Mnemonical Gesture-based Mobile Interaction

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Abstract. Mobile Interaction gained a vast importance in the actuality. However, graphical user interfaces with mobile devices are still mainly used, creating difficult situations for a constantly changing and on-the-move context. A gestural interface, with its natural characteristics and expressivity, is able to fill the lack of consistency of those interfaces and provide the user with a suitable and fast on-the-move access to the favourite tasks, especially if combined with meaningful mnemonics. In our work, the concept of body mnemonic is explored. Users will be able to associate parts of the body and mobile device's applications, in order to trigger them with a gesture towards the correspondent body space. We explore three technologies that are able to support mobile body gestures: Radio Frequency Identification (RFID), Electromyography (EMG) and Accelerometers.

Keywords: Mnemonics, Gestures, Mobile, Electromyography, RFID, Accelerometer.

1 Introduction

Mobile devices are lightweight, small and with large battery capacity. However, all the efforts in the improvement of the mobility of the device itself are not being followed by the same principle when constructing the user interface. These devices are still based on graphical interfaces similar to desktop computers, and the input is made though small keyboards. The user is obligated to look at the device to receive visual feedback and memorize or look to the keys to interact, which results on a high workload and inconvenience when the user is moving. Many of us already found difficult to interact with the mobile device when walking, driving or when some activity requests our total visual attention. Our belief is that gestures can be the most suitable interface to interact with mobile devices. Gestures are commonly used among people to communicate with each other, with great efficiency, and that principle has been applied in Human-Computer Interaction with pleasant results. Furthermore, mobile devices are small, easy to handle and have increasing processor capabilities, allowing them to be "gestured" and /or process data efficiently. Three different techniques were explored to achieve body shortcuts. Primarily, we have Electromyography (EMG) as a subtle gestural interface for mobile devices, as described by Costanza et al [2]. Radio Frequency Identification (RFID) as also been used for gestural interaction, using RFID readers on mobile devices and RFID tags on clothes or personal objects. Headon and Colouris [5] presented a RFID-based interface to interact with the mobile device, using a grid of tags on the shirt. Finally, accelerometers had been largely used because of its low price, easy integration on mobile devices and precise measure of acceleration on multiple axes, permitting, for example, to recognize numbers drawn in the air [1]. In our work, we decided to study all these 3 approaches (EMG, RFID and Accelerometers) in the context specific type of gestural interaction: the Mnemonical Body Shortcuts.

2 Mnemonical Body Shortcuts

Gestures are a natural method for human expression. People apologize joining two hands or open one hand when tying to stop someone. However, it is also known that people are able to create strong mnemonics such as using a finger with the mouth to order silence or touch the wrist when asking for the time (Fig. 1). Our approach to the creation of a gestural interface is based on the strong relations that gestures and body parts have with the different functionalities of a mobile device, creating a strong mnemonical help. For example, the user should be able to make a gesture towards its mouth to silence the mobile device or towards the wrist to know the actual time. All these shortcuts should be personalized to be mnemonically stronger, because each person may have their own preferred body shortcuts. It is also important to give appropriate feedback, preferably audio, to enhance the interaction and turn the Mnemonical Body Shorcuts on a truly efficient, low workload and easy-to-remember user interface for people on the move.

Fig. 1. *Silence* common gesture

3.1 Task analysis

In earlier studies, the working group made a task analysis on the state of interaction with mobile devices, on-the-move usage and the validation of the Mnemonical Body Shortcuts concept [3]. The task analysis was a twenty-user study about the habits of mobile interaction. There were three main conclusions following that study: People use key shortcuts, but they confess that when they have many shortcuts, they hardly remember most of them; Observation proved that, even when people have programmed shortcuts, they usually rely on menu selection to interact with the device; Voice shortcuts are not used, mainly because of its low recognition rate and social constraints. In fact, the solutions that mobile devices propose to the users to achieve a faster moving interaction seem to fail to be used, which increases the important to create a gestural interface.

The concept of the Mnemonical Body Shortcuts was also studied using an RFID prototype (see 3.3). Twenty individuals were asked to complete 20 shortcuts with both gestures using the prototype and with key shortcuts chosen by them, and repeated the process one week later to test the remembrance of each association. In the first test, the key shortcut error rate was 9% of errors per user, while with gestures the error rate was 0.8%. The results were still very favorable for Mnemonical Body Shortcuts one week later, with an error rate of 22% for key shortcuts and 6% for the gestural interaction. The results showed that, even against some established key shortcuts, gestural mnemonics had better results and may surpass the problem of low memorization of key shortcuts, providing also a wide range of possible associations, when compared with the physical limit of keys present on a mobile device.

