Computing without Mice and Keyboards: Text and Graphic Input Devices for Mobile Computing

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Abstract

Computers have been progressively becoming smaller and more mobile. The past few years have seen computers evolve from the desktop to the notebook to current handheld systems. Each new device is more portable and less cumbersome than last. The next step in this progression is the wearable computer: a computer consisting of parts small enough to be worn as clothing or accessories. However, the portability gained from a wearable computer is lost if the input devices are no smaller than existing ones. The main concept behind this thesis is that, in order for wearable computers to be effective, they need to throw away the mouse and keyboard interfaces in favour of a new style of input. These new interfaces should be designed to be easily transportable, quickly accessible, easily usable in a variety of environments, and minimise interference with "real world" interactions. In order to test this theory we have built a graphic (Biofeedback Pointer) and a text input device (Chording Glove) based on these design principles. These devices are designed to work in tandem, with the Chording Glove's text input complementing the Biofeedback Pointer's graphic input.

The Chording Glove is a text input device made from mounting the keys of a chord keyboard onto the fingers of a glove. Chords are made by pressing the fingers against a firm surface. After 11 hours of use, the average input speed on the Chording Glove was 16.8wpm, with an error rate of 17.4%. The Chording Glove's entire 97 character keymap takes, on the average, 80 minutes to learn, with users needing to look up chords around 0.5% of the time after 6 hours of use. There is evidence of keymap retention after significant absence from the device, but this remains to be proven. Evidence also shows that there is no significant difference in performance on the Chording Glove while standing or sitting, implying that the device is as mobile as intended.

The Biofeedback Pointer is a graphic input device controlled by wrist motion. Moving the wrist causes the pointer to move in that direction. The pointer works by measuring the Electromyograms (EMGs) of four of the main muscles used to move the wrist. This data is interpreted by a neural network which is trained for each user. The network takes about half a minute to learn to recognise the user's EMG signals. After the training the user learns to fine tune the pointer control through a biofeedback process. Fitts' Law was used to compare the performance of the Biofeedback Pointer with a standard mouse. The average index of performance of the Biofeedback Pointer was found to be 1.06, while the mouse was 7.10. This is about half of the lowest performance of a common graphic input device. Using a more sophisticated neural network or better training may improve the device to a more comparable level.

These results show that the design criteria established here for mobile input devices can be used to build workable computer interfaces which encompass both graphic and text input. Hence input devices are shown to exist which are transportable and usable, thereby making wearable computers a viable technology.

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A final note: The work for this thesis began at Queen Mary and Westfield College. This is where the bulk of the Chording Glove research, including the experiment, was performed. Due to a transfer in 1996, the remainder of the research was carried out at University College London.

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