Hardware and Software latest innovations in HCI for Portable Devices: a State Of the Art

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ABSTRACT

This article discuss the state of the art in human computer interaction for portable devices. We do it by dividing the argument into two main parts: the first shows the direction the scientific community is taking to bring improvements and innovations on this argument, the latter highlights the state of the art in industrial production in order to find the common goals and to highlight which part of these innovation reach the final users. Before introducing the latest innovations, we need to briefly present the argument while limiting its width on the portable devices. This is done by presenting the hardware means of interaction a portable device usually integrate while highlighting their main characteristics.

KEYWORDS: State of the art, handheld devices, handheld interaction.

INTRODUCTION

Modern portable devices became more and more powerful and comfortable thanks to the evolution of both hardware and software they are built on. The technological innovations let the researcher implement new interaction techniques in order to improve the final user satisfaction and gratification.

In order to understand the direction of the evolution in this field, we introduce this article with the state of the art in the hardware means of interaction. This preliminary knowledge is important in order to consider the real limitations the researchers have while proposing new software techniques, and to focus on the possible improvements in the hardware domain itself.

Once the main interaction means have been described, the article moves on the description of some projects developed in the latest years, both in the research community environment and the industrial one, showing the main problems linked to the subject. These problems, in fact, represent the most limiting factors while developing for such devices.

Finally in the conclusion section, we propose some personal considerations in order to highlight the goals described during the article itself. These considerations want to remark the existence of a boundary between the WIMP (window, icon, menu, pointer) approach normally used on traditional PCs and the improving post-WIMP techniques that are going to dominate the portable devices world.

THE MEANS OF INTERACTION

In this section we present the hardware means of interaction a portable device usually integrate and consequently we highlight their main characteristics.

The display

The first hardware component is the display. It is the most studied and developed in the computer science; it is used in almost all the devices (portable or not) and a lot of interaction techniques have been developed using it. Furthermore, it is both an output mean used to show the user informations about its data or about system events and status, and an input device used as an alternative or to improve the existing ones. The presence of a display, especially in portable devices, strongly influence the interaction approach of the device itself.

The speaker and the microphone

The second important hardware interaction mean we need to cite is the speaker. Even though several studies have been carried out to improve its functionality it still has several limitations and its main function is to catch the users' focus on system events (we focus here on the interaction between the system itself and the user, we are not considering the speaker as mean to establish a communication between users). Moreover, catching the user attention through the speaker is also limited by its suitability among different environments and/or situations. Once analyzed the function of the speaker in a portable device, we must spend some words on its counterpart: the mi-

crophone. Nowadays, it is present in portable and ultra portable computers. Even though its important is evident in devices while establishing communication, it has a quite limited role while used as input means to control the system itself.

The sensors

We move now to the latests improvements in consumer technology, they are position and movement sensors. The first have been introduced since some years in devices to implement GPS technologies, for example, and its functions have not been developed moreover, so that the presence of a position sensor in a portable device is motivated with ad-hoc software application. The latter, represent the next generation input technology. Movement sensors, have been recently introduced in consumer devices and still represent an open challenge in interaction methods. Their presence in a portable device strongly influence the other means of interaction, the user interaction techniques the device implements and the user experience the costumer undergo. To better understand their importance and the influence they have against the public, we just have to consider the impact the Nintendo WII had in the world console market in comparison of its rivals the Play Station 3 and the XBOX 360. In fact, even if they are graphically and computationally more powerfull, the new interaction technique the Nintendo proposed thanks to the movement sensors, greatly influences the selling rates.

STATE OF THE ART

The second part of this article present the state of the art in human computer interaction for mobile devices both from the point of view of the scientific community and from the one of the industry and consumer product then. The projects and the devices, presented in this section, highlight how the means of interaction presented in the first part are used by the new hardware and software techniques.

The direction of the community

First of all, we start by presenting the latest hardware innovation brought by the scientific community. Two great examples are briefly introduced,: the earPod [12] and shoogle [11].

EarPod EarPod [12] is the product of a study whose direction was to investigate in such an input techniques that didn't need the users' full attention. It is actually a wheel menu, like the one integrated in the iPod. Differently from the iPod itself, the earPod [12] project focus on an auditive feedback instead of a visual one. In other words, while using the wheel, the user doesn't need to look at a display in order to understand the state of the menu, but the system describes it to him by *saying* the menu item name. In their studies, the authors found that even if the learning curve is a bit high at the beginning, the intuitive manipulation let the users easily understand its functions.

