Gestural Text Entry on Multiple Devices

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ABSTRACT

We present various adaptations of the EdgeWrite unistroke text entry method that work on multiple computer input devices: styluses, touchpads, displacement and isometric joysticks, four keys or buttons, and trackballs. We argue that consistent, flexible, multi-device input is important to both accessibility and to ubiquitous computing. For accessibility, multi-device input means users can switch among devices, distributing strain and fatigue among different muscle groups. For ubiquity, it means users can "learn once, write anywhere," even as new devices emerge. By considering the accessibility and ubiquity of input techniques, we can design for both motor-impaired users and "situationally impaired" able-bodied users who are on-the-go. We discuss the requirements for such input and the challenges of multi-device text entry, such as solving the segmentation problem. This paper accompanies a demonstration of EdgeWrite on multiple devices.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *input devices and strategies*.

General Terms

Experimentation, Human Factors.

Keywords

Text entry, text input, accessibility, ubiquitous computing, isometric joystick, trackball, PDA, unistroke, EdgeWrite.

1. INTRODUCTION

In our previous work [10], we showed that the stylus-based unistroke method EdgeWrite was significantly more accurate than Graffiti and about as fast for both able-bodied novices and for some users with motor impairments. EdgeWrite's main feature was its use of physical edges, which bound the input area and provided stabilizing barriers for the stylus. This work was an early step in making PDAs more accessible. Next, we adapted EdgeWrite to wheelchair joysticks and touchpads [8]. The alphabet used was the same as that for the stylus version, but the new devices posed their own challenges, such as segmenting between letters on the joystick, since that device lacks the notion of "lift."

In the current work, we extend EdgeWrite to devices that have further implications for accessibility and ubiquitous computing. Large-ball trackballs like the Kensington Expert® series are popular among many people with motor impairments, but text entry with trackballs has, until now, required on-screen keyboards and much mouse movement. In contrast, our trackball version of EdgeWrite allows for integrated mousing and gestural text entry on the same device. Meanwhile, isometric joysticks like the IBM TrackPoint® have been proposed as pointing devices for ubiquitous computing [7]. Now they can also be used to "write" using EdgeWrite gestures in an extremely compact form factor.

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2. MOTIVATION AND REQUIREMENTS

Multi-device input is important to accessibility because: (1) Users with motor impairments often experience rapid fatigue, and multi-device input means they can switch among devices to distribute strain across different muscles. (2) Some diseases are degenerative, and multi-device input means users can switch to new devices as their abilities change without having to learn new techniques. (3) High cost, device complexity, and the need for configuration and maintenance have been cited as barriers to access [2]. Designing for multi-device input enforces simplicity in aiming for effectiveness on readily available input devices, which are affordable and robust.

Similarly, multi-device input is important to ubiquitous computing because: (1) In the coming era, more devices will be imbued with computing power and will need text input. For example, watches were once purely mechanical devices but now can be touch-screen PDAs too small for stylus keyboards [1]. (2) New devices continually emerge, and today's user must often learn a new input technique for each new device [4]. A design for multi-device input means that users can "learn once, write anywhere."

Thus motivated, we now identify requirements for multi-device text entry in service of accessibility *and* ubiquity; that is, in service of both physical and "situational" impairments [6].

- *Technologically simple*—new devices have different capabilities, and multi-device designs must presume few. This is also likely to reduce complexity and maintenance.
- *Spatially compact*—compactness aids those with limited ranges of motion, and emerging devices are ever-smaller.
- *Physically stable*—stability is important for both tremulous users and on-the-go users experiencing vibration.
- *Highly tactile*—tactility is important for low-vision users and on-the-go users whose visual attention is divided.
- *Gestural*—selection-based methods (e.g. soft keyboards) require a display, which prevents eyes-free entry and further clutters already tiny screens. Also, tiny screens can be hard to read, especially for low-vision users. Although selection-based methods are often faster for novices, experts are usually faster using gestures [3].
- *Guessable*—gestures must be easy to guess; one way is to make them feel similar to writing Roman characters [9].

