WEARABLE COMPUTERS

S. Ivanoska

Institute of Informatics, Faculty of Natural Sciences and Mathematics
Sts. Cyril and Methodius University
Arhimedova bb, P.O.Box 162, Skopje, Macedonia
sonja_i@freemail.pmf.ukim.edu.mk

Abstract: In this paper we describe wearable computers and analyze their main characteristics. Different operational modes of wearable computing and hardware are topic of our analysis. A special paragraph concerns applications of wearable computers.

Keywords: wearable computer, augmented reality, Remembrance Agent (RA)

1. Introduction

Wearable computer is a computer, which can be worn like clothing. A fuzzy definition of a Wearable Computer is that it is a computer that is always with you, is comfortable and easy to keep and use, and is as unobtrusive as clothing. A wearable computer is a computer that is subsumed into the personal space of the user, controlled by the user, and has both operational and interactional constancy i.e. is always on and always accessible. It is powered by batteries and it can be connected to several input and output devices, depending on tasks performed by the wearable computer. It allows a much closer association between the computer and the user. Wearable computing combines the ideas from mobile computing and ubiquitous computing. In addition, it offers an advanced user-interface technologies. People are no longer confined to their desks with the desktop or the laptop.

The wearable computer is truly personal. It is a device worn and used all the time. As it is constantly on and running, the user does not have to turn it on to use it. The computer is always receiving signals from its environment and from the user, processing and displaying information to the user appropriately. It provides a higher level of privacy; people walking near you are not able to see what your HMD display; it can serve as an intermediary for interacting with untrusted systems.

Most portable electronics such as cellular phones, compact disc players or camcorder can be incorporated into the wearable computer. Using a heads-up display and earphones, it provides a better interface. Graphics, text and sounds are overlayed on the physical world. The sensors attached to the wearable computer allow seeing what the user sees, hearing what the user hears. It is able to analyse these informations and react accordingly.

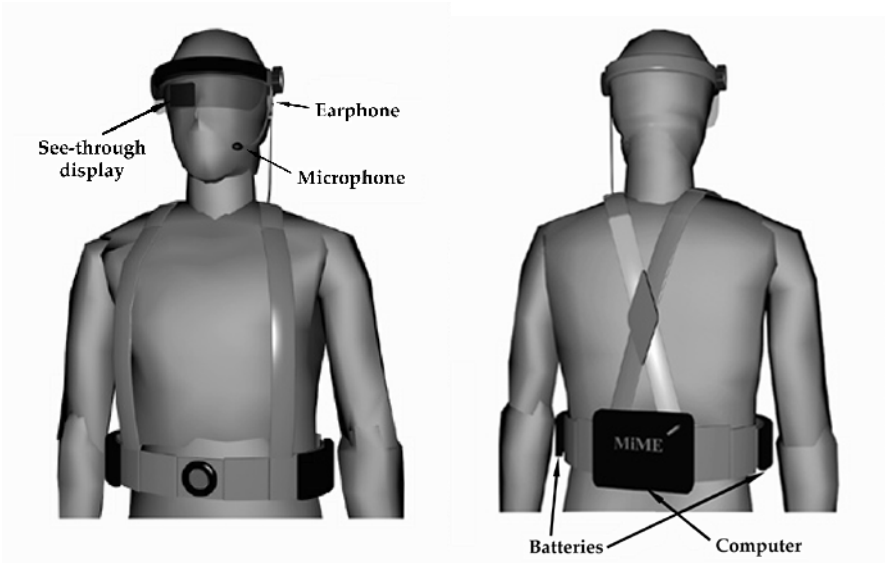


Figure 1: Possible version of wearable computer

The main characteristics of wearable computers:

- **portable while operational** -The most distinct difference between desktop and laptop computers and wearable computers is that the latter can be used while the user is walking or moving around. The user have uninterrupted access to applications provided by the wearable computer while moving around freely and not constrained to the worktable.
- **hands free use** -The user can use both hands or at least one of his hands for other tasks while using the computer.
- **Sensors** -In addition to user inputs, sensors are used for the computer to gather information about its environment. Such sensors include cameras for visual information and microphones for audio information. The wearable computer should be able to perceive and act upon certain aspect of its physical environment.
- **augmented reality** -This is a user interface technique that allows focusing the user's attention and present information in an unobtrusive,

context dependent manner. It is like the integration of real and virtual world.