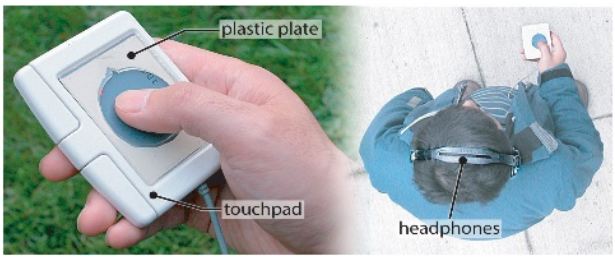

Figure 1 **:** The prototype of the earPod [12].

According to their tests, the input technique experimented with the earPod [12] is comporable with the iPod-like one.

Shoogle The Shoogle [11] project is a different answer to the same problems highlighted by the earPod [12] one, that's *contemporary actions*. Differently from the previous one that wanted to reach a full control of a system without catching the users' full attention, this project investigate a way to let the users obtain system status informations without paying full attention toward the device. The system uses the movement sensors as means to catch input commands. While exciting the device, a software physic environment uses auditive feedback to inform the users on its status.

Figure 2 **:** The shoogle [11] auditory feedback.

Thought the synthetic purpose of this article oblige us don't to talk about other interesting projects, we want to remember the existence of works aiming to detect user's hand movement on mobile phone using the camera[10], or proposing new kind of mechanics means such as the clickable wheel. On the pure software side, the community recently presented some projects improving the precision in pointing and selection using touch and multitouch screens and the menus of mobiles graphical user interfaces.

Shift Software technique implemented to improve human computer interaction, usually tends to round some hardware compromise. In this category lives the Shift [9] project. It is actually an investigation on the object occlu-

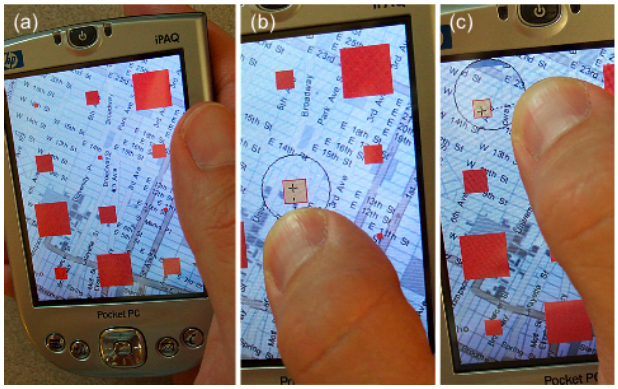

Figure 3 **:** The Shift technique in action. When the finger occludes small target, the callout reproduces the non-visible part of the screen.

sion problems, where the main occluding object is actually the pointing device itself. In this case, the pointing device is the finger itself, when used on a touch screen devices with an interface studied to be used with a pen. In these conditions, the size of the finger is not negligible. As shown in Figure 3, the solution consist on a "callout showing a copy of the occluded screen area placed in a non-occluded location" [9].

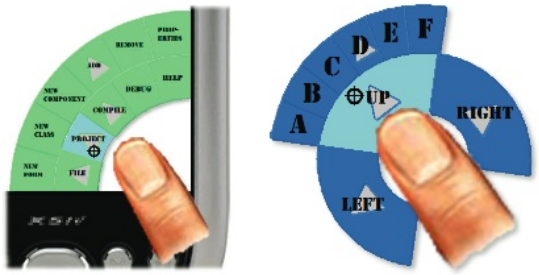

Figure 4 **:** ArchMenu and ThumbMenu.

AcrhMenu and ThumbMenu This project evolve the visual occlusion considerations done in the Shift [9] one caused by the finger when used as a pointer. The work focus on two new types of circular menus, such as the marking menu. The menus described in this paper are especially studied and developed for post-WIMP interfaces based on finger touch pointing technique. In order to avoid the finger itself to occlude the part of content of the menu itself, they propose such a semi-circular marking menu. With this research, the community want to offer a specially designed contextual menu technique developed to improve the mobility experience.

Tumbler and Splatter Another interesting project investigating on the object occlusion problem. Even if it is not directly developed on portable devices, it is interesting because it proposes a new selection method. The project focus on some *explosion* methods as a remedy of the 2D graphic object occlusion. The Tumbler and Splutter are presented as "tools that facilitate access to occluded content" [8] using 3D effects. Using the visual feedback, the project shows a way that let the user simply choose among different objects, even if this involve the users to distract from what he was doing.

