TANGERINE - A Tangible Awareness Landscape

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Invisible devices supporting events that occur largely on the periphery of awareness are key features in the realisation of Weiser's vision of a future in which computers disappear into the fabric of our homes, leisure- and workplaces. It is easy to get absorbed by the technological challenges ahead. However, it is important to remember that not all of the ubiquitous media solutions to the issues of our daily lives will be high technology solutions. Support for interpersonal communication must form a core part of any ubiquitous computing strategy and in this paper we describe the development of a light-hearted, low technology Tangible Awareness Landscape developed to support informal social interactions. Despite the light-hearted nature of this work, its underlying principles have important implications for anyone for whom maintaining an informal sense of presence in a given remote physical location is an issue.

INTRODUCTION

Our system, which we've called TANGERINE (TANGible Embodiment of Remotely Initiated Notification Events), is a lightweight system developed to support informal, social interaction between remotely located individuals. The TANGERINE system evolved in support of an overall requirement to provide some sense-of-presence artefacts for members of our research group who where off-site for protracted periods. The design of the system went through several iterations during its time of use and resulted in some experiences that apply to the kinds of environmentally-based information technology-rich applications of so much interest to the ubiquitous systems community.

BACKGROUND

The development of TANGERINE began with a physical space that had previously been identified as a focal point for both formal and informal interactions between research group members. The fact that this space was an office, and the fundamental workspace of a number of people, immediately placed constraints on the choice of notification and communication technologies that could be used. The aim was not to create a heavyweight, task-supportive media space, rather simply to provide some physical sense of the remote user within the office.

We were aware of systems where data related to network [11] or human traffic [5], say, where given a physical representation within a given physical location. We also looked at systems such as AROMA [9] which have gone a step further, enabling local and remote users to be party to some abstract data relating to each others' activities. But rather than providing a one- or two-way data monitoring system, we specifically wanted a mechanism whereby remote users could actively register their presence in a given physical space. Our aim was not to facilitate peripheral awareness of ongoing activities but instead to provide a mechanism for specifically drawing the attention of the local users to some event instigated by a remote user.

INFORMAL INTERACTION

The importance of supporting informal interactions between remotely located individuals has been established [1]. In our case we did not need to support the kind of accidental encounters that have been a concern in video-mediated communication [2, 3]. Our wish was for remote users to be able to simply look into the office via a web camera and if they saw someone they wanted to say hi to they should be able to instigate some kind of event that said to the room occupant "Hi, I'm here too". As other more content-rich forms of communication were already available via traditional media a deliberate decision was made by the group that a new, light-weight communication mechanism was desirable. Furthermore we wanted to present the remote user instigated notification event in such a manner as to leave open the level of response required by the local users.

Our aim at this point was therefore to provide a light-hearted way for remotely located group members to experience a sense of their presence within the office, whilst limiting the level of disruption within the office to that of an informal, head-round-the-door visit. It was identified that this action could be represented as any discrete event, which was available to the office as a whole. For example, a simple audio message or perhaps something more abstract such as a pager-like beeping, or flashing light bulb may have been appropriate. The general consensus however, was that these could simply become annoying to the occupants of the office. We needed therefore to choose a communications media that would be acceptable to those people whose principal workspace the office was. It could be neither visually or operationally intrusive to the existing space and would ideally reflect the good-natured intent of a quick hello.

AESTHETICALLY APPROPRIATE

Whatever technologies are to be brought into a communal space need to be aesthetically appropriate and afford minimal interruptions for the occupants of that space. In our case, both the office occupants and the remote workers expressed the desire for a solution that was light-hearted and fun to use. In the end we decided to activate some of the toys and mascots the people in the office already had on their desks. This not only limited the impact our system into their environment, but also the light-hearted nature of the resulting interaction devices increased the affinity of the notification mechanism with both remote and local users alike.

