A Digital Photography Framework Enabling Affective Awareness in Home Communication

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ABSTRACT

By transforming the personal computer into a communication appliance, the Internet has initiated the true home computing revolution. As a result, Computer Mediated Communication (CMC) technologies are increasingly used in domestic settings, and are changing the way people keep in touch with their relatives and friends. This article first looks at how CMC tools are currently used in the home, and points at some of their benefits and limitations. Most of these tools support *explicit* interpersonal communication, by providing a new medium for sustaining conversations. The need for tools supporting *implicit* interaction between users, in more natural and effortless ways, is then argued for. The idea of affective awareness is introduced as a general sense of being in touch with one's family and friends. Finally, the KAN-G framework, which enables affective awareness through the exchange of digital photographs, is described. Various components, which make the capture, distribution, observation and annotation of snapshots easy and effortless are discussed.

Keywords

Affective awareness, ambient media, awareness, calm technology, Computer Mediated Communication, digital camera, home photography, implicit social interaction, social role of home photography, ubiquitous computing, World Wide Web

1 INTRODUCTION

The so-called "personal" computer has made its apparition in the home more than two decades ago. It seems, however, that the true revolution has only been initiated much more recently [Venkatesh 1996]. Among other factors, it is the addition of communication features and the wide popularization of the Internet that can explain the profound social impact of home computing. Access to the Net has indeed transformed a device that had no real domestic function into an appliance extensively used for information access, entertainment and interpersonal communication. As a result, the personal computer is becoming more meaningful for the household, used both by the entire family and for home-related tasks (as opposed to work-related tasks performed at home). In this light, it might very well have effects as dramatic as those from previous technologies, such as the television or the telephone.

Emerging communication technologies are deeply affecting the way people "socialize", in other words the way people meet, keep in touch and interact with each other. While this is true at work, it is also true at home. People are offered new ways to maintain relationships with their family and friends, new ways to establish contacts with local and global communities, etc. But while the social impact of Computer Mediated Communication (CMC) technologies is generally acknowledged, it is not clear whether it is mostly positive or negative. Some praise the Internet as a medium that removes economical, spatial and temporal constraints and thus allows people to extend their social networks. Others fear that mediocre computer-based communication may lead to social isolation and reduce well-being.

In any way, it is very important that engineers and computer scientists take into account the observations and recommendations of ethnographers and sociologists studying the impact of new technologies in the field. Adopting a multi-disciplinary approach should help make the best use of a very unique and pervasive communication infrastructure. As a matter of fact, the Internet is a very flexible platform, on top of which it is possible to build a wide diversity of tools supporting social interaction. The challenge is to figure out what these tools could and should be, and how they could and should be used by the general population. It will take time, imagination and effort to address this challenge, and to truly leverage the potential of global and ubiquitous networking.

In this article, our goal is more modestly to look at existing CMC technologies used in the home, to point at some of their limitations, and to discuss a number of ideas that would overcome these limitations. While recognizing the merits of current technologies, we argue for the need to augment the functional spectrum they cover. We introduce the idea of *affective awareness*, and discuss the envisioned benefits of tools supporting lightweight, effortless and emotional interpersonal communication through shared experiences and non-verbal communication. We explain how such technologies require to go beyond the traditional personal computer, and beyond traditional human-computer interaction (seen as a one-to-one, exclusive dialogue).

An illustration of these ideas is then proposed with the design of KAN-G, an interpersonal communication framework based on the exchange of digital photographs. The KAN-G framework consists of a variety of hardware and software components, which support the capture, the distribution, the observation and the annotation of photographs. The foremost motivation for designing the framework has been an observation of the social role played by "traditional" home photography, and a reflection on how emerging digital photography technologies may affect this role. Family snapshots are seen as very powerful artifacts that create and strengthen affective and emotional links between people. Digital imaging technologies have the potential to make it easier to create, share and observe photographs, and thus to amplify the interpersonal communication function of home photography. We believe, however, that achieving this goal requires the careful design of "calm" systems [Weiser and Brown July 1996], that should be natural to use, that should be merged with architectural spaces [Junestrand and Tollmar 1998, Rijken 1999, Wisneski, et al. 1998], and that should privilege aesthetic and artistic quality [Padula and Amanda 1999].

The remaining sections of this article are organized as follows. In Section 2, the current use of Computer Mediated Communication (CMC) technologies in domestic environments is discussed. The functions and interaction modes supported by existing tools are described, and some of their problems and limitations are pointed out. A number of field studies on the social impact of home computing are then mentioned, and important implications for the design of communication technologies are highlighted. The idea of affective awareness is finally introduced and placed in the context of related work. The discussion stresses that tools enabling affective awareness should not replace, but augment traditional technologies such as electronic mail.

Section 3 illustrates the previously introduced ideas with the KAN-G framework, designed to support affective awareness through electronically mediated home photography. The social role of "traditional" home photography is discussed first, with references to visual anthropology. It is then explained how a number of different emerging digital imaging technologies are likely to affect and amplify this role. The components of the framework are reviewed, and it is explained how they support the capture, distribution, viewing and annotation of digital photographs. It should be noted that the implementation of the KAN-G framework is still in progress. Prototypes for the components described here have been implemented, but their integration has not been fully completed yet. The main objective of this article is thus not to report on the implementation, but rather on the design of the framework. More importantly, it is to raise attention on emerging domestic applications for digital photography and to foster research in this area.

2 COMPUTER MEDIATED COMMUNICATION IN THE HOME

Computer Mediated Communication covers a broad spectrum of technologies, from electronic mail to the WWW, from real-time video-conferencing to MUDs and MOOs. Such technologies support very different functions, and enable very different interaction modes. Most of them were developed to support work related processes, but are now also used to support tasks within households. But because the requirements of work and domestic environments are very different, it is not clear whether current CMC tools really fit the needs of home users. On the contrary, it is likely that CMC performed in the home will raise a need of tools that do not have any equivalent in work environments. This is particularly the case for technologies that put an emphasis on entertainment and fun criteria.

In this section, we first review some of the most popular CMC technologies used in the home and point at some of their limitations. We then look at a number of field studies on the social impact of home computing and highlight important implications for technology designers and computer scientists. We finally introduce the idea of affective awareness and review some related work in the Computer Supported Cooperative Work (CSCW) and Human-Computer Interaction (HCI) literature.

2.1 Current use of CMC technologies

The applications and services that have been developed on top of the Internet infrastructure can be categorized in different ways. The first way is to distinguish between *interpersonal* and *mass* communication tools. *Interpersonal communication* tools support the direct exchange of information between two (or a small number) of participants. They are thus electronic surrogates to face-to-face, paper mail or telephone communication. *Mass communication* tools allow the dissemination of information from one publisher to a possibly large number of consumers. In that sense, they are comparable to traditional media such as the television, the radio and the press. A fundamental difference with Internet technologies, however, is that the barriers to entry are extremely low. Therefore, and for the first time, virtually everyone has access to mass media as an information publisher.

The distinction between interpersonal and mass communication technologies is in fact quite loose. The WWW, for example, is generally seen as a mass communication medium. But when a site is designed to be visited by a small number of people (e.g. a Web site published by a family, mainly visited by the members and friends of that family), its main role is to support interpersonal communication. Conversely, when electronic mail (primarily seen as an interpersonal technology) is used in conjunction with large distribution lists, it becomes similar to a mass communication tool.

