Determination of Placement of a Body-Attached Mouse as a Pointing Input Device for Wearable Computers

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Abstract

We believe the notion of hands free operation is critical to the successful use of wearable computer systems. As such, we investigated possible placements of an input device, for a wearable computer, on different portions of the user's body, while the user assumed different postures (sitting, standing, kneeling, and prone).

1 Introduction

We were inspired by the paper *Design for Wearability* [4], where Gemperle *et. al.* produced 13 design guidelines to help mapped the design space for developing wearable systems [1, 3]. Current workstation input devices (such as mouse, joystick, and keyboard) would not be practical for users standing in an outdoor environment, as such devices require a level flat surface to operate. A new form of input device is required, but how would users interact with this new kind of input device? For example, how does one point or select objects displayed on a HMD? And how does one enter text or commands without a desktop keyboard?

One solution to the first question is to place a pointing device on the user's body [5]. A suitable device is the Touchpad mouse commonly found on Apple laptop computers. An example of a Touchpad mouse is shown in Figure 1. Where on one's body should such a device be placed? This study evaluates the effect of the placement of a Touchpad mouse on a user's body.

We **aimed** to determine whether there is any difference to a user operating a wearable computer with a Touchpad mouse when the following factors are varied: firstly, the position of the Touchpad mouse on the user's body – forearm, upper arm, torso, thigh front, or thigh outer side; secondly, the posture of the user – standing, sitting, kneeling, or in the prone position (laying down with the user propped up on their forearms). The study measured differences in time to complete selection tasks and the number of errors that occurred.

We reduced the number of possible combinations of mouse position and orientation from a total of twenty to seven for the final experiment, by discounting the non-preferred options[1].

2 Experimental Design

This section describes the design of the experiment, including the wearable computer system, training session, and the experimentation session. All sessions were performed in the Wearable Computer Laboratory.

The hardware portion of the computer system consists of the following components: *Toshiba Portable Personal Computer 320 Series* laptop computer, *Sony Glasstron* see-through 800 x 600 SVGA display, and *Easy Cat*^{TM} Touchpad mouse [2]. The computer and power converters are stored in a small backpack.

The subjects then undergo a training session for the use of the Touchpad mouse attached to the top of a desk, while viewing the computer screen with the Sony Glasstron display in the opaque non-see-through mode.

A second experimentation session with a duration of about one and a half hours is performed individually with a supervisor.The task the subjects perform during the experiment is to use the Touchpad mouse to select

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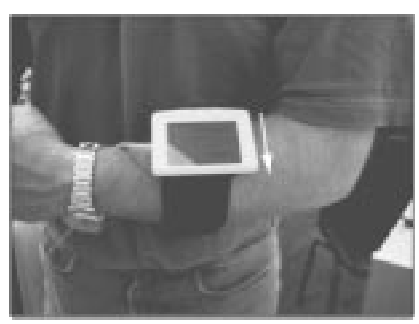

Figure 1: The forearm

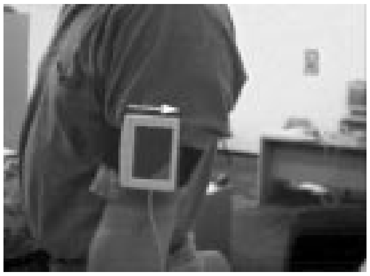

Figure 2: The upperarm 1

Figure 3: The upperarm 2

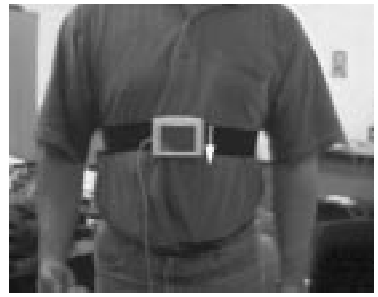

Figure 4: The torso

Figure 5: The torso 2

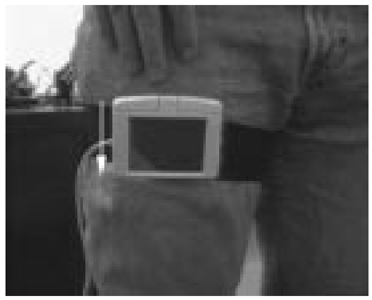

Figure 6: The front of the thigh

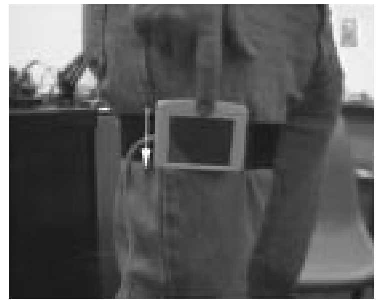

Figure 7: The side of the thigh

a target place in the centre of the screen. Once the target has been selected, that target is removed from the screen. A second target is placed offset of 183 pixels in one of eight directions, equally spaced around the centre of the screen. The targets are circles of 40 pixels in diameter. For each trial, the subjects perform 40 tasks in random order, the eight target positions presented five separate times.

3 Results and Discussion

This study involved 25 subjects performing selection tasks with a Touchpad mouse while wearing a wearable computer on their back and using a head mounted display. The each subject performed the tasks in 27 different combinations of four posture (sitting, kneeling, standing, and prone) and seven different placements of the Touchpad mouse on the subject's body (forearm, thigh by 2, torso by 2, and upper arm by 2). We measured the time and error rate to complete the selection of a circular target.

For posture, there are similar time effects for sitting, standing, and kneeling. These results indicate that the prone position is a posture which reduces the user's performance significantly. Further study is required to determine the cause of this poorer performance.

The effect of mouse position and orientation shows three groupings of the results for the seven different mouse positions. The front of the thigh is the best position for the mouse. The forearm, side of the thigh and upper arm towards the user's hand are the next grouping. The least favourable mouse positions are torso (with both mouse orientations) and the upper arm with mouse buttons in the up direction.

When the posturing and mouse position conditions are combined, the results would indicate the thigh front mouse position would most appropriate for sitting kneeling, and standing postures, and the forearm mouse position is to be used for the prone position. If only one mouse position is to be used for all four postures, the forearm position would be the best choice.

References

[1] Len Bass, Chris Kasabach, Richard Martin, Dan Siewiorek, Asim Smailagic, and John Stivoric. The design of a wearable computer. In *ACM CHI 97*, pages 139–146, March 1997.

[2] CIRQUE Corporation, 433 W. Lawndale Dr., Salt Lake City, UT, USA. *Easy Cat: Touchpad mouse.*

[3] C. Esposito. Wearable computers: Field-test results and system design guidelines. In *Human-Computer Interaction INTERACT '97*, pages 493–500, Sydney, Australia, July 1997. Chapman and Hall.

[4] F. Gemperle, C. Kasabach, J. Stivoric, M. Bauer, and R. Martin. Design for wearability. In *2nd International Symposium on Wearable Computers*, pages 116–122, Pittsburgh, Pennsylvania, October 1998.

[5] B. H. Thomas, S. P. Tyerman, and K. Grimmer. Evaluation of text input mechanisms for wearable computers. *The Virtual Reality Journal*, 3:187–199, 1998.