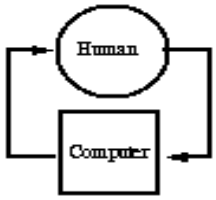
- **Proactive -** A wearable computer is able to convey information to the user even when it is not actively in use. The computer is always running, working and sensing. Model assumptions

2. Model

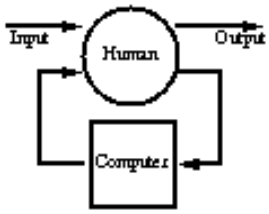
2.1 Operational modes of wearable computing

There are three operational modes in this new interaction between human and computer:

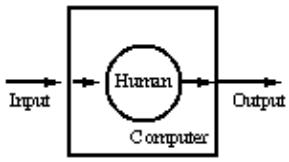
Constancy: The computer runs continuously, and is "always ready" to interact with the user. The signal flow from human to computer, and computer to human, runs continuously to provide a constant user interface.



Augmentation: Wearable computing is based on the notion that computing is not the primary task. Thus the computer should serve to augment the intellect, or augment the senses. The signal flow between human and computer is depicted in

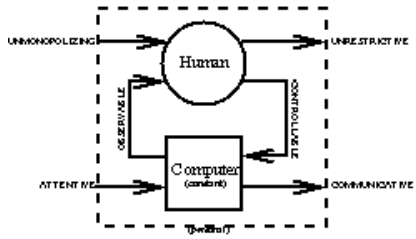


Mediation: Unlike hand held devices, laptop computers, and PDAs, the wearable computer can encapsulate us.



It doesn't necessarily need to completely enclose us, but the concept allows for a greater degree of encapsulation than traditional portable computers.

Wearable computing is a framework for enabling various degrees of each of these three fundamental modes of operation. Collectively, the space of possible signal flows giving rise to this entire space of possibilities



While individual embodiments of wearable computing may use some mixture of these concepts, the signal path provides a general framework for comparison and study of these systems. The signal paths typically each, in fact, include multiple signals, hence multiple parallel signal paths are depicted in this figure to make this plurality of signals explicit.

2.2 Hardware

There is a great variety of different devices. The choice is dependent on the task of the wearable computer and the preference and the need of the user. The common devices used are:

2.2.1 Processing

The processing unit of the computer can be either local or remote. A local unit is part of the wearable computer and thus carried with the user, while a remote unit may be stationary and more powerful and connected to via a network

2.2.2 Small keyboards

Small keyboards are useful in situations where relatively large amounts of highly variable data need to be entered into the computer. The keyboards are identical to desktop-computer keyboards except that the keys are much smaller. The keyboard provides lots of flexibility but also requires both hands, one to support the keyboard and one to type. The keyboard also poses a problem for users who are required to wear work gloves. In addition, the keyboard may sometimes get in the way since it is mounted on one if the forearms.

2.2.3 Chording device eg the Twiddler by Handykey

This device has five keys which can be used separately or in combination to generate letters, numbers and symbols. It is like a keyboard and it has the advantage over the keyboard because it requires only one hand to use it; . how-

ever, that hand is always attached to the chording device and cannot be used for other tasks. Chording devices are useful for the same reason as keyboards; they have great flexibility to enter highly variable data. Chording devices take a little longer to learn to use than the traditional keyboard but can be used very efficiently once they are learned.

2.2.4 Pointing device: track pads and track balls

This is useful for interacting with the interface of the wearable computer. It can also be used to input variable data as a chording device by using an on-screen virtual keyboard.They are small and sensitive.