2.1.1 Electronic mail

At home like at work, electronic mail is certainly the most common CMC technology. In domestic environments, it is essentially used to sustain *conversations* (with family, friends and people met on-line) and interactions with commercial and administrative entities (e.g. with customer support services or tax office). Several factors can explain the wide popularity of email. First, it is relatively easy to use and does not require a long learning curve. Everybody in the family has thus access to the medium, without any particular requirement of technical expertise or time. Second, email is already ubiquitous, as almost everybody now has an email address. The technology can thus be used to interact with a very large number of people. Third, email is an interesting alternative to traditional communication tools (e.g. paper mail, telephone), which among other benefits offers low cost and immediate delivery.

One particularly interesting application for email is exemplified by the "kids-at-college" scenario, where parents can more easily keep in touch with their children when they leave home. Writing an email requires much less effort than writing a letter, buying a stamp and finding a mailbox. Writing an email is also cheaper than making a long-distance phone call. These factors and others contribute to increase the level of communication between the members of a family who do not live together. This is seen as a positive social impact of the technology, as it contributes to strengthen social relationships.

This, however, does not mean that electronic mail is the ultimate interpersonal communication tool and that no alternative or extension should be searched for. For instance, one problem is that keeping up with electronic mail is often very tedious and requires a lot of time. As a consequence, people often reduce either the frequency (e.g. from daily to weekly) or the quality (e.g. limit to state weather information) of their messages. But these apparently insignificant messages are far from being useless. In many cases, what is important is not so much the content of the message, but rather the simple fact that the message has been sent. The message, by its mere transmission, *connects* the sender to the receiver. Sending an email is in some cases very similar to waving or smiling at someone.

In other words, the real function of email is sometimes not to support the exchange of explicit messages (i.e. conversations), but rather to convey a general sense of being connected to each other (what we will define later as *affective awareness*). But if this is the case, then other tools should be developed to support this function more appropriately. The KAN-G framework, described in Section 3, was precisely developed with that idea in mind: instead of exchanging mediocre textual messages, people could maintain mutual affective awareness by exchanging i) photographs and ii) impressions on these photographs. This would present the advantage of being at the same time less constraining (taking a snapshot takes less effort than writing a few paragraphs) and emotionally richer (looking at someone's smile conveys a stronger impression than reading a weather report).

Electronic mail should of course not be abandoned, as there will always be a need to exchange factual information. But electronic mail should be augmented and used in conjunction with other tools that focus on lightweight and informal communication.

As a matter of fact, there are already examples of technologies which have roots in electronic mail, but which are particularly targeted at non-professional users. One example is the PostPet mail software[1], tremendously popular in Japan. Although it can be used as a standard POP3 client, PostPet has a unique user interface and functions inspired from the famous "Tamagochi" artificial creatures. The main window represents a room, in which lives a small animal (e.g. a pink bear). When the user sends an email to a friend, it is the cute creature who gets the envelope, travels across cyberspace and enters the receiver's living room. At this point, the two creatures play with each other for a while, for the great enjoyment of the user. This application illustrates that an important aspect of CMC communication, when it performed at home, is entertainment and fun.

Another example is the electronic greeting card service offered by several Internet companies[2]. Users can choose among various categories (birthday, mother day, friendship, etc) and send annotated drawings to their friends, who can view them with a standard Web browser. Sending an electronic postcard is very similar to sending a paper postcard. The main function is not the communication of factual information, but the expression that the sender is thinking of the receiver. One limitation of electronic postcards is that they require the receiver to use a PC to look at them. This requires too much time and is too difficult for some people (e.g. older people who have and will never use a computer). A better idea would be to have special displays (maybe on the fridge, or on a screen phone), where the postcards would automatically be shown after delivery. This would make the whole system much easier and natural to use.

2.1.2 The World Wide Web

The World Wide Web is another very popular application with home users, that can be used in two different ways. First, households can act as *information consumers*. This is the case when kids search information for doing their homework, when parents do on-line shopping, and when the whole family surfs the Web for entertainment purposes. The Web has often been described as a potential substitute for television. One difference, however, is that watching television can be a group activity (several people can easily watch the same TV screen, *share* an experience and exchange comments), as surfing the Web is more often an individual activity. The "Let's browse" collaborative agent [Lieberman, et al. 1999] has been an attempt to make Web browsing a collaborative and co-located activity.

Second, households can use the WWW as *information producers.* Increasingly, home users can design and maintain their own Web site. This has become both easy and cheap, with the availability of GUI design tools and the possibility to get free storage space at various Internet portal sites. Very often, people take this as an opportunity to introduce their family to the world, to give information about their hobbies and almost always to share a few photographs.

Sometimes, the family Web site is also used to support interaction around a specific event. For example, Web sites are often created to announce and remember a wedding celebration. Before the wedding, useful information is offered to the guests (maps, accommodation, schedule, etc). After the wedding, pictures, short comments and stories are added to the site.

When a Web site is created by a family, the popular term "*home* page" seems particularly appropriate. The Web site appears to be a digital extension of the physical dwelling. As such, it could become a social place where the family could interact with visitors. This is however still rarely the case, for several reasons. The first reason is that it is difficult to grasp the activity occurring within a Web site, for example to track visitors in real-time. The publishers of a Web site therefore do not know when visitors are arriving, and what they are doing in the site. Sometimes they do not even know whether visitors are coming at all. The second reason is that the physical and electronic worlds are still very much separated from each other. As a

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[1] http://www.sony.com.sg/postpet/

[2] for example: http://www.bluemountain.com

consequence, when people are engaged in activities in the physical world (cooking, reading books, etc), they are not aware of what is happening in the digital world. The visitors of the digital home are therefore not perceptible to the inhabitants of the physical home, which prevents much interaction between them. We have discussed these problems in a previous article [Liechti, et al. 1999], and introduced the metaphor of a window bridging the physical and computational worlds. When this window is open, users hear different sounds when different events are detected on the site (e.g. they hear bird chirps or dog barking when particular pages are accessed by particular people). A related approach has been proposed in [Benford, et al. 1996], with the idea of a virtual foyer (on the WWW) connected to the real foyer of an organization.

Finally, it should be noted that some families already have attempted to create a bridge between their real and virtual homes, by putting a Webcam in their living room (i.e. a camera which periodically takes pictures that are then visible on a Web site). This however only creates a link from the real world towards the virtual world, and not in the opposite direction. While the use of Webcams is interesting, it raises obvious privacy issues.

2.1.3 On-line communities

Another popular CMC application is the support for *online communities*. Newsgroups, multi-users virtual worlds (e.g. MUDs and MOOs), and more recently WWW portal sites are some of the technologies that are used for this purpose. Although some are, many online communities are not work-oriented. They can be interest-focused (e.g. pregnant women or guitar players), but can also be bound to geographical communities (e.g. foreigners living in Tokyo or residents of the San Francisco bay area).

The first category offers a good example of how the Internet offers new possibilities to meet people. They remove not only spatial and temporal barriers, but also psychological barriers. For example, shy people find it easier to initiate interaction when they are on-line and protected by some anonymity. Of course, one might argue that this kind of interaction is artificial, shallow and not as gratifying as "real" interactions. The image of the asocial teenager, spending all his time in front of his computer easily comes in mind. But there are cases where people really get a benefit from on-line interaction, as reported in [Rheingold 1993]. On-line communities sometimes allow people to share their problems with others and to get some comfort. This interesting aspect has been discussed in [Preece 1998], with the description of *empathic* communities. In these, participants are primarily interested in sharing feelings and supporting each other, as opposed to exchanging factual information. According to the author, current CMC tools are not very well suited to support empathic communication. The usual interaction mechanism is often limited to text, which lacks many channels used to convey feelings and compassion in face-to-face communication. Accordingly, there is a need for designing better user interfaces, with the potential to improve the quality of life for thousands of people.

An interesting aspect of the geographically-bound communities is that they make it easier to augment on-line interaction with face-to-face interaction at some later point. For example, after having met interesting people in a discussion forum, it is possible (and cost-effective) to meet them "in real". This is not as easy when people from Europe and Japan meet in a subject-focused community.