3.2 Electromyography

Electromyography (EMG) is defined as the study of the muscular function through the analysis of the generated electric signals during muscular contractions. The potential difference obtained in the fibers can be registered in the surface of the human body through surface electrodes due to the biological tissues conducting properties. We studied the muscular activity as an input in order to launch applications. A large set of target muscles is available so we can interact widely with the mobile device. In order to accomplish this task we monitorize muscle activity through an electromyographic portable device, process the digital signal and emulate certain events accordingly to the features detected. Being able to detect and to evaluate muscular activity in an individual gives us the possibility to associate it with determined shortcuts, thus having the myographic signal as input [4]. The advantage of an EMG-based approach is the subtleness of interaction as the user can create an event by contracting a muscle without disrupting the surrounding environment. However, although some body gestures can be detected, most of the user's selected mnemonics cannot be recognized using this technique as there are no contractable muscles in the selected body part (i.e., ears). Also, as the user moves, the probability of false positives increases. Therefore, we observed that EMG can be used for mobile interaction but only in a minimal scenario to react to a small set of events.

3.3 Radio-Frequency Identification

RFID technology is based on 3 basic components: the RFID tag, small integrated circuit with an attached antenna allowing communication via radio waves; the RFID reader that is used to interrogate the RFID tag to obtain its data; an host computer to receive the data, in this case a mobile device with a RFID reader on it.

The prototype used was formed by a Pocket LOOX 720 with a compact flash ACG RF PC Handheld Reader (Fig. 2). The software, programmed in C# with the Compact

Framework is able to read each tag and block simultaneous reads and also write a log for a better test analysis. User tests made on [8] which results were resumed on section 3.1 were made using this prototype. The RFID tags used were sticked on each body part the user chose and, when prompted to trigger a certain shortcut, the user had to bring the Pocket PC to a position near the tag. The results also showed that this prototype has a low error rate, since it provided a satisfactory average of 94% correct readings.

The RFID approach permits the detection of point within the body frame of the user, and that characteristic is a clear advantage when applying the Mnemonical Body Shortcuts, together with the high recognition rate and the possibility to use the tags invisibly. However, the feedback from the users made us realize that the usage of the tags may be the main problem of this approach. People do like the style of interaction but would hardly accept the need of use RFID tags on clothes and objects on a daily basis.

Fig. 2. RFID Prototype

3.4 Accelerometer

An accelerometer is an electromechanical inertial sensor capable of detecting acceleration on multiple axes. When accelerometers started to be produced with MEMS technology they became suitable and practical for usage in small devices because of their small size, weight, power consumption. The objective of the development of a prototype based on accelerometers was to recognize the gesture towards body points, as it was done with EMG and RFID, taking in account that mobile devices have lower processing capabilities.

Our algorithm for position detection makes a straightforward use of the acceleration. We decided to have an initial position (chest) and to have an "action button" that enables the use of the motion sensor. The final position of the device is calculated with a double integration of the acceleration. Finally, a threshold is applied to find the exact start and end of movement, because minor accelerations would have a significant amount of effect in the result (final position). The algorithm is applied to both x and y axis, and returns a point in the space for each axis, relatively to the centre of the chest. The Mnemonical Body Shortcuts can be recognized in two different forms. The first is to use predefined points that are related to the height of the user. In this case, the user has only to select the application and a body part (ex: left ear, right shoulder, etc). Training the system is the other option, where users can do the pretended gesture, which gives a point in space, and the next recognized gestures are based on those trained points. This prototype allows the user to perform Mnemonical Body Shortcuts without any additional hardware such as electrodes or RFID tags, making it more suitable to be applied with mobile devices and used on a daily basis. However, there is one major limitation of the prototype. Because the gravity acceleration is always present, it has to be eliminated, considering that the mobile device is always on the initial position. However, when gesturing, people may give some unintentional rotation to the mobile device, which is hardly detected and has a large effect on the position result.

5 Conclusions and Future Work

The interaction with mobile devices based on graphical interfaces is not suitable for a truly mobile interaction, because they demand visual attention. In previous work, the task analysis on this subject revealed that attempts to enhance the interaction on-the-move are not successful, namely with key shortcuts and voice shortcuts. We understand that is possible to create a gesture-based new interface that enables users to interact with their devices even when mobile. Our work focused on the study of three technologies that are able to create a gestural interface with mobile devices based on the possible mnemonical relations between gestures, body parts and applications on mobile devices. We developed an Electromyography-based prototype and concluded that it is a promising technique for mobile interaction due to its intimacy and subtleness but it is error prone and therefore must be used carefully within a restricted interaction set. An RFID prototype was also developed and tested, with a recognition rate of 94%. The main problem users found on the prototype was the need to carry RFID tags to interact with the mobile equipment. Finally, accelerometer data was used in order to find the position of the device related to an initial fixed point on the chest. The device is able to recognize 2D points, associate them with a body part and, later, recognize a certain 2D point as a gesture towards that body part. In the future, we intend to test all the three prototypes with real users within real life scenarios and compare the results between them.

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