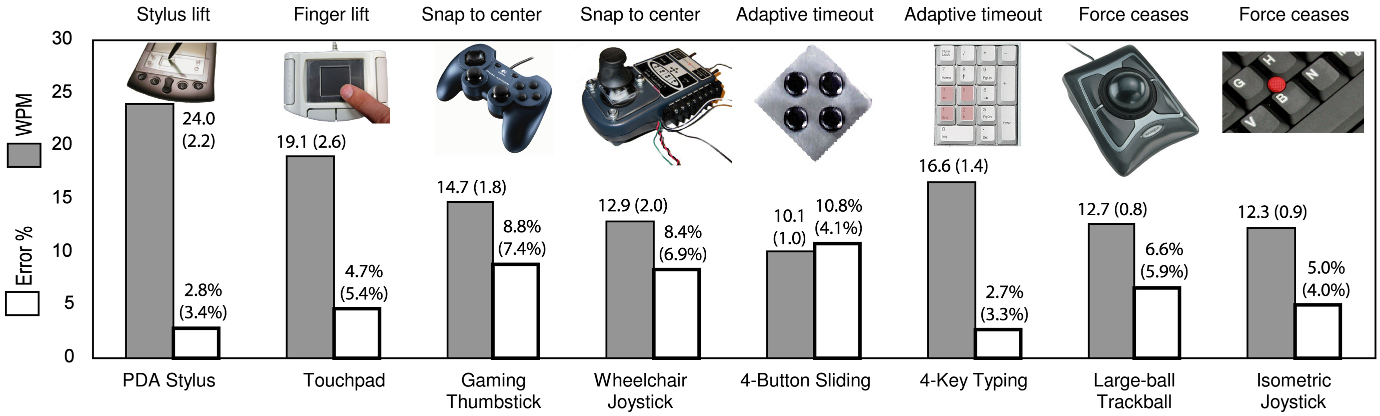

Figure 1. Speed (higher is better), error rates (lower is better), and segmentation schemes for EdgeWrite on multiple devices. Averages are from able-bodied experts: the first author and/or others from prior work. (Standard deviations are in parentheses.)

3. TEXT ENTRY ON MULTIPLE DEVICES

This paper accompanies a demonstration of EdgeWrite on multiple devices. Figure 1 shows the devices and their expert speeds and error rates for able-bodied users. The same EdgeWrite alphabet is used on all devices. The most up-to-date alphabet charts are available on-line at www.edgewrite.com.

PDA stylus, touchpad—These versions use "lift" to segment between letters [8,10]. Physical edges imposed by a plastic template aid movement and provide stability of motion.

Gaming thumbstick, wheelchair joystick—These versions segment when the joystick snaps-to-center [8]. They use a spring-loaded displacement joystick bound by a square. While snap-to-center segmentation has proven reliable, error rates seem higher due to the competing forces of the joystick.

Four buttons, four keys—Since EdgeWrite depends only on four corners for recognition [10], one can write by simply sliding one's thumb over four sensors (e.g. buttons) or by typing on four keys. While 3- and 5-key methods have been described elsewhere [5], they have until now required on-screen keyboards and have been selection-based. EdgeWrite segments with an adaptive timeout that is proportional to the pace at which the buttons/keys are hit.

Trackball, isometric joystick—These versions lack absolute position, so rather than use physical edges, they rely on the angle of motion formed by a "pulse" of force. Since pulsing at an angle is not a target acquisition task, *per se*, one can pulse arbitrarily far without having to be particularly accurate. Segmentation occurs with these devices when the user's force acting on them ceases.

4. CONCLUSIONS AND FUTURE WORK

We presented multi-device input for accessibility and ubiquity and have enumerated design requirements in service of both. We offered EdgeWrite as an example of a text entry design for multiple devices. Currently, we are focused on testing and refining EdgeWrite with motor-impaired users. In the future, we will create a mobile phone version that uses gestures over a touch-sensitive keypad, and a version for a wrist watch [1]. We will also improve speeds through word-level stroking, where entire words can be created in single fluid strokes.

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