Mobile Phones, Refrigerators, Bar Code Readers, Cameras, The Web and People

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Abstract:

The paper examines awareness of other people in a context of mobility, consumer electronics, and World Wide Web. We approach the topic by presenting an existing demo system, and extra CSCW components that need to be added. An imaginative usage example is also presented. Because standard systems are designed on a Web (single viewpoint) model, difficulties will appear for multiple simultaneous users. These suggest issues for further discussions. Our main contribution is to open new doors to the fields of co-operative buildings and ubiquitous computers, and present issues for discussions to be considered when designing and implementing future systems.

Keywords: WWW, awareness, CSCW, ubiquitous computers, IS applications

1. Introduction

The major issue of distributed co-operation and interaction is the maintenance of situation awareness (SA) between participants, when changes taking place in one location affect the activities in another. SA can be roughly divided into two elements: workspace awareness (WA) and user awareness (UA). Workspace awareness means understanding of other people's actions on artefacts and tasks within a shared workspace (Gutwin & Greenberg 1997), while user awareness is information about who is around, whether they are available, and what they are doing. In general, awareness information supports group consciousness by keeping everyone adequately informed (Chen & Gaines 1997).

Workspace awareness involves knowledge about the tasks and activities that other users perform in a workspace. This knowledge is intermediate to observing users through changes in the states of artefacts that they need to understand. This is similar to Robinson's "Double-level-language" (1991). There are two layers of action in group work; actions upon artefacts/documents while simultaneously using spoken language to point out and discuss issues arising from those objects. In everyday life, when co-operating using physical objects, sensed communication through changes to artefacts is often as important as direct communication (Dix 1996) even more important in special situations where opportunities for direct communication are not offered.

Since situation awareness consists of these two elements, user awareness should not be

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ignored in design. The importance of background awareness of other people and their actions has been widely noted in CSCW (e.g. (Heath & Luff 1991, Heath et al. 1993, Goodwin & Goodwin 1996)). In addition to awareness of objects and other people, conversational support is necessary. By this we mean questions like "did they hear me, understand me, believe me" (Clark & Brennan 1991) are essential for shared workspaces and repairing dialogues (Bannon & Schmidt 1991, Suchman 1983).

In the next sections, we will look at situation awareness in the specific context of networked home environments. A humorous example is presented to highlight both the potential and immanent problems of such a system, as well as to show it's complexity. Instead of focussing in technology and how the system could implemented, we concentrate on human issues and problems arising from the use of the system. Finally we will present a set of issue to consider when designing such systems.

2. Technology

"Ding!

Excuse me. That's my e-mail bell. Let me call it up.

To: kmaney@usatoday.com

Message: My ice maker is jammed.

From: refrigerator@yourhouse.hom

Ahem. I'm not sure what this is about. Let me send a reply.

Reply: Yeah, right. Who is this really?

…

Ding!

The e-mail again. Pardon me.

Message: It really is your refrigerator, sir. My ice maker is jammed. Please attend to it at your earliest convenience.

Reply: C'mon, who's doing this? Is this Tony in systems? If you're really Mr. Refrigerator, what's in my cold cut drawer, buddy?

…

Ding!

Message: Olive loaf, sir. According to my internal bar-code scanner, the olive loaf in your cold cut drawer is exactly 21 days past the expiration date. Perhaps you should purchase a new package. Would you like me to place an electronic order with NetGrocer? ...".

(Maney 1998).

The situation imagined by Maney could be everyday life in the near future. Technology to accomplish such actions is not commercially available yet, but will be soon. For example, ICL and Electrolux (ICL 1999, Kahney 1999) have developed a refrigerator that includes a touch screen and bar-code reader built into the door, a PC running Microsoft Windows 95, and an external Ethernet connection. In principle, excluding the artificial intelligence, their demo system could run Maney's scenario.