The first notification device constructed consisted of a wooden, motor-driven parrot operated via a serial connection to a web server in the office. A remote user could send an event to the web server by pressing a button on a web page and cause the parrot to spin for a short period of time. The potential invisibility of a spinning event led us to quickly ad a sound component so that a remote evocation caused the parrot to both spin and emit an appropriate bird sound.

LIGHTWEIGHT COMMUNICATION

The intention of people passing a door is often less the opportunity to enter into discourse with the occupants, as to say simply "I'm here". As established, the focus of our initial design was to provide remote users with a mechanism for saying a quick hello or simply affirming their presence within the physical space. In order to contextualize our solution, it is worth considering for a moment another, increasingly popular mechanism by which people use technology to tell someone they are thinking about them - text-messaging. No one who has moved through any public space can fail to be aware of the almost constant call of text-messages winging their way to mobile phones all around us. A MORI poll carried out in September 2000 indicated that 23% of the UK population where hooked on text-messaging [MORI 2000]. But why is text-messaging so popular? What specific features do text-messages that make them so compelling?

1. Text-messages are short are short - Quick to send. Quick to receive/ process
2. Text-messages are immediate - You know that as soon as you've sent a text-message it will arrive at the recipient's phone almost instantaneously.
3. Text-messages are informal - Possibly because of the personal nature of mobile phones people tend to use them mostly to send less formal, more personal messages.
4. Finally text-messaging is asynchronous - Text-messages most often do not require a direct response, leaving the recipient free to answer at the leisure (or not at all if the message content does not require it).

By way of an analogy then the tangible end point of our system (i.e. the parrot) was conceived to be the equivalent of an emoticon smile sent via some instant messaging service. The important differences were that our parrot was a physical entity and potentially available to a group rather than just one individual (although a desire for personal parrot "smiles" came later).

EXPERIMENTAL DEVELOPMENT OF TANGERINE

The evolution of our system was driven by its users and the way they utilised the technologies available. Those technologies where:

- A motor-driven wooden parrot that spun and made bird sounds in relation to an incoming event
- Some text to speech software
- A web camera

In order to "pop in" to the office, remote users simply pressed a button on a web page. This event caused the parrot to activate for a few seconds. In addition, the web server would grab the network address of the sender's machine, which could be identified using a pre-compiled list of known users. The web server would therefore follow the parrot event by announcing the identity of the sender. Other features on the parrot's web page enabled the remote users to send text messages that were converted to speech by the web server, causing the message to be spoken to the office occupants.

During the first phase of evolution, we noticed that communications often took the form of composite notifications such as a parrot-spin to attract attention, followed by a spoken message or request. Incoming spoken events indicated that remote message senders were occasionally seeking feedback in response to the initial attention-grabbing event. Requests such as "Is Simon there?" could be responded to by Simon's subsequent appearance (or not) in front of the camera. Requests for general information "Does anyone know…" would either cause someone in the office to email a response, or if it were a short answer, put a note in front of the camera. The webcam provided a feedback loop that was not initially designed into the system, but one which evolved as a result of user ingenuity.

We were happy at this point that TANGERINE fulfilled adequately its initial requirements in that it enabled remote visitors to send an informal greeting to colleagues in the office. In addition to this, remote users utilised the notification technologies in order to make simple enquiries and for them to receive quick responses to those enquiries. Remote users particularly liked the opportunity to send a parrot-mediated or verbal greeting and "be there when it arrived" by viewing the response in the office via the webcam. Remote users would, of course, also access the webcam just to see who was in the office.

PERSONAL NOTIFICATION DEVICES

The informal and accessible nature of the communications technology meant that it was soon being used by individuals outside of the initial user-group. Family members and friends of the local workers were comfortable with the idea of pressing a button to send a parrot-spin event in lieu of greetings. But as the web server was unable to identify their machine's network address, it was impossible to tell who had sent the event. This problem was further compounded by the ambiguous nature of the generic parrot-spinning event, which effectively meant *hello* to everyone in the office at the time.

