Computer Access for Motor-Impaired Users

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INTRODUCTION

Computers can be a source of tremendous benefit for those with motor impairments. Enabling computer access empowers individuals, offering improved quality of life. This is achieved through greater freedom to participate in computer-based activities for education and leisure, as well as increased job potential and satisfaction.

Physical impairments can impose barriers to access to information technologies. The most prevalent conditions include rheumatic diseases, stroke, Parkinson's disease, multiple sclerosis, cerebral palsy, traumatic brain injury, and spinal injuries or disorders. Cumulative trauma disorders represent a further significant category of injury that may be specifically related to computer use. See Kroemer (2001) for an extensive bibliography of literature in this area.

Symptoms relevant to computer operation include joint stiffness, paralysis in one or more limbs, numbness, weakness, bradykinesia (slowness of movement), rigidity, impaired balance and coordination, tremor, pain, and fatigue. These symptoms can be stable or highly variable, both within and between individuals. In a study commissioned by Microsoft, Forrester Research, Inc. (2003) found that one in four working-age adults has some dexterity difficulty or impairment. Jacko and Vitense (2001) and Sears and Young (2003) provide detailed analyses of impairments and their effects on computer access.

There are literally thousands of alternative devices and software programs designed to help people with disabilities to access and use computers (Alliance for Technology Access, 2000; Glennen & DeCoste, 1997; Lazzaro, 1995). This article describes access mechanisms typically used by individuals with motor impairments, discusses some of the trade-offs involved in choosing an input mechanism, and includes emerging approaches that may lead to additional alternatives in the future.

BACKGROUND

There is a plethora of computer input devices available, each offering potential benefits and weaknesses for motor-impaired users.

Keyboards

The appeal of the keyboard is considerable. It can be used with very little training, yet experts can achieve input speeds far in excess of handwriting speeds with minimal conscious effort. Their potential for use by people with disabilities was one of the factors that spurred early typewriter development (Cooper, 1983).

As keyboards developed, researchers investigated a number of design features, including key size and shape, keyboard height, size, and slope, and the force required to activate keys. Greenstein and Arnaut (1987) and Potosnak (1988) provide summaries of these studies.

Today, many different variations on the basic keyboard theme are available (Lazzaro, 1996), including the following.

- Ergonomic keyboards shaped to reduce the chances of injury and to increase comfort, productivity, and accuracy. For example, the Microsoft® Natural Keyboard has a convex surface and splits the keys into two sections, one for each hand, in order to reduce wrist flexion for touch typists. The Kinesis® Ergonomic Keyboard also separates the layout into

right- and left-handed portions, but has a concave surface for each hand designed to minimise the digit strength required to reach the keys and to help the hands maintain a flat, neutral position.
- Oversized keyboards with large keys that are easier to isolate.
- Undersized keyboards that require a smaller range of movement.
- One-handed keyboards shaped for left- or right-handed operation. These may have a full set of keys, or a reduced set with keys that are pressed in combinations in the same way a woodwind instrument is played.
- Membrane keyboards that replace traditional keys with flat, touch-sensitive areas.

For some individuals, typing accuracy can be improved by using a key guard. Key guards are simply attachments that fit over the standard keyboard with holes above each of the keys. They provide a solid surface for resting hands and fingers on, making them less tiring to use than a standard keyboard for which the hands are held suspended above. They also reduce the likelihood of accidental, erroneous key presses. Some users find that key guards improve both the speed and accuracy of their typing. Others find that key guards slow down their typing (McCormack, 1990), and they can make it difficult to see the letters on the keys (Cook & Hussey, 1995).

The Mouse

A mouse is a device that the user physically moves across a flat surface in order to produce cursor movement on the screen. Selection operations are made by clicking or double clicking a button on the mouse, and drag operations are performed by holding down the appropriate button while moving the mouse. Because the buttons are integrated with the device being moved, some people with motor impairments experience difficulties such as unwanted clicks, slipping while clicking, or dropping the mouse button while dragging (Trewin & Pain, 1999). Tremors, spasms, or lack of coordination can cause difficulties with mouse positioning.

Trackball

Trackballs offer equivalent functionality to a mouse, but are more straightforward to control. This device consists of a ball mounted in a base. The cursor is moved by rolling the ball in its casing, and the speed of movement is a function of the speed with which the ball is rolled. Buttons for performing click and double-click operations are positioned on the base, which makes it easier to click without simultaneously moving the cursor position. For dragging, some trackballs require a button to be held down while rolling the ball, while others have a specific button that initiates and terminates a drag operation without needing to be held down during positioning.

Thumb movement is usually all that is required to move the cursor to the extremities of the screen, as compared to the large range of skills necessary to perform the equivalent cursor movement with a mouse.

Joystick

The joystick is a pointing device that consists of a lever mounted on a base. The lever may be grasped with the whole hand and have integrated buttons, or may be operated with the fingers, with buttons mounted on the base. The cursor is moved by moving the lever in the desired direction. When the lever is released, it returns to its original, central position. Of most relevance are models in which the cursor moves at a fixed or steadily accelerating rate in the direction indicated by lever movement and retains its final position when the lever is released. The buttons are often located on the base of such models, and a drag button is generally included since it is difficult to hold down a button while moving the lever with a single hand.

Isometric Devices

Isometric devices measure force input rather than displacement. An example is the TrackPoint device supplied with IBM laptops: a small red button located in the center of the keyboard. These devices do not require any limb movement to generate the input, only muscle contractions. As it has been postulated