2.1.4 Internet presence and instant messaging

Finally, two related technologies that have recently received a large echo in the press are Internet Presence (IP) and Instant Messaging (IM). Although they have existed for a very long time (on time-sharing and UNIX systems), these mechanisms are now used by millions of people on personal computers connected to the Internet.

Internet Presence makes it possible to know when a group of people (often called the buddy list) are connected to the Internet, and to have an idea of their status (e.g. busy, available, etc.). Instant Messaging then allows to send short messages to these people. Instant messages usually appear immediately on the receiver's display (unlike email, the messages are not stored in a mailbox).

An interesting aspect of IM is that they support some level of awareness between users. A window dynamically reflects the status of the user's contacts, which conveys a sense of approachability. To some extent, it gives the impression that one's "buddies" are right there behind the screen, almost reachable. This is particularly interesting for home users. The members of a family who do not live together can "feel" closer to each other, on a continuous basis. There seems however to be room for much development of IP and IM. For instance, status information is now very limited (e.g. offline, online, available, busy, away). If IM is to be used to create an artificial sense of "living together", then additional information could be beneficial (e.g. mood, an idea of the current activity, etc.).

2.2 Field studies and their implications

The social implications of home computing have interested a number of scholars for many years. Behaviors and usage patterns have been examined in field studies, and important observations have been made. The implications for industrials, policy makers and technology designers are important. Some studies are now reviewed, and important observations for the design of digital communication technologies are highlighted.

In 1985, Vitalari, et al. [Vitalari, et al. 1985] examined the impact of home computers on time allocation patterns, by analyzing the behavior of some 282 users. They observed that the introduction of PC in the home increased the time spent alone and decreased the time spent with family and friends. It was however not clear whether this was a short-term or long-term impact, in which case it might be hypothesized that computers can lead to social isolation. The authors also observed a shift from pleasure-oriented to task-oriented activities. But it should be noted that at the time of the study, there were still very few applications targeted at home users and that the home computer was merely a work-oriented tool used at home.

A very interesting point raised by the authors is that the traditional human-computer interaction paradigm plays a key role in the time reallocation process:

"The time allocation phenomenon in computing is especially poignant with respect to personal computers, where personal, in operational terms, means a one-to-one real-time interaction with the machine. [...] The popular example of the personal computer "widow" exemplifies this dilemma."

The problem we see here is that interacting with a personal computer generally requires the user to be isolated from the rest of the household, both physically and mentally. The first reason is that the computer is often in a room used by individuals (an office, a room) and not in a room used by groups (the kitchen, the living room). In other words, the PC user is often in a room where others don't spend much time, and is thus often alone. The situation would be quite different if the computer was in public space, for example in the living room. The user would then share the physical environment with the other family members and be less isolated. There are several reasons why PCs are not placed in public spaces more often, including factors such as poor aesthetic quality, unavailable space and noise disturbance.

Observation 1. *Placing home computing technologies in public spaces, such as the kitchen or the living room, could reduce the risk of social isolation for users. This requires a careful design of the devices, which have to nicely integrate in the architectural space.*

The second reason is that when using a computer, it is difficult to do anything else at the same time. The hands, the eyes, the whole body and the entire attention of the user is generally mobilized by the interaction. A good illustration for this problem is that many people feel very tired after using a computer for several hours. For some tasks (e.g. writing a report with a word processing software), it is quite difficult to overcome this problem. But in some cases, it seems that the interaction between the user and the computer could be achieved more naturally, not necessary requiring the use of a keyboard and a mouse.

The distribution of electronic postcards, mentioned earlier, provides a good example for this issue. It seems that having the postcards automatically shown on displays scattered within the home (on walls, desks, phones, etc) is an advantageous alternative to the current situation. In this case, people would not have to dedicate a significant amount of time to the task of consulting incoming mail (going to the PC room, switching it on, launching the browser, fetching the URL, turning everything down, coming back), but would rather continuously and seamlessly be using the technology, without really noticing it.

Observation 2. *Human-computer interaction mechanisms that do not monopolize the mental and physical attention of users could reduce the risk of social isolation. This requires the design of multi-modal user interfaces, where interaction is supported through voice, gesture and other means.*

In another study published in 1996, Venkatesh compared the situation of home computing in the early 1980s and the 1990s. He explained how a number of factors had contributed to have delayed the "home computer revolution" announced with the first apparition of computers in the home. The addition of communication features and the availability of software supporting household tasks (entertainment, education, financial management) are two factors that explain the greater acceptance and significance of home computers in the 1990s. Another critical factor is the understanding that technological innovation can happen in the home, and does not have to happen at work and then be transferred in the home:

Observation 3. *Computing technologies do not have to be transferred from work to domestic environments. Instead, they should be developed with a consideration of the particular needs of home users.*

Another observation made by the author was that to gain acceptance within the home, computers had either i) to compete with existing technologies (e.g. phone) and to support existing tasks more efficiently or ii) to enable new activities that were not possible without computers. For the designers of digital communication technologies, it means that radically different ways to support interaction between people should be searched for:

Observation 4. *Digital communication technologies should not only mimic traditional communication media. Instead, they should enable functions that were not possible without a pervasive communication infrastructure.*

Another study with important implications is the HomeNet field trial. A research group at Carnegie Mellon University observed the online behavior of more than 70 households during their first years of Internet use.

The first question, addressed in [Kraut, et al. 1998], was to find out what home users really want to use the Internet for. Is it for information acquisition and entertainment, or is it for interpersonal communication? To answer this question, the respective use of a Web browser (used for access to information and entertainment) and of an electronic mail client (used for interpersonal communication) were compared over time. The collected data suggests that users generally prefer email over the Web. In other words, the use of the Internet at home seems to be motivated first by interpersonal communication, and not by information access. In the opinion of the authors, however, there has been a tendency so far to focus primarily on information access and entertainment services:

"The commercial development of Internet services and public policy initiatives to date have probably over-emphasized information and entertainment and under-emphasized interpersonal communication."

The implication for computer scientists is that an effort should be made to improve existing interpersonal communication applications. It also means that it is worth investigating new forms of interpersonal CMC, as there is a strong demand for it:

Observation 5. *Interpersonal communication is what people really want to use the Internet for. Therefore, a special effort should be made to improve existing interpersonal communication technologies, and to propose new ones.*

Another question examined in the HomeNet study is also the title of an article [Kraut, et al. 1998]: "Internet paradox: a social technology that reduces social involvement and psychological well-being?". Because it is not clear whether the social impact of the Internet is mostly positive or negative, the authors collected data to identify a possible correlation between Internet use, social involvement and psychological well-being. Social involvement was measured by family communication, size of local social network, size of distant social network and social support. Psychological well-being were measured in terms of loneliness, stress and depression. The findings of the research indicate that greater use of the Internet was associated with declines in social involvement, and increases in loneliness and depression.

In order to explain these results, the authors made two hypothesis. First, the negative impact could be due to the fact that Internet use requires to abandon other activities, such as reading books or talking with family members. This is the same problem as mentioned before, with the analysis of Vitalari et al. on the impact of home computing. Second, the authors argue that current CMC tools do not allow social interactions that are as good as face-to-face or telephone interactions. They thus suggest that a considerable effort should be made to develop better interpersonal communication technologies on the Internet.

2.3 Affective awareness

A particularly interesting application for CMC in home settings is to offer efficient ways for people to keep in touch with their families and friends. The notion of "keeping in touch" is very general and has very different aspects.