The chosen solution to this issue was the reconfiguration of the parrot so that its interface enabled a virtual visitor to choose who their event was aimed at. So, for example, spinning and tweeting could be an event to the entire office, whereas spinning accompanied by some other sound effect could signify that the greeting was for a particular office member – a bell for Jez, laughter for Peter, and so on.

The problem still remained that the entire office would receive notification of an event meant only for one person. However, thanks to the simplicity of the architecture, individuals in the office began to elaborate on the theme of turning their "desk-clutter" into notification devices and the first configurable, personal notification device was created. One such device involved the incorporation of a counter-weighted motor into a pot-plant. On receiving an activation signal, the plant would vibrate, alerting its owner to the notification event.

This type of personal notification device was proximal to their owner, who limited the audible component of an incoming notification so as not to disturb others in the office. Where representation of events on the public parrot were constrained by the need for a shared understanding of the signals, a personal device had the potential to be customised by the owner, who could then use it to represent multiple events. Thus the configurable web plant previously mentioned had the choice of 4 motor speeds (from a short gentle shake all the way up to violent, leaf-shaking convulsions) and a range of sounds, combinations of which could be associated with each type of event.

Additional buttons on the original web page now allowed both local and remote users to send a range of discrete events to an individual (Hi, I've sent mail, I'm going for coffee, I'm back in the office, etc). Another user chose to augment their serial mouse by inserting a small motor, which provided only tactile event notifications, lessening the environmental distraction (but this suffered from the obvious drawback that they only received events if their hand was on the mouse at the time).

THE CURRENT SYSTEM

The result of the user driven evolution of TANGERINE was the production of a rich landscape of awareness information which was markedly different from the single device system which was first developed and different from any other tangible awareness system that we could find. Figure 6 shows the architecture of the current TANGERINE system. The fundamental architectural design is an asymmetrical one, where both the notification events and the feedback loop (use of the web cam to gather feedback on previous events) are driven by the remote users of the system. This is in contrast to systems where a remote user issues an event or message and the local user replies with an appropriate event or message. Symmetric and asymmetric architectures are illustrated in figure 1.

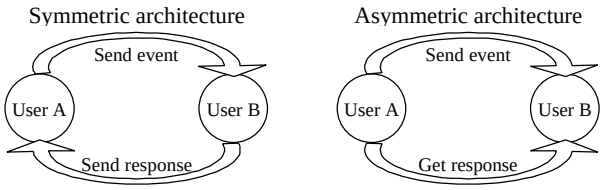

Figure 1. Symmetric and asymmetric architectures

Technologies such as video conferencing attempt to maintain a symmetrical awareness model, with both local and remote parties receiving similar information, in terms of video and audio. Most peripheral awareness technologies [4, 6, 10, 11] differ in that they maintain a uni-directional awareness model, with *only* a local user receiving a continuous stream of events about the state of some chosen event-generating phenomena. The total number of serial ports on the main server determines the number of devices which may be attached to it. All simple serial devices have a consistent interface and thus may be replaced or 'hot swapped' while the system is live, without the need to restart or reconfigure the software. This allows local users to perform quick physical reconfiguration by plugging a new device into the appropriate notification port.

Unlike existing systems [4, 7] the implemented notification architecture has not been designed with the notion of users registering for particular events and not for others. This is due in part to the fact that the initial architecture was designed to support the issuing of notification events to the whole office and the ability to opt out of receiving events would violate this model.

The introduction of *configurable* devices, such as the web plant, does not effect the plug-ability of devices, since it only requires additional features to be added to the controlling software, rather than alterations to the hardware. Thus it is possible to have some plain notification ports and some configurable device ports, yet be able to freely swap devices between all ports.

