The WearBoy: A Platform for Low-cost Public Wearable Devices

Peter Ljungstrand, Staffan Björk and Jennica Falk
PLAY: Applied research on art and technology
Viktoria Institute, Box 620, SE-405 30 Gothenburg, Sweden
{peter,bjork,jennica}@viktoria.informatics.gu.se
http://www.viktoria.informatics.gu.se/play/

Abstract

We introduce the WearBoy – a wearable, modified Nintendo GameBoy – as a platform for exploring public wearable devices. We have minimized a Color GameBoy to enable users to comfortably wear it, making the device not much larger than the actual screen. Technical properties of the WearBoy are discussed, along with two applications using the platform.

1. Introduction

Currently, many wearable computing prototypes are rather clumsy and heavy to wear, and often rely on several different electronic devices connected together by cables hidden in the user's clothing. This might be necessary for computationally demanding applications, but in many cases the application does not need much computational power, especially not if wireless access to more powerful resources is available. Several such low-end wearable platforms have been built and tested, e.g. the Thinking Tags [1]. These prototypes are usually custom designed around a small microcontroller with some additional features, but commonly lack a more general interface.

Most currently existing wearable computing applications act as personal companions, augmenting the individual perspective (c.f. [6]). However, we believe that wearable technology could also be used to support and enrich social interaction between people to a much larger extent than is the case today. To explore these ideas, we needed a platform that would allow shared views and casual interaction between several people and/or devices.

In this paper, we present the *WearBoy*, a modified Nintendo GameBoy, as a midway alternative between using small dedicated hardware and cumbersome general-purpose hardware. By using already well-established technology, slightly modified to serve our purpose, the WearBoy allows cheap and rapid prototyping for public wearable devices.

2. The GameBoy Device

We wanted a small and versatile platform that would be self-contained, but which would also have a sufficiently large display to be viewed by people other than the actual wearer. The Nintendo Color GameBoy, a hand-held video game, provided these features although it was not designed to be worn. If one could redesign the device to be wearable, one could take advantage of the many features the hardware platform provided:

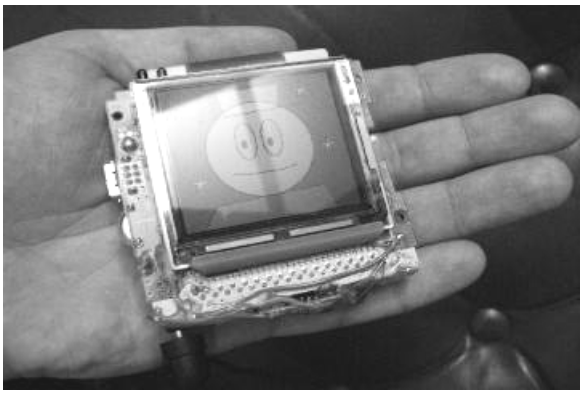

Figure 1. The WearBoy Prototype

- Sufficient CPU. Though not as powerful as a PC-based system, the Z-80 based, 8.388 MHz MCU provides serial and IR communication. The use of exchangeable cartridges [2] makes it easy for users to change between different applications.
- Multimedia capabilities. Having a color screen (2.6", 160x144 pixels, 32K colors) and a 4-channel stereo sound output allows for quite complex information presentations.
- Small, robust, light and portable. The whole system has low power consumption (0.6W at 3V DC) and weighs only 210 grams.
- Inexpensive. At the low cost of about $70 per unit, they are expendable and allow for affordable multi-device systems. The available freeware software development tools [4] further reduce the overall cost.

One drawback of the GameBoy hardware was its limited expandability, due to the lack of sufficiently many I/O ports. This can be addressed by building an I/O expansion board that fits the GameBoy's cartridge slot [7]. However, the serial port and the buttons allow digital I/O with peripheral devices with little or no hardware modifications.

3. The WearBoy Platform

Before designing the WearBoy, we had already used unmodified GameBoys fitted with radio transceivers to implement Hummingbirds - portable, personal awareness devices that convey information about what members of ones group are present in the physical vicinity [5]. During this work, we had learned that GameBoys were excellent platforms for rapid prototyping of small, wearable devices, but also that the original GameBoy was somewhat too big to be comfortably worn. However, when examining the hardware layout of the Color GameBoy, it became clear that it would be possible to reduce the circuit board size to be just slightly bigger than the screen itself, while keeping almost all the functionality intact (see Figure 1). By moving a voltage converter and some capacitors from the lower part of the circuit board to the upper part, we could remove the lower part altogether. Although this part of the circuit board contained the loudspeaker and the buttons, this loss was acceptable as new buttons and other types of I/O are easy to connect. Furthermore, it is possible to place these new buttons wherever they are feasible, i.e., where they are easy to access. Currently, the power source (2 AA size batteries) is the only external part of the device. Mounting other types of batteries directly on the board or cartridge eliminates the need for cables and reduces the weight of the device to less than 90 grams.

By arranging the GameBoy's IR port in the same direction as the screen, two WearBoys can communicate when their wearers are facing each other, similar to the Thinking Tags [1]. One potential problem is the short range (about 10 cm) of the IR port. However, amplifying the current to the IR diode and replacing the original diode with a more powerful one can extend the range. It is also possible to implement a standard IR protocol (e.g., IRDA) allowing for communication with a wealth of portable devices.

4. Applications

We are currently using the WearBoy for two projects, where the primary user of the system is not the wearer of the device but the viewers of that device. Doing this, we apply the technology to augment social interaction between people. This is in contrast to providing an information channel that is solely for the wearer, as is done in most wearable computing applications (c.f. [6]).

4.2 The ActiveJewel

Merging jewelry design, graphical art and wearable technology, the ActiveJewel was designed to hold the WearBoy's display in a brooch-like frame. As the name implies, the ActiveJewel has a changing appearance with computer generated patterns constantly evolving on the display. Our aim with the ActiveJewel is to create a new kind of adornment similar to traditional jewelry, but with a visual appearance that change over time. The ActiveJewel expands the traditional concept of jewelry, as an important aspect of self-decoration and display of symbolic values, with movement and non-repeating patterns to draw further attention to the item.

4.2 The BubbleBadge

Further exploring the design space of public, wearable applications, the BubbleBadge [3] turns the idea of a wearer's private display "inside out". The wearer's control over the information displayed is loosened, allowing the environment and viewers of the device to request information. For example, at the request of a viewer, the device can present new incoming email on the wearer's display. Preliminary user tests have shown interesting new ways of interaction afforded by such devices, which require further exploration.

5. Future Work

The radio transceivers used with the Hummingbirds [5] can easily be connected to a WearBoy. This would allow for ad-hoc networking of a relatively large number of devices and experiments where many users simultaneously interacted with the devices.

As a next step, we will implement an I^2C compatible bus for the WearBoy, using the serial port. By doing this, many kinds of chips used in consumer electronics (e.g., EEPROMs, MP3 decoders, radio tuners, and programmable audio filters) can be attached to the system. This would further expand the platform's functionality while keeping the system small and affordable.

6. References

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