It seems that current technologies primarily support one of these aspects, which is idea of *conversations*. In other words, they support the explicit exchange of factual information. This means that to keep in touch with someone, it is necessary i) to explicitly initiate an interaction, ii) to encode a message (usually by typing text), and finally iii) to transmit this message. The pace at which messages are sent back and forth between the participants depends very much on the technology. With email they might be exchanged once a day. With synchronous text-based communication (e.g. IRC, MUD, chat rooms), they might be exchanged every few seconds. In any way, this kind of interaction always requires some effort from the participants, at least to establish the communication. This effort, as small as it could be, represents a barrier to communication and potentially reduces the amount of social interaction.

When people share the same house, the situation is very different. For example, consider what happens in the kitchen, when a family is having breakfast. Even when they are not talking, people have many ways to interact with each other. They can easily guess what is the emotional condition of each other, have an idea of their daily schedule. Body language, dress code, facial expressions are some of the many natural channels that convey this information. In this situation, people are interacting tacitly: they do not have to explicitly exchange messages (i.e. talk) to feel "in touch" with each other. The important thing is that they do not have to do any effort to interact with each other: sharing the same physical space is sufficient.

A recent survey [Philips 1998] was conducted to get an understanding of communication patterns between middle-school-age children and their parents. The results showed that 58% of the parents and 73% of the children said that they spend less than an hour a day in conversation. Moreover, 27% of the parents and 46% of the children said that they spend less than 30 minutes a day in conversation. This was interpreted negatively by the authors of the study, who then proposed different ways to increase the level of communication between parents and kids. But a more encouraging way to look at these results is to point out that conversation is not the only mechanism through which parents and kids build affective relationships. Therefore, digitally mediated social interaction should not only be supported by conversation, but also by other means.

What we call *affective awareness* is a general sense of being close to one's family and friends. It seems that affective awareness is best achieved when people are engaged in shared experiences, especially when these experiences affect their emotional state. Watching a funny TV show, observing paintings at an art gallery, enjoying a good meal, playing games are all simple of activities that, when performed together, make people feel close to each other. It seems that CMC technologies that would recreate this kind of interactions would be very beneficial to users. First, because they would not require much effort, they would be used frequently and would increase social interaction within distributed families. Second, because they would not require the explicit interaction between a user and a computer, they would avoid many of the problems mentioned in the previous section (in particular the risk of social isolation caused by extended periods of computer use).

As a matter of fact, similar issues have already been studied in work environments. Distributed working groups have very similar problems, in particular the difficulty to maintain a context for communication. The notion of awareness has been extensively discussed in the Computer Supported Cooperative Work (CSCW) literature [Dourish and Bellotti 1992, Dourish and Bly 1992, Gutwin and Greenberg 1998, Isaacs, et al. 1996, Tollmar, et al. 1996]. More specifically, *peripheral awareness* has been identified as the awareness that people can maintain about each other, seamlessly and without effort, when they are close to each other. A number of systems have been developed to artificially recreate peripheral awareness within distributed groups. Media spaces [Bly, et al. 1993, Pedersen and Sokoler 1997], ambient user interfaces [Wisneski, et al. 1998], and calm technologies [Weiser and Brown July 1996] are all related to this idea and have been an inspiration for our work.

An important aspect is that in these approaches, human-computer interaction is not achieved through a conventional keyboard-display installation. Instead, the computing environment is more closely integrated with the architectural space, and is surrounding the users. Sounds, images, but also temperature and tangible artifacts [Ishii and Ullmer 1997] are used to create an interface between the physical and digital environments. Once again, this seems to be particularly valuable to address the issues raised in the previous section, as it does not require users to be cut out from the social environment when they are using the CMC technology.

It is interesting to note that because media space technologies rely on high-speed and continuous network connections, they have long been confined to office settings. But continuous high-speed Internet connections are becoming a reality for home users, which will make it possible to develop similar systems for domestic use.

3 AFFECTIVE AWARENESS THROUGH DIGITAL HOME PHOTOGRAPHY

The previous section has argued for the need to augment existing CMC technologies with tools that support affective awareness. The benefits of applications that do not support explicit, but implicit social interaction, have been suggested. Engaging remote participants in shared experiences, that have an emotional effect on them, seems to be a promising way to achieve this goal. In this section, it is explained how home photography provides a context for enabling affective awareness in digital environments.

The social role of traditional home photography is discussed first, with references to visual anthropology. A description is then made of the KAN-G framework, which integrates hardware and software components supporting the capture, distribution, observation and annotation of photographs. The framework supports affective awareness between two categories of users: photographers and watchers. An affective link is created between them, in two directions. First, watchers are connected to photographers when they receive their snapshots. At this point, the reaction of watchers is captured and notified back to the photographers, who in turn feel connected to them. This two-way process is best achieved when the components that display the photographers snapshots and the watchers feedback are integrated in the living environment, and do not require the users to interact with personal computers.

The description of the KAN-G framework is illustrated with a number of emerging digital imaging technologies, such as digital cameras, on-line services and innovative displays.

3.1 Social role of home photography

Photography can been considered both as a visual medium, as an art and as scientific instrument. Furthermore, photography supports a range of social functions. For example, photographs allow people to keep a memory of history, they allow them to discover other cultures. The study of these functions has been of foremost interest for many scholars, particularly for visual anthropologists [Ruby 1981].

Home photography is a particular type of photography, that is concerned with the creation and utilization of pictorial artifacts in the context of the home. In a broad definition, it includes snapshots, family albums, slides, home movies and home videotapes [Chalfen 1987]. Increasingly, it also includes digital artifacts and supporting technologies, such as digital cameras and on-line photo albums. Richard Chalfen is a visual anthropologist who has been particularly interested in studying the functions of home photography. His ethnographic studies are useful to get a better understanding of how and why people take, display and share pictures. They have also important implications for the design of digital imaging technologies, particularly when they are used to support social interaction.

Looking at Japanese home media as a popular culture [Chalfen 1997], Chalfen describes several uses of photographs and highlights differences between Japanese and occidental cultures. Questions that have interested him were, in his own words:

"*When and where, under what conditions have Japanese people made photographs and, in turn, looked at them, displayed them or otherwise showed them to other people? In turn, how do Japanese people understand and value their own photograph collections?*"

In his discussion, Chalfen describes five examples of photograph use. The first example is referred to as *shared photographs*, and highlights the fact that people often like to share pictures with their relatives, friends and colleagues. The second example is called *household photography*, and relates to the display of photographs within the home (on walls, furniture, etc). An interesting observation is that there are generally few pictures displayed in Japanese homes, unlike in occidental homes. This illustrates the fact that the functions of photography depend very much on cultural factors. The third example is *work photography*, which is about snapshots both i) taken and ii) displayed at work. Again, there are significant differences between Japan and occidental countries: Japanese tend to take more pictures at work, but at the same time tend to display snapshots at work less often (one reason is that there is a greater separation between private and public life). The forth example is *wallet photography*, which indicates a common practice to always carry a few snapshots (usually family snapshots). Finally, the fifth example *is tourist photography*.

The observations made by Chalfen are interesting for several reasons. First, they clearly show that photographs are social artifacts that can trigger affective processes. This is why people display photographs at home and at work, this is why people carry photographs in their wallets. Looking at someone's photographic portrait naturally leads to think about this person. It often recalls memories and emotionally affects the viewer, provoking for example happiness, sadness or anger, depending on the situation.

Second, they show that sharing photographs is a social process that connects people to each other. Particularly in Japan, there is a social obligation to regularly exchange snapshots with relatives, friends and coworkers. After a party or a trip, for example, people often exchange reprints where they appear together. In this case, snapshots have a function of "social currency" and serve to strengthen relationships and to reinforce group cohesion.

