature review draft was then produced as a new standalone document. Finally, the review was created as a separate document. Throughout this process, a document was maintained containing requested system features and the status of their implementation.

DESIGN AND USE OF SOCIAL AWARENESS SUPPORT

Design Principles

Our approach is inspired by the observation made by Schmidt [7] on awareness in co-located work settings (e.g. control rooms [4]): workers *display* awareness cues to others while *monitoring* their peers’ actions and presence. The obtrusiveness of displaying and monitoring is carefully balanced by the *competent members* of the setting, depending on the work situation.

Two initial principles guided our design. *First* we decided to limit the processing of the information from the cues (both sensorial and non-sensorial) to a minimum, and not try to combine the information from different cues in any way, instead, we decided to offer views of cue information (i.e. outlets) that will let users *monitor* the awareness information at-a-glance, out of the corner of their eye. This principle is consistent with the awareness-related design implications of many ethnographic studies of work settings (e.g. [4]). Once we decided not to do any complex computation over the data coming from the cues, we became inspired to let the users add *annotations* to their cues, which would have little computational value, but have a lot of interpretative value for the users who monitor the cues, thus being part of the way users *display* their cue information to the co-workers.

Second, we decided to let the users install and configure the cues themselves as part of their *displaying* awareness to others. We regard the act of installing a sensorial cue, deciding whether to install it in a working or a leisure area of the home, and annotating it as such, as an act of "configuring awareness" [4] in which *"participants render visible selected aspects of their activities"*.

Sensorial Cues

Two types of presence detection sensors were used: pressure sensors placed on chairs and infrared sensors that users placed in various spots of their homes and office spaces (Figure 1). The sensor kit given to the users also includes wires of various lengths and a box (which we refer to as the "awareness probe") that included one connector for each sensor. Every type of sensor has a different kind of jack connector, to avoid system or sensor damage or malfunction due to wrong connections. Each user had at most 4 sensorial pressure or infrared cues, known as P1, P2, I1, and I2. The awareness probe is connected to a domestic power outlet and to the serial port of the user home PC.

Figure 1: A pressure sensor installed on the TV sofa (left) and an infrared sensor hanged on a shelf near the desk (right)

Here are some annotations made by the users on their sensors for the co-workers to see. Most annotations are qualifications of the sensor installation in regard to the particularities of the home and the local work/living habits. Users reported experimenting with different ways of arranging the sensors.

I1: the sensor is located in my hall, that's where my workplace is. the sensor indicates that someone in my family is in the hall.

P2: pressure 2 is on my TV chair, it indicates do not disturb.

I1: is located in the heart of my flat, the hall. It indicates that I'm walking around, probably not by the computer. It may "see" my boyfriend as well.

Non-Sensorial Cues

Several non-sensorial cues were detected from usage of the home PC or of the system: "(home) Computer on" (CO), "System on" (SO) indicating if the shared workspace was open in the user's browser, "System used" (SU) indicating whether the user interacts with the system. Later on, 'CH' was added to indicate whether the user was active in the chat tool included with the prototype.

Although there were fewer configuration possibilities for non-sensorial cues (they could just be disabled) users still took advantage of the cue annotation feature to characterize the cue in relation to their work habits. For example:

CO: I´m having the computer on, check the other cues [to see] if I´m working or just playing.

The FingerPrint Outlet

As shown above, an important design principle was to provide a glance-view that would allow users to easily monitor who is around. The system has only one outlet to display the cues of all users, in matrix fashion, with one color for each user (Figure 2). This constitutes a fingerprint of the ensemble of all cues (also called like that with reference to the 'finger' Internet user monitoring tool). One can check at a glance (using color) if any cue of a certain user is on. Moving the mouse over each cue brings up the user annotation for the respective cue. When needed, more details can be found upon clicking on the cue. The cues that were not installed or were disabled for a certain user are represented as an 'underscore' hyperlink which leads to an explanation of why the cue is missing for that user.