2.2.5 Bar code readers

It is especially used for collecting data from items. Bar code readers are useful for prespecified information. Some models can be mounted on the back of the hand like a glove.Its inflexibility is its main disadvantage, but it can input a lot of information quickly and accurately.

2.2.6 Microphones

At present voice recognition is not as accurate as the other input devices, but the technology is improving. This is the only input device which can have both hands completely free for other tasks. It is not as flexible and voice input could be either speaker-dependent or speaker independent. The latter is not as accurate as the former but it offers a higher degree of flexibility. As for output devices, they generally include visual and auditory displays.

2.2.7 Visual display

Is generally a small LCD display that is worn in front of one of the eyes. The visual display can be used to display text, graphics, animations, and/or videos. Currently, most wearable displays are limited to 640x480 pixel resolution. Head mounted display (HMD) can be used

2.2.8 Audio outputs

The audio output devices generally consist of auditory displays. The auditory display consists of one or two earphones, sometimes integrated into the same headset as the visual display. The auditory display can be used to play voice, alarms, or musical signals.

2.2.9 Network

A user needs a way to interconnect all devices making up the wearable computer. In order to allow for independence of devices and make them easy to change, physical wires should be avoided. Using the human body as a network would be inexpensive, noise resistant and hard to attack from a distance, thus making it a good alternative.

2.2.10 Power

As batteries are both heavy and bulky, human powered devices may be of interest.

2.2.11 Biosensors

As emotional affect plays a large role in human life, providing a wearable computer with this information may be of use. As devices would be in contact with the user's body, various biometric information such as blood pressure and temperature could be retrieved. This may then for example adapt help interfaces according to the user's stress level.

In many cases it makes sense to have multiple input devices, this is called multi-modal. Multi-modal input appears to have some advantages over single input devices. At the very least it allows for a backup input method. In addition, since humans communicate in a variety of ways, it seems natural to communicate with a computer through more than one mode.

3. Applications of Wearable Computers

3.1 Remembrance Agent (RA)

Is a program that continuously “watches over the shoulder” of the wearer of a wearable computer and displays one-line summaries of notes-files, old email,

papers, and other text information that might be relevant to the user's current context. These summaries are listed in the bottom few lines of a heads-up display, so the wearer can read the information with a quick glance.

The Remembrance Agent (RA) is comprised of two parts, the user interface and the search engine. The user interface continuously watches what the user types and reads, and it sends this information to the search engine. The search engine finds old email, notes files, and on-line documents that are relevant to the user's context. This information is then unobtrusively displayed in the user's field of view.

3.2 Personal communication and collaboration

Collaboration primitives, which are relevant for synchronous collaborative wearable systems (i.e. system providing real-time audio-video conferencing):

Remote awareness: Users of collaborative systems feel more comfortable when they know who else participates in a conversation. Awareness of remote communication partners can be achieved in many ways, for example, by presenting icons or pictures of each participant. For wearable applications, one can also think of audio-only representations.

Remote presence: Going one step beyond remote awareness, remote presence provides a richer and more natural conversation by using live representations of participants. This can be in the form of a live-feed from a camera showing a user's face or in form of an avatar, a 3-dimensional representation of a user's face or body controlled by a remote user. In both cases, remote presence gives users the ability to convey non-verbal clues like gesture and mimic, resulting in an improved intimacy between communication partners and a feeling of co-presence.

Remote presentation: By remote presentation we mean a user's ability to superimpose images over a wearable user's (real-world) view. By using shared computer screens it is possible for a participant to put a wiring diagram in the field of view of another wearable user. Remote presentation is thus an effective means for sharing information and focusing verbal communication.

Remote pointing: The ability to control a remote cursor enables users to point at objects in other users' view. Such objects can either be virtual objects (a wire in a wiring diagram) or real-world objects captured by the camera of a wearable computer. Like remote presentation, remote pointing can increase the effectiveness of verbal communications by directing the participants' attention.