There are many other situations that illustrate the social function of snapshot exchange. Think for example of grandparents receiving pictures of their grandchildren. In this situation, they are likely to feel in touch with them for two reasons. First, looking at the snapshots naturally leads them to think about their children and grandchildren. Second, the fact that the photographs were sent tells them that their children are thinking about them, that they are not forgetting them. This is very comforting for them, and is an important positive outcome of the exchange. As a matter of fact, this observation has been a foremost motivation for the design of the KAN-G framework.

A related phenomenon that should be mentioned is the tremendous success of print clubs (pronounced "puricura") in Japan. Located on every street corner, these machines are used by high school students to take photographs of their smiling faces, later decorated with cute drawings and printed on small stickers. These stickers are then exchanged among friends and organized in large collections. What is interesting about print clubs, is that they are computing devices that stress the social function of photographs.

In another study [Chalfen 1998], Chalfen looked at the differences between still and video images. More precisely, he examined first how *effective* each of them is to *recall memories*. Second, he looked at how each of them is *qualitatively* perceived by home users. These questions were answered on the basis of interviews conducted with 30 teenagers. The participants were asked to evaluate the relative merits of using still and video imaging media for home photography.

The first observation was that video could recreate the past with greater fidelity. The amount of information is much larger (there is also sound), and thus is better suited to reproduce an ambiance. In other words, watching a video gives a sense of "being there". Participants to the survey generally agreed that video brought more memories than still pictures, that it made it possible to duplicate and live experiences of the past again.

But more interestingly, the study also suggested that this did not mean that video tapes were preferred over snapshots and photo albums, in the contrary. Clearly, there was an idea that in many cases, less information is better. People explained that they preferred still pictures, because they had to use their imagination to remember the people and the events captured on them. When watching a video, the past is recreated but the viewer is passive and does not think about anything that is not *in* the video. In the contrary, observing a still picture requires to make an imagination effort, and triggers a process that is not bounded to what is represented in the picture. This idea was mentioned several times, for example in the following interview excerpts:

"*When I look at a [still] picture of somebody, let's say someone I haven't seen in a long time or something, I think about everything I did with that person and everything that person said instead of that one movement which on video is usually quite unimportant in a home video.*"

"*Like still pictures, like they're like, you can look at them and you can like gather what you want. But videotape, like, you can't like, you can't really imagine anything about the situation.*"

Another reason why people prefer still pictures over videotapes has to do with the social interactions they generate when they are watched by a group of people. In the case of video, people are usually watching a TV screen in silence, and the level of communication between them is quite low. In the contrary, when a group of people watch still pictures and photo albums, they very often use them as a context to tell stories and exchange comments. In other words, it seems that still pictures are better suited to generate interaction between people.

This has interesting implications for the design of visual CMC technologies. At first, it could seem that video-conferencing is the ultimate interpersonal communication tool. Indeed, it provides rich interaction channels, and almost recreates the conditions of a face-to-face meeting. But maybe, as it is the case with memory and still vs. video images, there are situations where "less is better". When people join a video-conference, they *have* to communicate, they *have* to talk to each other. This means that when they don't have anything particular to say, or when they have do something that would not allow them to talk at the same time, then the communication is interrupted. On the other hand, a CMC tool that is based purely on the exchange of still photographs can generate interesting intellectual and affective processes. The person who receives a snapshot remembers and imagines people and events, and is emotionally affected by that. Another advantage of this approach is that it does not raise the privacy issues of video-based awareness systems.

The point we are trying to make is that it is not necessary to have an explicit, synchronous communication medium to create affective links between people. Very often, the only thing that is needed is to trigger a mental process with an artifact (e.g. a photograph) or a tangible event (e.g. a sound indicating that a person has smiled when looking at one of your photographs). This idea provides a foundation for the KAN-G framework, that we now introduce.

3.2 The KAN-G framework

KAN-G is best defined as an interpersonal communication framework supporting affective awareness through home photography. It has been named after the Japanese word *kanji*, meaning *impression* or *feeling*. This suggests that the goal of the framework is not to support the exchange of explicit messages, but rather to convey a general sense of being "in touch" among users. This goal is achieved through the exchange of i) photographs and ii) reactions of watchers on these photographs. The capture, distribution and observation of snapshots are performed with a number of digital imaging devices, distributed across the Internet.

The interaction between users of the system is based on the following observations:

- "Receiving and watching a photograph from a person *connects* me to that person."
- "Knowing that a person is watching my photographs, and knowing what this person thinks of them, *connects* me to that person."

Accordingly, as illustrated in Figure 1, there are two categories of KAN-G users: photographers and watchers. Photographers use digital cameras to take snapshots that they distribute to watchers (usually their relatives and friends). Watchers observe the snapshots, their reaction is captured and notified back to the photographers.

KAN-G supports the distribution of photographs via *publication channels* (i.e. buffers of limited size, to which pictures are successively pushed). Photographers can define several channels (e.g. "Family", "Funny pics", "Food"), and can decide to distribute a particular photograph to one or several of these channels. Symmetrically, watchers can subscribe to the channels they are interested in. One motivation for using channels, as opposed to large photo collections that continuously grow, is to make the system more dynamic. Because channels are limited buffers, it is likely that changes will be noticed more easily. This should make the system more interesting for watchers, and reinforce the impression that there is activity in the system. This is important, because the activity is interpreted as the manifestation of social interactions.

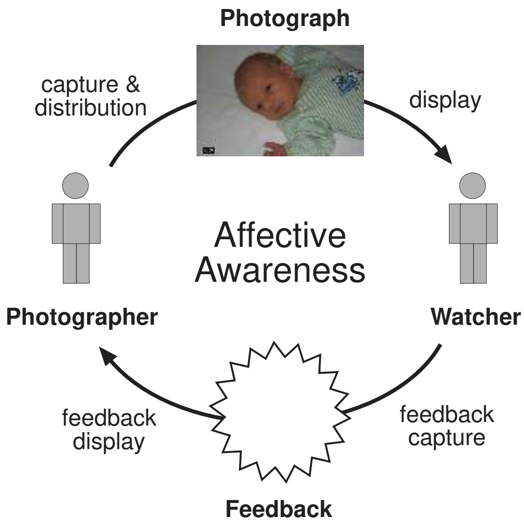

Figure 1. Affective awareness in KAN-G.

