# Sensory Augmented Computing: Wearing the Museum's Guide

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### Abstract

*A wearable computing device is much more than its desktop counterpart. It is rather like an intelligent assistant that always accompanies you and helps you solve everyday tasks. A key aspect of such devices is that they can operate autonomously and perceive the world as a human user does; without being fed manual input. They augment the user without encumbering him. A smart wearable computer sees what you see and hears what you hear to analyze, recognize and respond to the situations and people you encounter. We describe one incarnation of this smart perceptual remembrance agent, which is equipped with the ability to recognize objects in the user's visual field of view using real-time computer vision. Once an object is recognized, the system displays multimedia information that the user previously identified as being relevant to the object. The computer effectively becomes a tour guide, chiming in with augmented reality to give you reminders as you go about your routine.*

## 1 Introduction

To date, personal computers have not lived up to their name. Most machines sit on the desk and interact with their owners for only a small fraction of the day. Smaller and faster notebook computers have made mobility less of an issue, but the same staid user paradigm persists. Wearable computing hopes to shatter this myth of how a computer should be used. A personal computer should be worn, much as eyeglasses or clothing are worn, and continuously interact with the user based on the context of the situation. With heads-up displays, unobtrusive input devices, personal wireless local area networks, and a host of other context sensing and communication tools, the wearable computer may be able to act as an intelligent assistant.

In the near future, the trend-setting professional may wear several small devices, perhaps literally built into their clothes. That way, the person may conveniently check messages, finish a presentation or browse the web while sitting on the subway or waiting in line at a bank. Such wearable devices may enhance the person's memory by providing instant access to important information anytime anywhere. Operating these devices however will be an important issue. Often today's computers require your full attention and both hands to be operated. You have to stop everything you are doing and concentrate on the device. Using speech for input and output will become more popular but may be quite annoying in many situations. Imagine for example your neighbor on a cross-Atlantic flight constantly talking and chatting with his or her devices.

Wearable devices promise to be less disruptive, and may interact with people differently from other tools. A computational device that is with you all the time can influence the sense of who you are and what you can do. Just as we have adapted to cellular phones, watches and other personal devices, wearable computers are likely to shape our personal habits around them. Starting with technophiles and migrating to the average person, culture over time will shift to incorporate them. It is too early to tell which approach to wearable design will prove popular. The devices can be built in many ways, and it will take a fashion and style battle to determine what people really want to buy.

Although their potential is vast, many of these devices suffer from a common problem: they are mostly oblivious to you and your situation. They don't know what information is relevant to you personally or when it is socially appropriate to "chime in." The goal in solving this problem is to make electronic aids that behave like a well-trained butler or an intelligent assistant. They should be aware of the user's situation and preferences, so they know what actions are appropriate and desirable - a property we call "situation awareness." They should also make relevant information available before the user asks for it and without forcing it on the user-a feature we call "anticipation and availability."

An important aspect of a wearable device is that it can perceive the world from a first-person perspective: a wearable camera can see what you see and a wearable microphone can hear what you hear in order to analyze, model and recognize things and people which are around you. A promising direction for interaction with wearable devices is therefore to make the computers more aware of the situation the user is in and to model the user's context. Sensors, such as cameras, mounted to the user's glasses, can recognize what the user is looking at and might model what the user is doing. Using sensors of various types, the device can also monitor the user's choices and build a model of his or her preferences. A person can actively train the computer by saying, "Yes, that was a good choice; show me more," or "No, never suggest country music to me." The models can also work solely by statistical means, gradually compiling information about the user's likes and dislikes, and coupling those preferences to the context.

For anticipation and availability, the wearable device can take a few key facts about the user's situation to prompt searches through a digital database or the World Wide Web. The information obtained in this manner would then be presented in an accessible, secondary display outside the user's main focus of attention.

Therefore, a key challenge for wearable computing is to model and recognize the context of the user and the situation. This contextual information is one way to achieve seamless interaction with the user. In this paper we describe a system which uses a head-mounted camera to record and analyze the visual environment of the user. In particular a computer vision program is employed to recognize objects the