Remote manipulation: Remote manipulation refers to a user's ability to manipulate virtual objects that are in another user's view (positioning, zooming,

resizing, …). This concept becomes very powerful if two or more users manipulate the same shared objects, effectively creating a shared virtual workspace. Note, however, that remote manipulation of non-shared objects is also possible and useful.

Remote sensing: Means that a remote user has a direct, unmediated access to the output of sensors attached to the user's wearable computer. The technician, wearing the computer, can go for his routine check. With remote sensing, he is able to communicate with his colleagues in the office, who can see what is really happening via the camera on the wearable computer, and give advice to any problems accordingly. Remote sensing would require sensors like cameras, microphones, laser scanners and receivers for radio or infrared radiation.

As mentioned, the user is able to communicate with another person in another location via a wireless radio modems connected to a local area network. Also the computer will have access to the services available on the network.

3.3 Applications using Augmented Reality

Augmented reality is the combination of the real and the virtual to assist the user in his/her environment. There are many applications for this field.

3.3.1 Finger Tracking

This is one of the simplest applications of camera-based wearable computing. The computer would be able to track the user's finger, such an interface can therefore replace conventional components like the mouse with his/her own finger. The user would then be able to control the operating system in this manner, or even digitise an image and virtually annotate it.

3.3.2 Face Recognition

Working in conjunction with appropriate face-finding software, face recognition system can be adapted for use in wearable computing. Names would be overlaid on faces as the user moves about the world in his/her wearable computer. Markets include the police, reporters, politicians, the visually disabled (with an audio interface), and those with bad memories for faces.

3.3.3 Visual filter

This is particularly useful for the visually disabled, for example to map around 'blind spots'. The wearable computer can digitally magnify an image or a prose by a 'virtual fish eye lens' for help in reading. This can be done using a digital visual filter. The basic concept is to process video images digitally in real time to assist the user in everyday tasks.

3.3.4 Repair instruction

By putting as little as 3 distinctive marks at known distances from each other, a wearable camera with known focal length can recover the 3-Dimensional (3-D) location of an object defined by these three marks. With the help of an on-line manual on the technician's wearable, one can extrapolate and derive the rest of the object's 3D location. The repair technician can then easily transmit the diagnostics of a broken machine to the wearable. The wearable automatically determines the problem, locates the 3-D position of the object, and overlays specific 3-D real-time step-by-step guidelines on the object for the technician to follow.

3.3.5 Navigation

Connecting a Global Positioning System (GPS) to wearable and certain mapping software allows the user to track him while exploring a city. A visually impaired person might be able to receive warnings of approaching objects and hence promote safety in their daily lives.

3.4 Wearable Audio Computing

Wearable audio computing refers to wearable computing applications where audio is the primary medium of the interface. This can be used in note-taking applications, which will be useful for journalists, for instance, when the user may want to use while engaged in a conversation or seminar.

Another application is managing personal communications. Imagine having a cellular phone, pager and email all incorporated into a single interface. With a combination of speech synthesis, recognition and audio recording, the wearable computer becomes a virtual secretary!

Disability aids can take advantage of wearable audio computers. It can be a navigation guide for the visually impaired using synthetic speech, using GPS locators.

4. Conclusion

Wearable computing is capable of associating graphics and text with physical objects and locations. The computer is able to present information to the user in an unobtrusive way, allowing the user to attend other matters while using it. The wearable computer aims at becoming a part of the mind and body of the user, with the user doing tasks he and better at and the computing doing task it is better at.

Wearable computing provides an exciting way to explore augmented realities and begins to fulfill the promise of a truly personal digital assistant. While wearable computing augmented realities imply the potential for significant ad-

ditional informational sources for the user, the implementations described also provide better ways of managing such information. The result is a rich combination of physical and virtual realities that can intelligently assist the user instead of overwhelming him.

The applications of wearable computers are still under development, but it won't be long when it will really become a part of our clothing, transforming our daily lives.