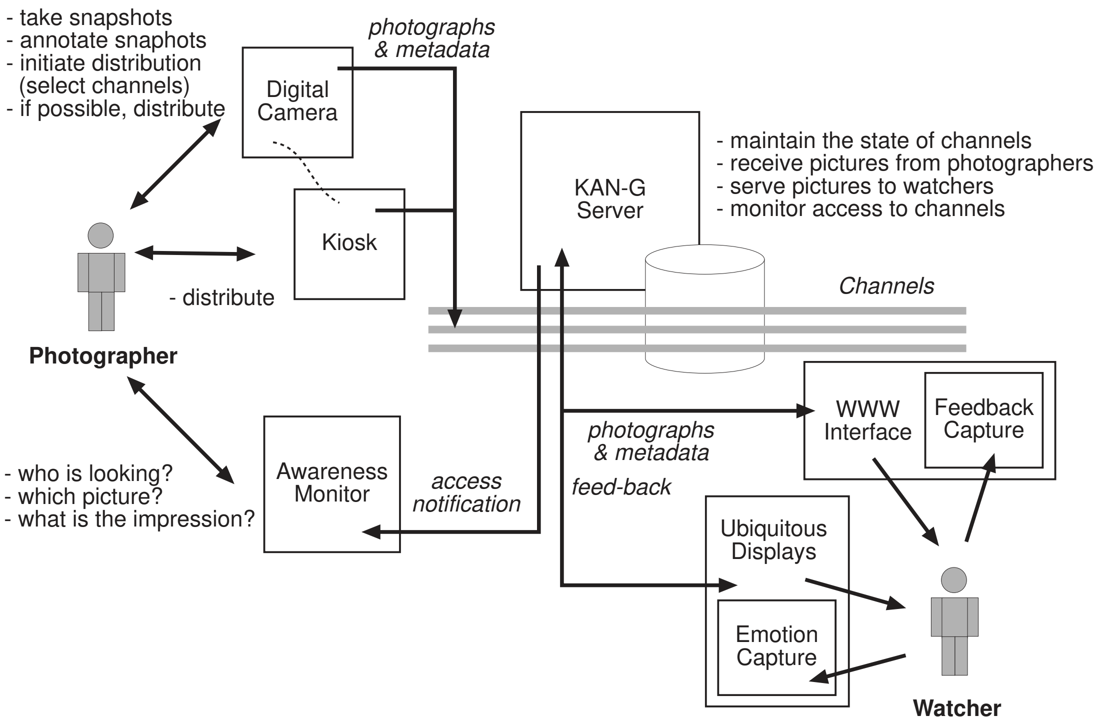

Figure 2. The KAN-G framework architecture.

The architecture that supports these functions is depicted in Figure 2. First, photographers take pictures with a *KAN-G digital camera*, and possibly add comments to them (title, short description, etc). Some contextual information (e.g. time, location if a GPS sensor is used) is automatically added by the camera. Photographers then use the digital camera to *initiate* the publication process (i.e. to specify which pictures should be published to which *KAN-G channels*).

When this is done, the pictures have to be transferred to a *KAN-G server*, which maintains the state of publication channels. If the camera is equipped with wireless Internet access, this step can be performed directly. If not, the user has to go through a *KAN-G kiosk*. This means that the storage media (e.g. Picture Card or Smart Media) has to be removed from the camera and inserted in a device connected to the Internet (e.g. a PC with a PCMCIA card reader). This device will then establish the connection with the *KAN-G server* and transfer the pictures.

Watchers receive and observe these snapshots with different tools (e.g. Web-based interfaces and ubiquitous displays), which get the photographs from a *KAN-G server*. These tools are also used to make comments and express emotions (e.g. laugh at a photograph). The feedback from watchers is finally notified to the photographers with various tools, called *awareness monitors*. They make it possible for photographers to virtually hear their friends laugh or cry when they observe their pictures.

In this scenario, there is no direct, explicit communication between photographers and watchers. We nevertheless believe that an affective link has been created between them.

3.2.1 Digital cameras

A very important component in the KAN-G framework is the device that is used to create the snapshots: the digital camera. Recent digital cameras can truly be described as *information appliances*: they integrate hardware components, an operating system, communication capabilities and a user interface. Moreover, their purpose is to produce, process and (temporarily) store information. Not only graphical information, but also contextual metadata such as the time, location or title of a photograph. Some digital cameras even integrate a programming environment, which makes them a unique platform for developing innovative photo-centric applications. Real estate, insurance and medicine are some of the professional fields that benefit from these applications, particularly because they enable automatic classification and efficient retrieval.

A very interesting device is the *Locatio*[3], recently introduced by Epson in the Japanese consumer market. This appliance is at the same time a PDA, a mobile phone, a digital camera and is equipped with location sensors (GPS). It is also interesting to note that many prototypes of wearable computers integrate a digital camera, for example [Mann 1997] and [Healey and Picard 1998].

Such devices are likely to change the behavior of home photographers. Low cost, immediate availability of the snapshots, ergonomics allowing to always carry a camera (e.g. when it is embedded in one's glasses [Mann 1997]) should increase the quantity of photographs taken. Besides, the electronic nature of the medium, combined with the Internet, makes it extremely cheap and easy to duplicate and share the pictures with others. But while it is already possible to exchange digital photographs (e.g. by attaching them to email messages), there is a clear need for better solutions.

When designing the KAN-G framework, one of our main requirements was that initiating the distribution of photographs should be as effortless as possible. Otherwise, people would not do it regularly. This is similar to the problem of keeping up with one's email or updating one's Web site, that was discussed in Section 2.1.1. Therefore, it seemed a good idea to implement this function directly on the camera, with two advantages. First, the task can be performed in context, i.e. when the snapshot has been taken and with a single task-oriented tool. Second, the task can be performed very rapidly, in a matter of seconds (no need to find a PC and to wait for it to boot up).

Most of the currently available digital cameras offer a limited number of functions, accessible via a user interface generally composed of an LCD display, a few buttons and a few switches. More interesting are the cameras, currently including models from Kodak and Minolta, that use the Digita operating system [Digita]. Digita is a proposed standard operating system for imaging devices. It includes a menu-driven user interface, various sub-systems and most interestingly a scripting language. Using this language, it is possible to extend the functionality of the camera and to implement interesting applications. Digita scripts can control the hardware (e.g. zoom in and out, take a shot), write text files (but unfortunately not read them yet) and control GUI widgets (e.g. option lists, informative messages, text input). They also have R/W access to a number of data fields storing metadata for each picture (e.g. location, title). The scripts are organized in hierarchical menus, which can easily be accessed by the user with a four arrow keys button.

As part of the KAN-G framework, we implemented two Digita scripts that run on the Kodak DC260 camera. These are used to indicate which pictures should be published, and to which channels they should be published. Screenshots of the digital camera screen are reproduced in Figures 3, 4 and 5. They represent the user interface at different steps during the execution of the scripts.

The first script, "Set channel", lets the user define which pictures should be published. The first step consists in going through the snapshots, and in marking those that are going to be published (Figure 3). When this is done, the user has to select the "Set channel" script in the menu (Figure 4), and then to choose one of the predefined channels in a scrolling list (Figure 5). The script then traverses the list of marked pictures. For each of them, it updates a metadata field with the reference of the selected channel. A completion message is finally displayed on the screen. This process can be repeated several times before the actual publication of photographs.

When the user has performed this first task, the second script can be invoked. The "Export to channels" script traverses the list of photographs stored in the camera and checks the content of the metadata field assigned by the "Set channel" script. During this process, the script generates an XML document [Bosak 1997], which specifies how the photographs should be published. This document also contains the metadata (e.g. time, title, etc.) that was created on the camera (either automatically or as specified by the user). The XML document is used when the snapshots are actually transferred from the camera to a KAN-G server, either directly or via a KAN-G kiosk.

[3] http://www.i-love-epson.co.jp/locatio/index.html

Figure 3. Marking snapshots for publication.

Figure 4. Selecting the Digita script.

Figure 5. Selecting the KAN-G channel.

3.2.2 Servers, channels and kiosks

In the KAN-G framework, pictures are not sent directly from photographers to watchers (as it would be the case with email attachments, for example). Instead, they are published on *channels* managed by *servers*. Photographers push information on these channels, watchers pull information from them. Therefore, KAN-G servers essentially have two functions. On one hand, they must accept photographs and maintain the state of channels. On the other hand, they must handle requests from watchers and give them access to the channels.

A KAN-G server has been implemented by extending the functionality of an HTTP server with a collection of Java servlets. Java servlets are one approach to dynamic content on the Web. In other words, they are an alternative to CGI scripts, and have several advantages over them. Because KAN-G servers are built as extensions of HTTP engines, they are directly accessible on the WWW. This seems to be very important, as it makes the system readily accessible to almost everyone. Using a standard Web browser is one possibility to browse through KAN-G channels. While it certainly is a required one, we will later explain that it might not be the best one.