A key feature of TANGERINE, which is supported by the current architecture, is ability for potentially anything that can be plugged into the serial port of a computer to be used as a notification device. This aspect of the system allows notification devices to become personal and personalisable. By being able to select a notification device which conforms to the interests, preferences and work behaviours of a user, the device may more easily represent, support, and complement the work of that user.

CONCLUSIONS

Essential to the design of TANGERINE was the need to support informal, lightweight communication. Rather than having to formally structure a message, remote users could quickly and effectively highlight their 'presence' by saying an abstract "hi". By providing this type of communication it became possible for users to send messages without content but that still had meaning to the users of the office. The system also had the flexibility to allow more complex messages, requests and notification of significant events. A benefit of this type of notification system identified by a number of the local users was that messages sent could be processed in a manner than ran parallel to any work in which they were engaged at the time. Whereas more formal messaging systems, such as e-mail, video-conferencing and lighter weight messaging services such as ICQ, require interruption of current task and serial processing of the content of a message in order to determine its significance and importance. The concise nature of the informal communication permitted fast evaluation of content and awareness of whether a response was required. This minimised interruption and permitted the filtering out of important messages from informal communication.

The potentially negative impact of the messaging and notification system in the office was minimised by the humorous nature of the notification mechanisms. Local users readily accepted the minor interruption caused by the parrot more readily than perhaps they would have done with more common notification mechanism such as pagers and ringing telephones. By concentrating on creating devices from the 'desk clutter' found in most office environments TANGERINE achieved a high level of integration and acceptance in the workspace. In addition to this, by utilising existing entities from the workplace, rather than introducing additional devices, the impact upon the office members often scarce desk space has been minimised.

The system also proved popular from the remote user's point of view in that it offered them a lightweight, real-time messaging facility with the potential for receiving feedback on the events sent to the office. The kinetic, physical nature of the devices provided a compelling, tangible notification mechanism, which we feel would not have been achieved by 'solid state' devices. Local users responded with humour toward the physical, proactive entities.

One interesting phenomenon identified during the four-month period during which TANGERINE has been in place is that of office haunting. This occurred on several occassions that we know of when a remote user sent events and spoken messages even when they believed the room to be empty. The phenomenon came to light on a number of occasions when, often late at night, an occupant of the room could not been seen via the web cam and a haunting had taken place. The exact reasoning behind this mode of system usage has not been isolated as the users who performed such actions were unable to give a clear indication of their motivations. This phenomenon does however illustrate the compelling nature of the remote embodiment aspects of TANGERINE. It seems that a certain level of satisfaction can be attained by the remote user when using the system, irrespective of the existence of a recipient of the notification event.

The work described here evolved from an initial requirement to provide a simple means for members of our research group, who were away from their workplace for extended periods of time, to maintain an informal sense of presence within our shared workspace. Individuals who were due to spend time away working in industry had expressed concerns that they would lose touch with events occurring in the research group. In each case, the remote users expressed their opinions that spinning the parrot and viewing the room occupants' responses helped them to maintain their presence within the research group.

FUTURE WORK

Our future interests in this area are twofold: Firstly we want to explore further the notion of tangible event notification devices. We'd like to more fully develop the idea of personal proxies. These personal proxies could be representative, tangible entities (like a photograph of an individual in an activated frame, say) which people leave behind when they are to be away from a particular physical locale for a period of time. Personal proxies could be used to draw someone's attention to the virtual presence of the photo's subject (i.e. the person in the photo wants you to know they are looking in). Similarly the personal proxy could be activated to send an "I'm thinking of you" personal message or be used as an informal way to establish some other form of communication. We have been particularly intrigued by the observed haunting phenomena and would like to explore further the potentially compulsive nature of remotely operated physical entities.

Our second area of further exploration will be extending the current simple architecture to explore the possibilities for advanced configuration of wireless tangible notification devices. It is to be expected that a core component in future ubiquitous computing media will be technologies for reaching out and touching friends and colleagues not only in a formal, work-based capacity but where appropriate in an informal light-hearted and personal manner.

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