Developing User Interfaces for Wearable Computers - Don't Stop to Point and Click

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Abstract

Typical usage scenarios for wearable computers are support of users doing a certain task, e.g. aircraft repair or military applications. If the user is moving while using the wearable some restriction for the user interface apply. In this paper we present some of these restrictions and suggest a wearable user interface taking these findings into account.

1 Introduction

The term "Wearable Computer" is used for a wide range of personal technologies, such as watches and mobile phones with enhanced processing capabilities, PDAs, and full featured wearable PCs (WPC). Over recent years many efforts have been made to improve the hardware, especially in the area of displays, power efficiency and batteries, and miniaturization of devices. Currently a number of commercial WPCs are available, such as Xybernaut[1] and Via PC[2]. The hardware is designed to cope with the new requirements given by the application scenarios for which wearable computers are designed. The software and especially the graphical user interfaces (GUIs) supplied with these computers are still the same as on desktop computers or developed in a very similar style, based on the WIMP (Window Icon Menu Pointer) paradigm. Also the GUIs used in research projects are mostly similar to desktop UIs [2] and [4]. This mismatch between the user interfaces and the constraints imposed by the anticipated usages scenarios motivated us to investigate this topic further.

In the remainder of this abstract we will concentrate on wearable PCs. First we introduce application domains that have been described for WPCs. From these requirements we derive discriminating features of wearable computers especially these concerning human computer interaction. Based on the observations we suggest design principles for wearable graphical user interfaces (wGUIs). Finally we describe an implementation of a wGUI that has been developed over the last few months in our lab.

2 Using Wearable Computers

The use of wearable computers has been study in-depth in different application areas by universities as well as by private research institutes and companies. The following areas are of major interest:

- Maintenance and repair, e.g. aircraft mechanics at Boeing
- Support of mobile workers, e.g. quality inspection
- Medical applications
- Computer support for logistics
- Wearable computers in tourism, e.g. translator or way finder

Most of the applications have in common that the computer is used to access information while doing a certain task. In comparison to a desktop computer the WPC is not the point of focus, it is rather used as a tool. We can also observe that the user is not in a certain position when using the computer – with a desktop PC we can assume that the user sits in from of a screen having a

[1] Xybernaut Wearable Computer: http://www.xybernaut.com/
[2] VIA-PC: http://www.via-pc.com/

keyboard and a pointing device in front of him. Another observation we made is that the applications provided on WPCs offer only a limited number of task-specific functions that are dedicated to help the user with the real-world task.

The main processing unit of most WPCs is similar to standard desktop computers, but smaller and wearable. Whereas the input and output hardware differs significantly from desktop systems. For output a number of different types of head-mounted displays are available:

- Personal Viewer (e.g. M1[3])
- See-around Displays (e.g. Albatech[4])
- See-trough (e.g. Sony Glasstron[5])

Input to wearable computers is rather difficult, especially when supporting users that are not stationary. Various cording keyboards, like the Twiddler[6] are available for text input. To uses these input devices efficiently the user has to be trained over a rather long time and also many people do not cope with the cognitive load of inputting text while doing something else. To use voice recognition is another option, but from our experience not yet applicable in real-world environments if the command set is large. For a very small command set it can be useful in certain environments. Different pointing devices are suggested for wearable computers (e.g. Xybernaut integrated the devices on the belt, Twiddler has a built-in pointing device, or a Handheld-Mouse). In a small study we could show that the pointing accuracy of these devices is acceptable when sitting or standing still, but if used while walking or while doing something else they are not useful to operate standard GUI-based applications.

3 Designing User Interfaces for See-Trough Displays

As described above interaction with wearable PCs differs significantly from desktop computers. The fact that the user is not stationary while using the computer makes it difficult to design WIMP interfaces that are can be used efficiently. This leads to several restrictions that have to be taken into account when developing a user interface. The main points are:

- **Blocking the users sight.**
  When the user is on the move using the wearable computer with a see-trough display, blocking the sight is a high risk. E.g. a box popping up blocking the whole screen while the user is running could be fatal, see [6]. Information should be always organized on the display in a way that guarantees sight to the real world surrounding the user.
- **Pointing**.
  Operating standard WIMP interfaces for a mobile user is not acceptable. Especially menus, scrollbars, and buttons in standard GUIs are to small to hit or change while the user moves. Pointing should be implemented in a way that there is no need for exact positioning of the curser.
- **Complexity**.
  The user is doing something else while operating the computer. Usually the focus of the user is on the task and not on the software. Attention is shifted frequently between the real world task and the GUI. Therefore it is important to minimize the complexity in the interface, to facilitate instant recognition of the state of the application. The rule of 7 ±2 items that a person can keep in mind easily [2] could give a guideline.
- **Visual acuity**.
  The highest visual acuity is in the region that is in a 5° field form the focus point. The recognition performance is decreasing rapidly outside this area. When applying this to an 800x600 display a single information chunk should be displayed in a 115 pixel wide area (considering standard viewing distance).

4 A wearable graphical user interface (wGUI)

Having in mind the points discussed above we designed a graphical user interface for WPCs. Our experiments have been carried out with an optical see-trough system (Sony Glasron PLM-S700E).

