Using Low-power Sensors to enhance Interaction on Wristwatches and Bracelets

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Abstract. In the last few years, new interactive wristwatches are available on the market. Despite their impressive hardware capacities, the interaction on such devices remains rather limited. We propose a cheap and low power consuming way to enhance interaction on a wristwatch but adding position sensors on the watchband. We then present a MP3 player application as a proof of concept for our prototype.

Keywords: input; digital jewelry; wristwatch; bracelet; interaction; low-power; potentiometer.

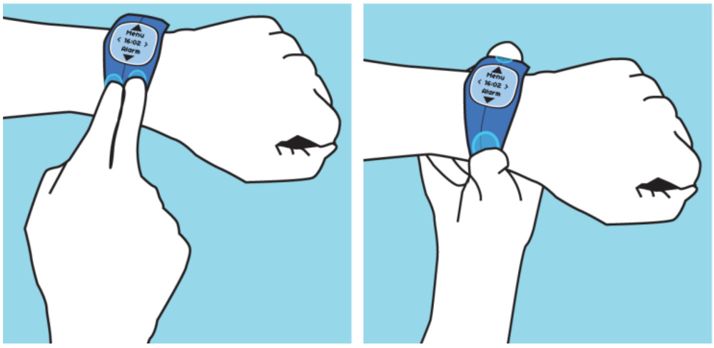

Fig. 1: Interaction on the watchband that prevents screen occlusion and offers a large interaction surface for precise interaction.

1 Introduction

After decades of miniaturization race, mobile computing is reaching a new step with the emergence of small mobile devices such as digital jewelry [3]. Interactive wristwatches, in particular, have gained an increased attention from researchers and companies. In the last two years, mature commercial products arrived, such as the

"I'm Watch" [1] or the Sony Watch[2]. The hardware capacities of these devices are really impressive, but since 2001 and the IBM Linux Watch [4], interaction with wristwatches did not evolve and remains rather limited: interaction relies solely on small touch screens.

These small touch screens suffer from two main problems in terms of interaction: screen occlusion and *fat finger* problem [5]. When interacting on a touch screen, the user will place his finger directly on the screen, hiding anything displayed under. Also, since the surface of the finger is quite large compared to the surface of the screen, it becomes harder to acquire small targets on such devices (the *fat finger* problem). A solution would be to add additional sensors on the wristwatch, but that would lead to an increase of power consumption on a device where power is a critical and rare resource.

To solve the two interaction problems presented, we propose to add low power consuming potentiometers on the watchband of a wristwatch to take advantage of a large surface that was previously not used for interaction. We then present how a MP3 player can be controlled using simple gestures on the watchband.

2 Related work

The usual approach to avoid the screen occlusion and the fat finger problem on small devices is to interact around the device and not directly on the screen. To the best of our knowledge, no previous work suggested the use of watchband for interaction.

Abracadabra [2] allows the user to point around the device by using a magnetometer. It allows for precise input and does not consume a lot of power (around 0.15 mA for the additional magnetometer). However, this technique requires the use of a magnet that can be lost or bothersome to wear.

Other techniques, such as Butler's SideSight [1] use proximity sensors to track finger positions around the device for mid-air pointing, but the additional power consumption implied by the system does not makes it suitable for wristwatches.

3 Using linear potentiometers for interaction

Interacting with the watchband offers several advantages: it helps avoiding the screen occlusion and the *fat finger* problem, and the watchband can also be seen as a prolongation of the touch screen. The large surface offered by the watchband makes interaction simpler and more precise for users.

To allow interaction on the watchband, we needed to find a low consuming sensor that could be used for interaction. After a careful investigation, we found out that linear potentiometers were the best candidate for this.

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[1] http://www.imsmart.com/en

[2] http://www.sonymobile.com/global-en/products/accessories/smartwatch-2-sw2/

3.1 Hardware

We designed our first watchband prototype using a 2-cm wide watchband composed of four resistive potentiometers: two of them were positioned on the internal part of the band (below the screen) and the two others on the external part of the band.

The potentiometers consist of 5-cm long thin bands flexible enough to be used on the watchband without getting damaged. Each potentiometer is a variable resistor (100 Ω to 10kΩ) with low variability (less than 1%). They are all connected to an Arduino Fio board, that provides a 3.3V input and to an additional 100 kΩ resistor. It requires only 0.03 mA/potentiometer.

The microcontroller detects up to 1024 different positions on the potentiometer (around 200 positions/cm). The hardware prototype is presented on the Fig. 2. With this implementation, pseudo "multi touch" interaction is possible: two different contacts can be sensed on each part of the band.

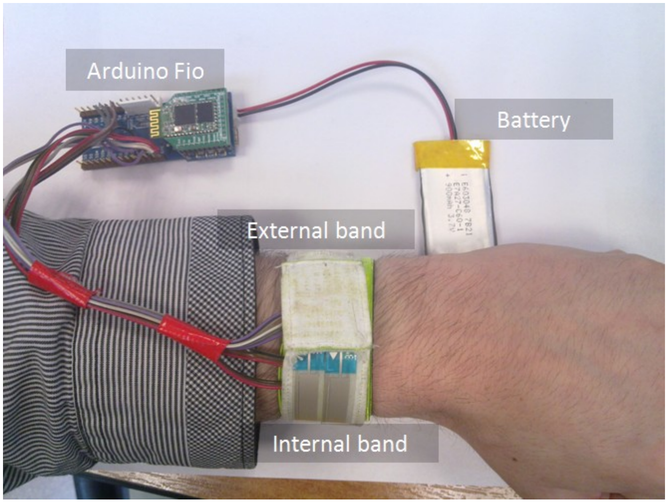

Fig. 2: Hardware prototype of the augmented wristband.

3.2 Advantages of the technology

While capacitive technology was an possibility, we chose the resistive technology for the following reasons:

1. It requires less power to be operated (0.03 mA/sensor).
2. The pressure needed to activate them helps preventing accidental activation.
3. The potentiometers can also be hidden under an opaque layer that would make the sensors totally invisible and would thus not alter the aesthetics of the device, and could be integrated on any commercial product to integrate.

4 MP3 player application

We want our system to be simple to use. Yet, it has to provide a rich interaction that could allow the user to command any application without having to directly interact on the touch screen. We thus designed a simple gesture vocabulary based on pointing or sliding the finger on the watchband.

First, we found that a nice resting position for users is to grab their wrist by putting their thumb on the internal part of the band, and their index and middle fingers on the external part of the band. Then, by simply tapping with one finger on the corresponding band, it is possible to simply input three different commands: by tapping with the thumb, it would trigger the “Play/Pause” command, by tapping with the index, it would be “Previous Song”, and “Next Song” with the middle finger.

For volume control, users would first grab their wrist with the thumb and the index finger (one on the internal part, other on the external one) and simply slide them.

Our software also allows navigating inside a song: in that case, users simply put both their index and middle fingers on the internal part of the watchband and slides them to navigate through the current song.

We conducted an informal study to confirm that the gestures were easy to perform and that our system was able to recognize them. For recognition, we used a simple state machine based algorithm that could easily be implemented directly on the microcontroller (and would thus require very few CPU power).

5 Conclusion

In this paper we presented a novel way to enhance interaction on interactive wristwatches. In the particular context of small mobile devices, battery life is quite critical. Our solution relies on resistive technology that does not require a lot of power to operate, can also be invisible and prevents two well known interaction problems: the screen occlusion and the fat finger problem. We also presented an implemented MP3 player as a proof of concept.

References

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