Hower Widget While analyzing the ThumbMenu [5] project we introduced the concept of the contestual menus. Actually, even if it proposed a solution to the occlusion problems, the project didn't offer a way to open the menu itself without interacting with the GUI present on the screen. HoverWidgets [4] faces this problem. They define some particular and unintuitive pen-based gestures in order to command the system to open the menu where the gesture have been detected. In this way, the gesture are not tracked by the GUI, because they are seen by the system as simple movement. On the other hand the user can quickly contextualize the menu without losing is concentration.

Precise Selection One important issue touch interfaces driven by finger have to face on, is the lack of precision due to the finger itself. This lack is mainly caused by the size of the fingers and the lack of sensing. This deficiency can make the touch screen interaction difficult. The Precise Selection [3] project aims to offer a solution to this issue, thanks to the use of multi-touch techniques. The project in fact, implement some tools that should be driven by the non-dominant hand. These tools let the user change the pointing options (such as change the Control-Display ratio, the zoom, the visibility of the pointer) while actually continue pointing with his dominant hand. This solution offers contextualized menus that let the user keep the attention on his work while interacting with the system.

BlindSight In order to conclude the panoramic outline of the community direction in improving the user experience in mobile devices, we present a project involving both hardware and software improvement to reach a higher usability level. This project is BlindSight [6].

Figure 5 **:** The image represent a user interacting with the BlindSight [6] system on a prototype mobile phone.

The project gives the possibility to the users to access some phone services like their agenda while talking to the phone without interrupting continuously the conversation. It shows an example of interaction that collects the char-

acteristics introduced in this article. So that, it is an eyes-free way to access the informations with an auditory feedback while talking to the phone (contemporary actions). “Users control blindSight using the phone keypad while the phone is held up against the user’s ear” [6].

What about the industry?

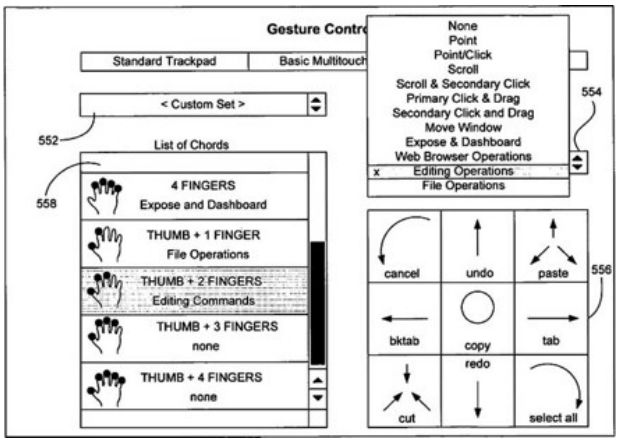

Figure 6 **:** An Apple patent showing the implementation of some gesture with their associated actions using a multi-touch device.

Finally, the last part of our presentation show briefly the state of the art in human computer interaction on the industry side. It is important because it is actually the state of the art in HCI for all the people, that’s for consumer i.e., for all the people that don’t have access to the research. In this environment it is important to consider that, even if cool devices such the iPhone have been presented and commercialized, the keyboard still resists in many others. Furthermore the majority of enterprises still continue to produce keyboard-based and multitouch based devices Figure 6, probably because the customer target is not unifiable. Moreover, the Android preview recently presented has both a keyboard and a touch screen, so that the device can boast both the interaction techniques.

CONCLUSIONS

We presented a wide variety of projects and techniques pointing out the directions the evolution of such methods are bringing to the interactions with mobile devices. Clearly interaction means we tried to strongly separate here, cannot be considered totally independents: for example, the presence of a touch screen strongly influences the visual look of a GUI. These aspects oblige us to orient the research on HCI and Usability on the Multimodal domain, that evidently seems to be the most fruitful studying direction.

Another important direction we can clearly trace considering the evolution of the presented interfaces is the Post-WIMP one. The presented works presume the use of new interfaces components and interaction methods. As a consequence we want to state the needs of these new requirements. Evidently the verification need to face against the GUI classical rules such as Fitts and Steering laws, in order to go over them. Additionally, the discussion against classical GUI and laws must face also against classical GUI elements: are still all of them necessary in Post-WIMP interfaces? The iPhone GUI, for example, show us that the control task the scroll bar has in WIMP interfaces can be easily substituted wth gesture so that this element reach only a visual feedback task.

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