In a near future, many digital cameras will be able to establish wireless Internet connections. This will make it possible to send photographs

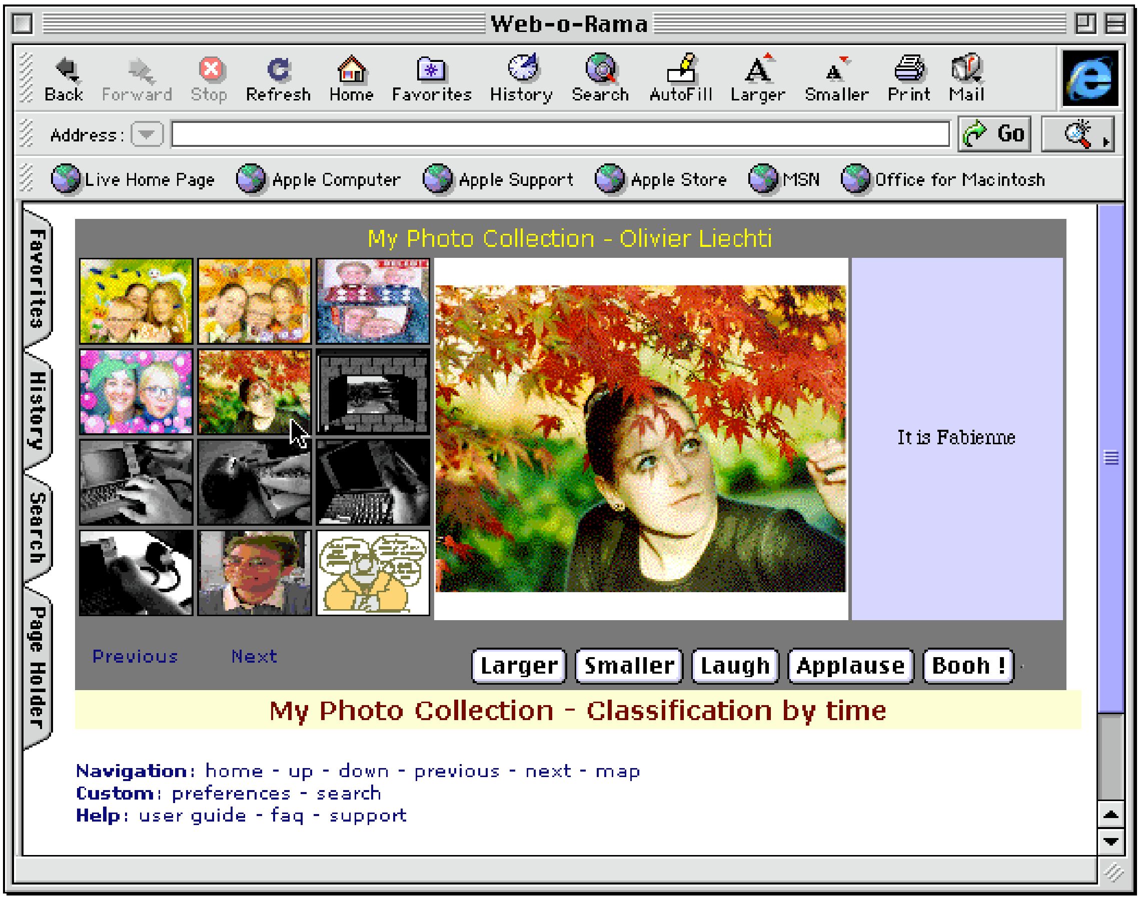

Figure 6. Web-based interface for browsing KAN-G channels.

directly from a camera to a KAN-G server. But because this is not the case yet, we decided to introduce *kiosks* in the architecture. After initiating the publication of photographs, i.e. after running the two Digita scripts, the user simply has to extract the storage media from the camera and to insert it in a kiosk. In our prototype installation, the role of the kiosk is played by a PC with a PCMCIA card reader. The software running on the kiosk reads the XML document generated by the script, which specifies what photographs to fetch. It also reads a special file stored on the picture card, that describes on which KAN-G server the user owns an account. Finally, a connection is established with the server and the photographs listed in the XML document are pushed to the specified channels. Although it introduces an extra step and some delay, the kiosk still keeps the publishing process simple and does not require much effort from the user (all necessary information has been gathered before, directly on the camera).

A number of commercial services already support some of the functions enabled by KAN–G servers. Kodak PhotoNet Online [Kodak] and FujiFilm.net [FujiFilm], for example, allow users to store digital photographs in on-line photo albums. These albums can then be browsed by family and friends. Besides, the visitors can also order reprints and various accessories (mugs, tee-shirts, etc). An interesting point is that when people send a regular film to be developed and printed, they can tick an option to have them digitized and published on-line. This is very important, because it makes the publication very easy for the user: no need to handle a scanner, no need to use FTP, etc. On-line photo services have limitations that we have tried to overcome in KAN-G. First, it is difficult to know when new pictures are published by a photographer. It is necessary to periodically check the Web site, which requires a substantial effort. Second, photographers don't know whether their family and friends are watching the pictures, nor what they think of them. Third, the only mechanism for looking at the pictures is to use a Web browser (and thus a PC). It seems that other ways to perform this task would be more appropriate, as we suggested earlier with the electronic postcards application (Section 2.2).

It should also be pointed out that digital photo collections, whether they are accessible on-line or on CD/DVD, raise a number of research issues in terms of efficient organization, annotation, browsing and retrieval. A very interesting system is the FotoFile system [Kuchinsky, et al. 1999], which makes the manual annotation of photographs easier. This is achieved by several means, in particular by the use of a narrative structure to organize the photographs. Because the collection organization process is transformed into a storytelling process, it is more enjoyable to the users.

3.2.3 Tools for watchers

Because KAN-G servers are HTTP servers, standard Web browsers can be used to observe photographs published in KAN-G channels. Different user interfaces can be developed for this purpose, from very simple ones (a Web page that shows the last photograph pushed on a channel), to very complex ones (where JavaScript and DHTML are used to create interactive behaviors).

An example for such a user interface is represented in Figure 6. On the left side, thumbnails of the pictures in a channel are displayed. When the user clicks on one of them, it appears at the center of the window, in large. On the right, a textual description of the picture (which has been defined on the digital camera) is displayed. Finally, the user can click on different buttons situated below the photograph. "Smaller" and "Larger" allow to change the size of the center photograph. More interestingly, "Laugh", "Applause" and "Booh!" are used to get a feedback from the watcher. When one of these buttons is clicked, a message is sent to the KAN-G server, and the photographer who published the photograph receives a notification (allowing for example to virtually hear the watcher laugh or applause). This user interface was only developed as a proof of concept, and more subtle ways to collect feedback from the watcher should be examined.

Web browsers provide a practical solution to watch pictures published in KAN-G channels: access to the WWW is ubiquitous and does not require particular hardware or software. It thus makes it possible for anyone to start using the system. Furthermore, a Web interface is sometimes perfectly suitable. This is particularly true when the watcher wishes to *browse* through collections of photographs. In this case, it is acceptable to use a personal computer, a keyboard and a mouse to watch and comment the photographs.

But only providing this kind of interface is not enough. In Section 2, we have seen how using personal computers presents a risk of social isolation. Two reasons for this were that using a PC often requires to be alone, and that traditional human-computer interaction monopolizes all the user's physical and intellectual faculties. The motivation for designing the KAN-G framework was to increase the level of social interaction among people who *do not* live together. But of course, this goal should be achieved by decreasing the level of interaction among the people who *do* live together. A worse situation would be achieved if a user was spending too much time exploring on-line photo collections, alone, and consequently unable to interact with the members of the household.

One solution to this problem consists in providing additional interfaces, through which users can interact with the system in more seamless ways. These interfaces should also enable processes where the user can remain passive, and does not have to give an input to the system (e.g. watching TV as opposed to browsing the Web). Whenever possible, these interfaces should be integrated in the architectural space of the home: in furniture, on walls, etc.

