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701 E. Chocolate Avenue, Suite 200, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.igi-global.com

ITJ 4691

This paper appears in the publication, International Journal of Ambient Computing and Intelligence, Volume 1, Issue 1
edited by **Kevin Curran © 2009, IGI Global**

Adaptive Awareness of Hospital Patient Information through Multiple Sentient Displays

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ABSTRACT

Sentient computing can provide ambient intelligence environments with devices capable of inferring and interpreting context, while ambient displays allow for natural and subtle interactions with such environment. In this paper we propose to combine sentient devices and ambient displays to augment everyday objects. These sentient displays are aware of their surroundings while providing continuous information in a peripheral, subtle, and expressive manner. To seamlessly convey information to multiple sentient displays in the environment, we also propose an approach based on abstract interfaces which use contextual information to decide which display to use and how the information in the display changes in response to the environment. Our approach is illustrated through a hospital monitoring application. We present the design of two sentient displays that provide awareness of patient's urine outputs to hospital workers, and how contextual information is used to integrate the functionality of both displays.

Keywords: *ambient displays; context-aware computing; patient care systems; pervasive healthcare; sentient computing*

INTRODUCTION

Sentient computing is an approach that allows users to naturally interact with the physical environment by becoming aware of their surroundings and by reacting upon them (López de Ipiña & Lai Lo, 2001). Awareness is achieved by means of a sensor infrastructure that helps to maintain a model of the world which is shared between users and applications – referred as Sentient artifacts (Hopper, 1999). Indeed, sentient artifacts have the ability to perceive the state

of the surrounding environment, through the fusion and interpretation of information from possibly diverse sensors (Addlesee et al., 2001). However, it is not sufficient to make Ambient Intelligence (AmI) environments aware of the user's context, they must be able to find a way to communicate this information to users while becoming a natural interface to the environment (Shadbolt, 2003).

Ambient displays could be embedded in everyday objects already known and used, thus becoming the user interface of the AmI environment. This vision assumes that physical interaction between humans and computational devices will be less like the current keyboard, mouse, and display paradigm and more like the way humans interact with the physical world. For instance, a mirror augmented with infrared sensors and an acrylic panel could detect human presence and act as a message board to display relevant information when a user faces the mirror. Hence, AmI environments could be augmented with such displays that unobtrusively convey information to users without requiring their full attention, while at the same time, allowing an implicit and natural interaction. Indeed, the notion of what constitutes a computer display is changing. No longer is a display confined to the typical CRT monitor with a single user paying focused attention while interacting with virtual objects on the screen (Lund & Wilberg, 2007). Rather, computer displays are found in such diverse forms as small screens in mobile phones or handheld computers, to ambient displays that provide peripheral awareness to the presence and status of people, objects or information.

In this article, by binding the ideas of sentient computing and ambient displays we propose the concept of sentient displays to define a new and appropriate physical interaction experience with an AmI environment. Such sentient displays will be capable of monitoring users' context, promptly notify relevant events and provide users with continuous information in a subtle, peripheral and expressive manner without intruding on our focal activity. Moreover, multiple such displays could be integrated in an AmI environment, with a decision of which one to use dependent on contextual circumstances, such as the user's location, the presence of other people or the activity being performed by the user. Thus, we also discuss an approach to develop contextual interfaces for a variety of sentient displays located throughout the intelligent environment. Our approach is based on the use of abstract interfaces that are specialized to specific devices once a decision is made as to which sentient display(s) should be used. This approach facilitates the progressive integration of new sentient displays.

To illustrate the concept of sentient displays we draw upon scenarios related to hospital work. Mobility and frequent task switching cause hospital workers to occasionally miss important events, such as a catheter being disconnected due to the patient movement or the need to change a urine bag that has been filled-up (Moran et al., 2006). Consequently, hospital workers have been held liable for their failure to monitor and promptly respond to patients needs (Smith & Ziel, 1997). Sentient displays located throughout hospital premises could be used for a diverse number of hospital applications, such as notifying hospital workers of a crisis or just provide continuous awareness of the health status of patients.

SENTIENT DISPLAYS: AUGMENTING NATURAL OBJECTS WITH AMBIENT DISPLAYS AND SENTIENT TECHNOLOGIES

Research in pervasive computing has included the development of ambient devices that can become part of the background while acting as a digital interface to ambient information. As stated by Mankoff: "Ambient displays are aesthetically pleasing displays of information which sit on the periphery of a user's attention. They generally support the monitor of information and have the ambitious goal of presenting information without distracting or burdening