However, the ICL-Electrolux demo is a single user system. There is no support for multiple users even if the devices are used by several people. You can check what is in the refrigerator via Ethernet connection, but there is no means to ask whether your family needs something even if they are standing next to the fridge. You have to use traditional separate technology (e.g. email, mobile phone). In other words, workspace awareness is only half-provided and conversational support not provided at all. To provide awareness information about other people and tools to human communication, the system needs to be expanded. Figure 1 illustrates ICL-Electrolux system extended with awareness and communication tools. The video camera (another refrigerator model by Electrolux includes such a feature) provides awareness information about any person accessing the fridge, audio tools allow communication between different parties, screens can display different messages, and a mobile phone allows content checks regardless of location. A standard WWW browser is able to retrieve information about the content of the refrigerator, but does not provide any tools to communicate with other fridge users, either itself, or through a mobile. Therefore, another Web enhancement tool, e.g. CRACK! PeopleAwarenessEngine (Robinson & Pekkola 1999, You & Pekkola 2000) is needed to allow users to be aware of each other and provide text or audio communication.

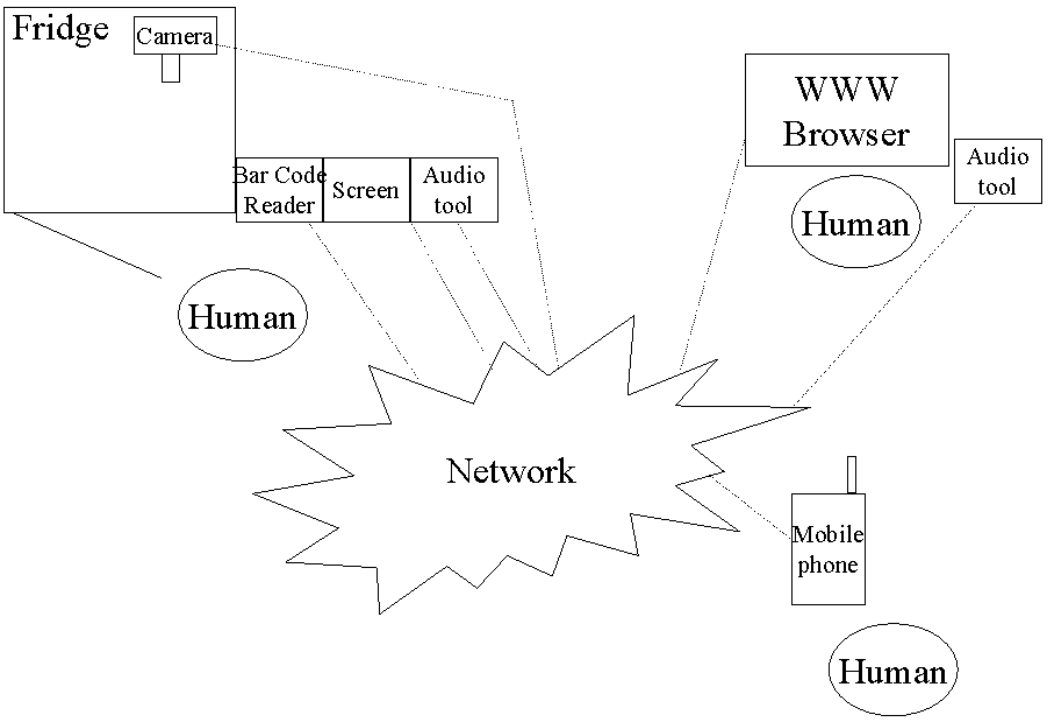

Figure 1. System architecture which combines mobile phones, refrigerators, bar code readers, cameras, the Web and people.

The full system illustrated in the Figure 1 supports situation awareness by combining all these tools. The most important is probably the bar code reader, which is essential to keep the refrigerator content up-to date. Appropriate usage requires that every item either put in or taken out of the refrigerator is identified. All other tools are needed to support different levels of awareness. A person next to the refrigerator is able to examine the usage of the system (i.e. user awareness) from the screen and the content of the refrigerator either from the screen, or simply by opening the door (workspace awareness). People using WWW browsers retrieve information about the content of the refrigerator (WA) on their screens, while video camera and touch sensors provide information whether the refrigerator's door is open, and who might be there (UA). Due to limited bandwidth, mobile users are in the worst position, since they receive only limited situation awareness; information about content (WA) and an indicator whether the door is open.

