

# Chapter 40

## Augmented Reality Interfaces for Smart Objects in Ubiquitous Computing Environments

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### ABSTRACT

*It is the goal of ubiquitous computing (UbiComp) to hide computers from the users. Instead, everyday objects embedded with computer processing capability become smart objects that act as interfaces to computer software. A challenge with this new paradigm of computing is to create natural and obvious ways for people to interact with objects and receive output from the computer software that these objects serve as interfaces to. In this chapter, a solution is proposed whereby virtual user interfaces are added to smart objects. These virtual interfaces are viewed in augmented reality through personal viewing devices which also allow people to interact directly with them. The implementation of UbiComp environments and personal viewing devices is described in order to illustrate the use of current technology in creating user-friendly UbiComp environments.*

### INTRODUCTION

Ubiquitous computing (UbiComp) refers to a paradigm of computing wherein computing can take place anywhere and everywhere. It was the vision of the man who coined the term “ubiquitous computing”, Mark Weiser, that computer hardware

would disappear into the natural environment, with seemingly everyday objects taking the place of computers so that “people will simply use them unconsciously to accomplish everyday tasks” (Weiser, 1991).

A subtle impact of UbiComp can be seen with the emergence of smart buildings and smart cit-

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ies. To save cost and energy and provide a more comfortable environment, sensor networks and distributed computing systems built into modern shopping malls and office complexes allow for optimized and automated lighting and temperature control; this is with the help of occupancy tracking and ambient lighting and temperature sensing and forecasting (“Occupying Yourself”, 2010; “LonWorks®-based Office Building”, n.d.).

UbiComp has begun to manifest in recent years in a literal sense. With embedded computer systems, smartphones and mobile devices, computers are practically everywhere. The pervasiveness of wireless internet and thus access to cloud computing allows for traditional computer tasks, e.g., checking e-mail, writing a document, and even playing games, to be done anywhere. There are also numerous smartphone “apps”, which are lightweight computer applications that support people in practically any conceivable way.

UbiComp can achieve its full potential if apps are built into the environment and the physical objects within the environment. This way, location-based services can be provided to people without them having to be aware of apps which have to be downloaded to their mobile device. The challenge lies in presenting such environment-embedded services to the people in the environment and the ways they can interact with these services.

This chapter presents a framework for implementing UbiComp environments that allows for virtual graphical user interfaces to be added to objects in the environment. These objects are imbued with computing and networking capabilities, and are thus known as smart objects. Using augmented reality (AR) technology, every smart object is given a virtual user interface that is augmented onto the user’s view of the physical environment, which can be seen through a personal viewing device. This means that the user does not have to shift his focus away from the environment while

still being able to access rich interactivity and complex functionality of the environment. The end result is a person being able to walk into an environment and immediately see the objects that are providing services and functionality beyond their physical capability.

The rest of the chapter is structured as follows. First, other solutions to the issues that have been discussed are explored. The proposed framework is described, followed by details on the ways to create smart objects and their individual user interfaces, as well different personal viewing devices that can be developed to provide intuitive and natural interaction with smart objects. Finally, future research directions are discussed.

## **BACKGROUND**

In the traditional computing model, a graphical user interface provides the awareness of the functionality of the software through helpful tooltips and contextually relevant iconic buttons; these are the means for interaction with the software through interaction elements like buttons and sliders, and the primary means of system output is via a computer screen. In UbiComp, the environment and the objects therein make up the computing platform, which means radically different implementations of user interfaces are required.

A novel kind of user interface is tangible user interfaces (TUIs) which are made up of physical objects that are directly and intuitively manipulated in order to interact with a computer-aided task. Some TUIs are designed as application-specific systems where the modes of interaction with the physical elements correspond to the functionality of the system (Lee, Hong, & Johnson, 2006; Nagel, Heidmann, Condotta, & Duval, 2010). There is also a generic approach in TUI implementation in which physical objects are converted to standard

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