Figure 2: Three screenshots of the FingerPrint outlet separated by a couple of seconds (user names were removed)

Although the issue of privacy was discussed in the design workshops, three users explicitly stated during the evaluation that they saw no privacy problems with the fingerprint outlet. On the contrary, they appreciated the feeling of knowing precisely what happens with their own cue information "*it was nice to see others' cues, and one's own*". Also, appreciation for not feeling alone was shown: "*the feeling that someone I knew was also using the system or at least I knew that a colleague was there working, eating or just passing by the motion sensor"*.

Outlet Aesthetics and Stamping Artifacts

When introducing "Provocative awareness", Gaver [3] emphasizes that the aesthetics involved in the awareness information visualization send an important "cultural message"; the same information can be presented in many ways, with different cultural messages conveyed. This inspired us to reflect on and make variations of the FingerPrint outlet aesthetics and their "provocative" effects.

For each artifact created in the system, we composed a quasi-unique logo, by 'copying' the fingerprint *as it was when* the artifact (e.g. a document) was created (a pseudorandom formation) and by taking away the line and column labels thus simplifying the image (Figure 3). Users started to wonder what did this reduced FingerPrint represent. Finding the answer (which two users did) required *competent membership*, which, as mentioned [7], is a key feature of awareness in a group. This, then, is the cultural message conveyed by our FingerPrint aesthetics.

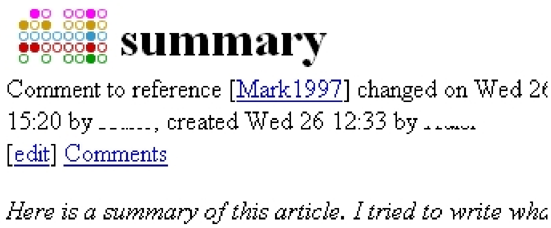

Figure 3: A quasi-unique FingerPrint logo 'stamping' an artifact created within the system

DISCUSSION

Throughout this pilot study, we were reluctant to introduce complex processing of sensor and other cue data to e.g. compose a score estimate of the co-worker presence. Instead, we let the users make their own inferences and estimates, by trying to show them efficient glance visualizations of the cue data, and by letting them qualify their own cue data with their comments, thereby strengthening both the monitoring and displaying sides of the awareness coin [7].

Users have *total discretion* over the sensors and cues: they can individually enable or disable their own sensors, they can individually check the status and the comments of the peers' sensors and cues. They have a good perception of how their actions and movements will affect the cues and how such cue changes will be perceived by the peers. In other words, by its transparency, the system is *accountable.* We concur with the principle of "technomethodology" by Dourish and Button [2] stating that "*By revealing more of what lies behind them, [] 'translucent' interfaces [] provide cues as to not only what the system was doing, but why it was being done, and what was likely to be done next, uniquely for the immediate circumstances*". We believe that such translucent systems are less likely to face e.g. privacy problems, as was shown by this pilot study.

Technomethodology places an important emphasis on abstraction, i.e. on what is hidden away from users to simplify the interface and what needs to be left accountable to them. This suggests implications for abstractions in context-enabled and context-aware computing. The tendency to hide presence sensor details (e.g. hiding "*whether the presence of people is sensed using Active Badges, floor sensors, video image processing or a combination of these*" [6]) in a similar manner with a GUI pointing device abstracting the internal details of a mouse is, we believe, harmful for the usability of context-aware computing. To exemplify our argument on this particular comparison: a mouse malfunction is much easier to detect than a remote presence sensor malfunction, and the social consequences of sensor malfunction (or wrong inference in combining the sensors, or lack of user understanding of sensor particularities), are potentially more serious than the social and usability consequences of mouse malfunction.

While we are conscious that it is hard to generalize from a short pilot study with a small number of users, our promising early results encourage us to believe that concentrating on the computational models of awareness information draws too many research resources away from the display and monitoring support that has been found to be essential in real-world awareness [7]. Instead, we propose that efforts should be channeled towards creating translucent, accountable sensor-mediated systems featuring effective glance views of rich awareness information, with attention to their aesthetics and cultural messages, as well as to providing effective means for users to display and characterize their awareness cues.

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