The techniques discussed support some aspects of situation awareness, but lack the second level of Double-level-language (Robinson 1991). People are aware of others using the system, but there are no tools for communication or pointing out groceries (e.g. for the benefit of someone standing next to the refrigerator). For this reason, audio tools (i.e. microphones and speakers) have been included. Conversational support is provided through synchronous media (audio and video) that allows parties to get immediate feedback on their actions.

To illustrate the usage of the system more precisely, let us describe a short example. Steve is standing by the fridge to put a bottle of milk in there. He uses the bar code reader to keep the refrigerator content up-to-date, and sees the changes in the content on the screen. From the screen, Steve also notices that Alice, his wife, is checking the content of the fridge on the WWW browser to be able to decide what new items should be bought. Thus Steve is aware of Alice, but Alice is symmetrically aware of Steve's presence and identity (because of the video camera), so they decide to open up an audio link and discuss the dinner menu. They finish the conversation and Alice heads to the shop. Meanwhile Steve realises he would like to get some ice cream, which they do not have, and which they did not agree to buy, so he uses the audio tool next to fridge to call Alice's mobile phone. Alice agrees about the ice cream. Later on, while shopping, Alice is unsure about the shopping list, so she uses her mobile to check the content of the fridge again. She notices that the fridge door is open, and has to ask the person who they are. (because of bandwidth limitations, identity via video image is excluded from mobiles) She discovers their son John has the fridge open to make a sandwich. John requests Alice to bring more bread, which Alice agrees and reminds him no to eat too much because the dinner will be coming soon.

The scenario illustrated a real-time usage of the system. However, it would also be possible to store the shopping list in the system as a kind of organisational (i.e. family) memory to avoid a number of re-checks. Allowing both input and output interfaces (e.g. a touch screen) could do this.

In the scenario, co-operation and interaction follow straightforward decision processes where two participants are involved. The participants co-operate to find solutions, which satisfies both (i.e. the menu for the dinner, and full refrigerator). As stated earlier in this paper, the major issues of distributed co-operation and interaction are the maintenance of situation awareness and conversational support. Steve and Alice are both aware of each other and the content of the refrigerator, and able to negotiate about the items via several different technical media. Alice is aware of changes taking place by the fridge (John and the sandwich) so she could change her plans and bring more bread as requested.

In principle, the system combines several different tools and communication media to provide a universal system and ubiquitous environment. Other researchers have examined the topic from different points of view. For example, Junestrand and Tollmar (1999) investigated the integration of video into a domestic environment, but their system did not support groceries or other physical objects. Koleva et al. (2000) examined the boundary between real and virtual worlds[1], but again, their approach was more towards humans than physical objects. On the other hand, Konomi et al. (1999) approached physical objects by using them as a digital information carrier. The identification of the objects was based on their weight, which is very accurate measurement since they used keys and eyeglasses. Similar kinds of identification method cannot be used for groceries, since their weights are variable, and diminish (as they are eaten.)

Systems, which combine multiple media to support human interaction and co-operation with digital objects are numerous. For example, COWS (Mandviwalla & Khan 1999) supports handling of digital documents and some indirect interaction around them. The DIVA system (Berlage & Sohlenkamp 1999) supports document handling and human communication while the VIVA system (Pekkola et al. 2000) concentrates on real-time human interaction and adaptivity to other platforms, but again, similar to COWS and DIVA, physical objects are excluded.

There are very few studies of which combine physical objects *with* computers *and* a group of people. Robinson and Pekkola (1999) have discussed the problems of combining numerous pieces of equipment in the context of multimedia classrooms. They identified issues such as wiring the equipment, and difficulties of adding to or replacing them. Sheer physical size, and digital restrictions on connections and configuration, to mention two. However, their work is based on one location with limited classroom context, so there will be many other issues to consider in the context of ubiquitous computers in the domestic environment.

In the next chapter we will discuss some potential and immanent problems from a situational awareness point of view.