Indeed, the home is already populated with a wide range of displays. These include televisions, computer displays, but also screen phones, wall-mounted panels, etc. In the future, information will be displayed on digital wallpaper, mirrors and windows. Very often, the displays found in domestic environments are used punctually for a specific purpose, but are inactive for long periods. This seems like a waste of interactive display real-estate, which could for example be used by CMC technologies, in particular by systems supporting social awareness between people. In our case, these displays could be used to show the photographs published in KAN-G channels.

As an example, Figure 7 shows a device that is used by one of the authors, in his kitchen. It is a Toshiba Libretto palmtop computer, that is never shut down (it is therefore always immediately available). There are a few interesting comments to make about how this device is used on a daily basis. First, it is in the kitchen, and is generally used when people are at the table (before a meal, for example). This means that interaction with the device is generally done when family members are together. Second, the keyboard is rarely used (this requires user interfaces such as the one described below), and there is no mouse. The pointing device is integrated to the palmtop, on the right side of the display. All this makes it possible to use the device almost like a book, and in very natural body positions. Finally, it exclusively used as a communication device, mainly of (non-professional) email and Web browsing. The interaction with the device often initiates social processes within the household. A good example is the conversations between the author and his wife that are triggered by incoming emails (the activity of writing emails is also sometimes done in a common).

Figure 7. KAN-G monitor used in the kitchen.

This device is perfectly suitable to be integrated in the KAN-G framework, where it could play the role of a digital picture frame. Digital picture frames are very similar to traditional picture frames: they have different shapes and sizes, it is possible to move them around, etc. The difference between the two is that the image displayed in the frame is digital and can therefore easily and automatically be changed. It is interesting to note that Sony has already introduced a digital picture frame[4] in the consumer market. While this device is still expensive and does not have a network connection (the pictures are transferred via a Memory Stick storage media), it is a promising device for home photography applications.

Digital imaging devices used to display photographs require a careful user interface design. The first thing to consider is that their main function is not to support the exploration of a photo collection (as it was the case with the Web-based interface). In the contrary, it is to automatically display photographs, without requiring the intervention of the user. Additionally, it is to gather some feedback from the watchers. Ideally, this feedback should be captured automatically. This would require the use of sensors (e.g. camera, microphone) and software to recognize emotions. This is of course a difficult problem, where many issues remain open. Nevertheless, a lot of research is done in this area [Moriyama and Ozawa 1999, Nakatsu, et al. 1999, Picard 1997]. While automatic emotion recognition is not possible, the user interface should make it as easy as possible for the user to give a feedback. In particular, it should not require the use of keyboard.

A prototype was built to provide an example for such a user interface. A snapshot, given in Figure 8, shows this tool. While it is difficult to get a good idea of its dynamic and interactive behavior with a static image, here is a brief description of the software:

- In the lower part of the display, photographs published in KAN-G channels are scrolling from left to right. In this way, the user can remain passive and simply watch at the incoming photographs.
- In the upper left corner of the panel, the user can express emotions inspired by the photographs. This is done by moving a circular cursor (with the mouse, or another pointing device) within a pie chart that shows six different emotions (happiness, surprise, anger, disgust, fear and sadness). The intensity of the emotion is variable and is determined by how long the user presses the mouse button before releasing it (a visual feedback is given by an expanding-shrinking size of the cursor).

4

http://www.sel.sony.com/SEL/consumer/ss5/home/digitalimagingmavicartmcamera/digitalimagingmavicartmcamera/phd-a55_specs.shtml

- When an emotion has been expressed, a visual feedback is given in the upper right portion of the screen, with vertically scrolling text. The size of the words indicates the intensity of the feeling expressed by the user (large size indicates a strong feeling, small size indicates a moderate feeling).
- When feedback has been gathered via this user interface, it is notified to the person who published the photograph. This function is supported by a messaging infrastructure integrated with the KAN-G framework.

Figure 8. A KAN-G watcher monitor

3.2.4 Awareness monitors for photographers

The previous components of the KAN-G framework support the flow of information between photographers to watchers. Their goal is to make the capture, the distribution and the visualization of photographs as easy and natural as possible. This is important to guarantee that users will not perceive the picture sharing activity as a burden, and will go through this process regularly and lastingly. While sharing photographs on the Internet is already possible (e.g. via email or Web sites), it requires considerable time and effort. Moreover it requires some technical knowledge that is not necessary mastered by the average consumer. All this contributes to limit the amount of digital photographs exchanged by home users.

Another original aspect of the KAN-G framework is that it enables a flow of information in the opposite direction, from watchers towards photographers. When photographers know that their relatives and friends are watching their pictures, they can feel connected to them. An even richer experience is achieved when they have some idea of what these people have felt when watching the pictures. Supporting this function first requires to capture the feedback from the watchers, as we explained before. It then requires photographers to use special tools to notify them about the social activity generated by their snapshots. These tools are called *awareness monitors* in the KAN-G architecture.

What was said about the tools used to display photographs also applies to awareness monitors. They should ideally not require the use of standard PC installations, but be more nicely integrated into the living environment. Here again, the idea of peripheral awareness is central: photographers should be able to interact with the system (i.e. to receive access and feedback notifications) while they are doing other tasks.

Awareness monitors can take many different forms, and their design is only limited by imagination. In simple cases, they might use audio and visual signals to notify the activity occurring in the system. In more elaborated scenarios, they might also involve tangible and ambient channels (physical objects, temperature, light, etc.). We developed tools based on both audio [Liechti, et al. 1999] and visual [Liechti and Ichikawa 1999] interfaces for the more general case of notifying activity occurring within Web sites. These interfaces could easily be integrated in the KAN-G framework, as accessing and commenting a personal Web site is very similar to accessing and commenting personal photographs.

Another prototype was also specifically developed to fit the need of KAN-G awareness monitors. This tool is using the new 2D imaging Java API, which among other features supports semi-transparency. When a notification is received by the awareness monitor, the photograph that is being looked at, as well as a caption indicating the identity of the watcher, fade in on the display. If the notification specifies an emotion, a sound is also played by the device. After a while, the photograph and the caption fade out. Using this tool, it is thus possible to hear that someone laugh across cyberspace. In a second step, it is possible to look at the device to find out who is laughing, and why (i.e. what picture is being looked at). This seems like a very natural process, that does not require any effort from the user.

It should be noted that this particular user interface is particularly suitable for synchronous notifications. It seems however important to also support asynchronous notifications. For example, it should be possible for the user to ask the system questions like:

- What was the activity during the last 3 days?
- What was the activity generated by this group of photographs?
- What was the activity generated by this group of people?

While we have many ideas for addressing these needs, they have not been implemented yet and have been left for future work.

4 CONCLUSION

This article has examined the role of Computer Mediated Communication in domestic environments. Existing technologies have been reviewed, some of their benefits and limitations have been described. Related ethnographic studies on the social impact of home computing have been mentioned, and important implications for technology designers have been highlighted.

The discussion has insisted on the fact that most of the current technologies support *explicit* social interaction, by creating a new medium for conversations. While the merits of conversations are recognized, the need to also support *implicit* social interaction has been raised. The notion of *affective awareness* has been introduced and defined as a general sense of feeling in touch with relatives and friends. It has also been explained how engaging people in shared experiences that emotionally affect them is one possibility to create affective awareness between them.

Finally, KAN-G has been described as an interpersonal communication framework that supports affective awareness through digital home photography. For a motivation, the social role of home photography has been discussed, with references to visual anthropology. It has then been explained how the KAN-G framework integrates a range of hardware and software components that make the capture, distribution, observation and annotation of photographs natural and effortless.

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