[3] M1 Personal Viewer: http://www.tekgear.ca/displays/m1.html
[4] Personal Monitor: http://www.skyex.com/albatech/
[5] Sony Glasstron PLM-S700: http://www.ita.sel.sony.com/products/av/glasstron
[6] Twiddler: http://www.handykey.com/

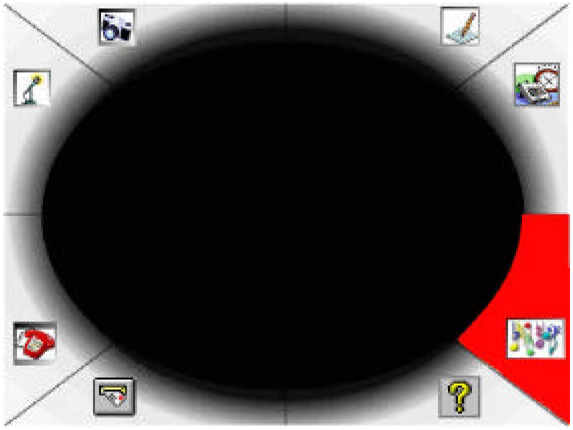

Figure 1: Main screen. Music player selected

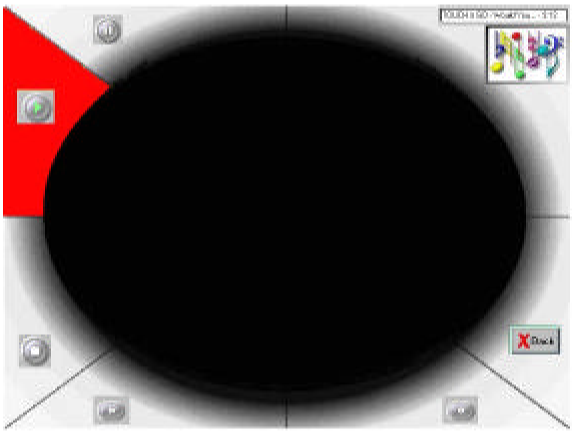

Figure 2: Music player screen. Play selected

In figure 1 and 2 screenshots of the interface are given; black is the color that is transparent in the display. Based on the following ideas the interface was designed:

- **Reduced selection space.**
  To solve the problem of pointing while on the move and also to tackle the complexity issue we reduced the selection space to eight elements. At any one time only eight choices are offered. The highlighted sector is the current choice. For most applications that we have been looking at the limitation to eight sectors did not appear to be a problem. In most cases applications all the important functions can be accessed with two or at most three selection steps.
- **Rotating selection.**
  From the negative experience with point and click while mobile we implemented a rotating selection. While the pointing device is moved the selection is rotating. When the pointing device is stopped the selection stays where it is. By pressing a button this choice is then selected. Using this mechanism the pointing device can be reduce to two buttons (one for rotating and one for selecting) or to three buttons (one for rotating left, one for rotating right, and one for selecting). We are currently investigating how finger pointing devices can be used efficiently with the wGUI.
- **Border layout.**
  All interaction elements are arranged around the border of the display. The display is separated in nine regions, eight sectors of each 45° and the middle oval. The sectors are used to display information chunks or controls. They are rather small to offer optimal visual acuity for single items in the display. Using this layout the head stabilized information is never blocking the sight of the user. It has also the advantage that if the user is focusing an objects in the real world the border gets out of focus and disappear in the field of vision. The middle region is as, shown in figure 3, transparent and can be used to display word stabilized information. This region should be carefully used not to block vision.

Figure 3: Looking through the glasses

In figure 1 the main screen is displayed with the music player selected. In figure 2 the screen after the selection is shown. Here the interface of the music player can be seen, with the play function selected. Everything that is black on the screenshots is transparent in the glasses, see figure 3.

The wGUI is currently implemented in Visual Basic and runs on Win32-Platforms. For input any pointing devices that can emulate a mouse can be used. For the rotation we have implemented different modes. In the one mode any mouse movement makes the selection rotate, in other modes the rotation direction is dependent on the direction of the movement. From our initial experience it seems also useful to provide audio cues during rotation. This gives a feedback to the user that is especially helpful if the real-world task performed is mainly visual.

5 Conclusions

The hardware for wearable computers is designed to be used in non-desktop environment. We investigated the software that is supplied with wearable computers and also the software that is developed and used in research projects. Here we realized that mainly metaphors known from desktop systems are used. In our experiments we found that most of these interfaces are not efficiently usable in situations in which wearable computers are applied, especially considering situations where the user is mobile while using the computer. Considering the usage scenarios of WPCs in combination with see-trough displays we saw that blocking the users sight, point and click, the complexity of the display, and the visual acuity are of major importance when designing a wearable GUI. Based on these observations we implemented an interface that offers selection by rotation supported by audio cues and a open sight for the user.

Currently we are also investigating how awareness technology, that provides information on the users context can enhance the interface. Of great importance is information about the current activities of the user, such as *user is running*, *user walking*, and *user is stationary*. This could be realized based on technologies that we have developed in other projects [5].

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