3. Issues to consider when designing ubiquitous system

Combining different tools, and adding technical support for multiple users, leaves many challenging questions in need of answers. For example:

- Synchronicity and remote access. Synchronising actions taken in different locations will produce problems; e.g. technically if Steve is using the bar code reader while Alice queries shopping need via mobile. e.g. socially, Alice is shopping while Steve is compiling a shopping list. Situation awareness (both user and workspace awareness) and its' maintenance (database management) are key issues to be resolved.
- Attract attention. To manage the situation above, it is essential to attract the other person's attention, to be able to inform them what one is doing, and to know that the

[1] It can be said that both digital information and means to support human communication form a virtual space. The boundary between real and virtual worlds can be supported in many ways, e.g. providing bar code readers and computer screens to capture and represent information.

other knows (i.e. to provide conversational support). This can be done e.g. by using a video camera and a screen, or by using flashing lights and audio, which can also draw anybody's attention if they are near the refrigerator (similar to telephone call).

- User interface. A wired fridge requires every item pass by the bar code reader every time they are put in or taken out of the fridge. However, this is in addition to habitual everyday activity. It means the bar code reader will probably not be used, or worse, partially used. Alternative techniques are few. Items are usually stored for variable and relatively short periods, and packaging thrown away when empty, so neither can be used as reliable indicators. Other metrics such as weight or size of the package cannot be used for obvious reason. Other alternatives could be image recognition or factory inserted magnetic stripes.
- Heterogeneous equipment and networks. Since different terminals have different capacities to operate as well as varying network requirements, interoperability will be an issue. For instance, mobile phones use two different channels to communicate with base stations, one for continuous transmission (i.e. for audio) and one for occasional control and text messages. This creates a problem since maintaining situation awareness and communicating through it are continuous, in ways mobile phones are not designed to deal with.
- Automated actions. In Maney's scenario, once the best-before-date was passed, the refrigerator made an automatic order to replace the item. However, this has several social (the item is not wanted anymore?) and technical, security, and 'junk-product' (ensuring no-one else triggers the computer to order unwanted items) issues to be considered.
- Identifying people. In our example, a video image of a person at the refrigerator was sent to other people. However, this requires a lot of bandwidth and powerful terminals, so the use of more economical techniques such as image-recognition or fingerprints could be considered.
- Other equipment and domestic items. Usually, when buying items for the fridge, other groceries (bread, coffee, etc.) are bought too. The 'wired' fridge would soon need electronic playmates, the 'wired cupboard' and the 'wired breadbin'.

4. Conclusion

In this paper, we have examined awareness of other people in a context of consumer electronics, mobility, and World Wide Web. We have approached the topic by presenting an existing demo system, and extra CSCW components that are needed to fully support situation awareness between co-operating participants. This addition of components is not as easy as it may sound like. Because standard systems are designed on a Web model, where only one user is present at once, difficulties will appear for multiple simultaneous users. If those difficulties are inspected purely from the technical perspective, they actually do not exist, because all technologies mentioned are already used widely, but independently, not combined as a whole. However, because the maintenance of situation awareness between participants is essential for effective distributed co-operation and interaction, every equipments must communicate with others as transparently to users as possible. As we have illustrated, the maintenance of situation awareness requires smooth co-operation between different applications, thus technical issues

arise again. As a summary, we have created an initial list of issues to consider and for further discussion when designing systems for ubiquitous computing. We hope this influences other researchers to investigate the combinations of domestic artefacts, like refrigerators, the Web, and mobile phones in more detail.

5. References

Bannon, L., and Schmidt, K. CSCW: Four Characters in Search of a Context, Studies in Computer Supported Cooperative Work. Bowers & Benford (eds.) Elsevier Science Publisher. 1991. pp. 50-56.

Berlage, T. and M. Sohlenkamp, *Visualizing common artefacts to support awareness in computer-mediated cooperation*. Computer Supported Cooperative Work: The Journal of Collaborative Computing, 1999. 8(3): p. 207-238.

Chen, L. and B. Gaines, "A CyberOrganism Model for Awareness in Collaborative Communities on the Internet", International Journal of Intelligent Systems, 12(1), 1997 pp. 31-56.

