TOWARDS THE INTERACTIVE OFFICE

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ABSTRACT

We describe a prototype system, the Interactive Office, which supports the occupant's daily activities in an office. Discrete sensors embedded in an office detect the occupant's movements whilst a number of actuators allow computer control of the environment. Integrating inputs from many sensors places the user in a context, which, combined with the actuators, can be used to automate simple tasks. Using this system, an occupant need not change their normal actions or directly interact with an interface. We describe the underlying technology for this type of indirect interaction and illustrate the potential of augmenting an office to support a user's daily tasks.

KEYWORDS

Context based interaction, ubiquitous computing, computer augmented environments, office automation.

INTRODUCTION

During the day, people continually contend with interruptions from a variety of sources, ssuch as a knock at the door, a telephone call or a notification from a computer. Some of these distractions are inconvenient. For example, when a meeting is in progress, it might be useful if it were possible to defer an interruption, such as a ringing telephone, until later.

A number of techniques are traditionally used to minimise this type of problem. Examples include shutting the office door to deter visitors or forwarding telephone calls to prevent interruptions. These approaches are inflexible and require the user to initiate appropriate control mechanisms as well as remember to cancel them when necessary. Traditionally, a more flexible solution is to employ a human, personal assistant who can react to constantly changing situations. This is done by monitoring the activities of the office worker, and using this contextual information to control interruptions. We have developed the Interactive Office, a prototype system which emulates some of these features. The system is based on a variety of sensors and actuators which range greatly in their location, operation and complexity. They are embedded in the office environment and effectively disappear from the user's awareness. Since they are unobtrusive, they are unlikely to interfere with the office occupants, who can go about their daily activities without constantly having to interact directly with the system. A computer program integrates the many discrete sensor inputs, formulates the user's context, and based on this context, contrls the environment appropriately.

Like the Interactive Office, other computer augmented environments[7] enhance our daily activities by merging the electronic world and the physical world. They integrate the advantages of computer technology with familiar physical devices. Ubiquitous computing [6] has the further goals of pushing computers into the 'background' and removing them from the focus of attention. However, unlike many of these systems, the Interactive Office does not require the user to wear or carry some technology in order to benefit, or to learn completely new ways of interacting. The user is ,unencumbered and can behave normally in the augmented environment.

Building-wide rather than single room contextual systems have been developed using active badges[5]. Badges are small electronic transceivers which are worn like identification badges. Sensors distributed throughout the building locate the wearers and provide information which can be used to forward telephone calls, redirect printouts or inform others, By combining active badges with occupancy detectors, the Responsive Environment project [3]models users' movement patterns. The models allow the system to control the heating, ventilation and air conditioning system thereby making the occupants more comfortable and decreasing energy usage. In both examples, coarse-grained contextual information has been used to control office equipment on a building-wide basis as opposed to in a solitary office.

UNOBTRUSIVELY DETECTING ACTIVITIES

We installed a variety of sensors in the office keeping them unobtrusive and therefore, unlikely to interfere with daily activities. The aim was to create an environment in which to explore the possibilities of an instrumented office. Some of these sensors are described below.

- Magnetic reed switches mounted over the door indicate the door position.
- Pressure switches in the chairs indicate where people are sitting; a wireless system is used so that chairs need not be tethered to the system.
- A small microphone mounted in the ceiling measures sound level in the room.

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- A light-dependent resistor detects the state of the office lights.
- Invisible light beams across the doorway detect movement into and out of the office.
- Passive infrared movement detectors (as used in home burglar alarms) provide coarse information about human movement around the entire office.
- Ultrasonic proximity detectors (popular in car alarms) provide finer grain information such as movement at a particular desk.

INTEGRATING SENSOR DATA

The system polls the sensors to get the associated activity information. The data collected is then integrated to ascertain higher level contextual information. Unfortunately, sensors are not always reliable and can "false trigger" for many reasons. We can help to overcome this problem by ensuring data from each sensor is never considered in isolation. Instead, the aim is to achieve *robustness through redundancy.* For example, if a meeting is in progress, then a number of people will have entered the room (light beam sensors), people will be seated (pressure switches), there will be movement (motion and proximity detectors) and conversation (room microphone). If the occupancy sensor indicates that no-one is in the office, yet there appear to be people seated and talking, it is still likely that a meeting is in progress. Currently, a fixed lookup table is used to implement the rules which use the discrete sensor signals to determine the context. Other projects[1] have proposed a software architecture using a set of flexible, communicating, distributed agents to determine sensor information and react to it.

Having ascertained the current context, the system *can* react appropriately. However, there is a problem with providing feedback whilst keeping the system in the background and unobtrusive. Currently, the system modifies the operation of equipment in the environment. In the case of a meeting, upon receiving an incoming call, the telephone ringer is switched off after the very first ring. The ring can be ignored, leaving the answering machine to take the call and thereby causing minimum interruption to those in the meeting. However, if the call is important, a user can simply lift the handset and answer the call as normal. The user is aware of the action taken by the system and is still in control. With this philosophy, if the system incorrectly determines the context the user can intervene.

FUTURE WORK

The Interactive Office can also detect that the occupant is on the telephone or that the office door is closed, perhaps indicating that the person is busy. This information can be used to control the volume level of background music, for example, or the audio portion of a video conference. As information of this type goes beyond personal use and is published for others, the issue of privacy must be considered. Appropriate control and feedback mechanisms must designed into the system[2]. Currently, a power switch fitted above the office light switch controls the entire system, allowing anyone to reliably disable the system upon entering the office.

In addition to integrating the sensors and actuators. other useful information is available through the networked computer system used in the prototype. Examples include electronic diaries and schedules, details of computer usage and active badge information. This would allow the system to increase robustness through more redundancy. Indeed, the inclusion of such data opens up many more potential applications for the Interactive Office, such as better location information for mobile computing and activity-based information retrieval[4]. The latter deals with helping users remember things they have forgotten, especially things they did not know they would need to remember.

CONCLUSIONS

We have described the Interactive Office, a system which integrates small, unobtrusive embedded sensors and actuators to provide a natural form of interaction. The user behaves normally and can be unaware of the system's existence. The prototype can determine a user's context and support everyday activities in a similar way to a traditional personal assistant. In particular, robustness and unobtrusive feedback are key issues in the design of such a system.

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