Clark, H.H. and S.E. Brennan, Grounding in Communication. Readings in Groupware and Computer Supported Cooperative Work: Assisting Human-Human Collaboration, ed. R.M. Baecker. 1991, CA: Morgan-Kaufmann Publisher. pp. 222-233.

Dix, A., Challenges for Cooperative Work on the Web: An analytic approach. Computer Supported Cooperative Work: The Journal of Collaborative Computing, 1997. 6(2-3).

Goodwin, C. and M. Goodwin. Formulating Planes: Seeing as a situated activity. Cognition and Communication at Work. 1996. N.Y.: Cambridge University Press.

Gutwin, C. and S. Greenberg. Workspace Awareness. Position paper for the ACM CHI'97 Workshop on Awareness in Collaborative Systems. 1997. Atlanta, Georgia.

Heath, C., M. Jirotka, P. Luff and J. Hindmarsh. Unpacking Collaboration: The Interactional Organisation of Trading in a City Dealing Room. Proceedings of the Third European Conference on Computer Supported Cooperative Work - ECSCW'93. 1993. Milan, Italy: Kluwer Academic Publishers.

Heath, C. and P. Luff. Collaborative Activity and Technological Design: Task Coordination in London Underground Control Rooms. Proceedings of the Second European Conference on Computer-Supported Cooperative Work. ECSCW '91. 1991. Amsterdam, Netherlands: Kluwer Academic Publishers.

ICL. Press Release: Innovations Developed By ICL Make Frigidaire Refrigerator High Tech. WWW reference: www.postsw.com/AboutICL/Releases/fridge.htm (Referenced 01/25/2000).

Junestrand, S. and K. Tollmar. Video Mediated Communication for Domestic Environments – Architectural and Technical Design. Proceedings of Cooperative Buildings: integrating information, organizations and architecture, CoBuild'99, Pittsburgh, USA October 1-2. 1999. pp. 177-190.

Kahney, L. The Coolest Internet Appliance. Wired 7(2) 1999. Available on the WWW: http://www.wired.com/news/news/technology/story/17872.html (Referenced 01/26/2000).

Koleva, B., H. Schnädelbach, S. Benford, and C. Greenhalgh. Traversable Interfaces Between Real and Virtual Worlds. in the Proceedings of Computer-Human Interaction, CHI'2000, Den Haag, 2000.

Konomi, S., C. Müller-Tomfelde, and N.A. Streitz. Passage: Physical Transportation of Digital Information in Cooperative Buildings. Proceedings of Cooperative Buildings: integrating information, organizations and architecture, CoBuild'99, Pittsburgh, USA October 1-2. 1999. pp. 45-54.

Maney, K. Just how smart could homes get? USA Today March 26 1998. Available on the WWW: www.usatoday.com/life/cyber/tech/ctc373.htm

Mandviwalla, M. and S. Khan. Collaborative Object Workspace (COWS): exploring the integration of collaboration technology. Decision Support Systems, Elsevier no 27, 1999. pp. 241-254.

Pekkola, S., M. Robinson, M.-J. O. Saarinen, J. Korhonen, S. Hujala, and T. Toivonen. Collaborative Virtual Environments in the Year of the Dragon. to appear in the proceedings of Collaborative Virtual Environments (CVE2000). 2000.

Robinson, M., Double-Level Languages and Co-operative Work. AI & Society, 1991. Vol 5:pp.34-60.

Robinson, M. and S. Pekkola, User communication and monitoring system for computer networks, European & US patents. 1999.

Robinson, M. and S. Pekkola. The Studio: Reflections and Issues Arising. in the Proceedings of CoBuild'99, Second International Workshop on Cooperative Buildings - Integrating Information, Organizations and Architecture. N. Streitz, J. Siegel, V. Hartkopf, S. Konomi (Eds.) October 1-2, 1999, Pittsburgh, USA. pp. 101-113

Suchman, L. A. Office Procedures as Practical Action: Model of work and system design. TOIS 1(4) 1983.

You, Y. and S. Pekkola, Supporting Awareness of Other People on the WWW: a framework and an example system. To appear in the proceedings of Pasific-Asian Conference on Information Systems (PACIS2000), 2000.