Interaction Techniques for Motor-Disabled Users: Introduction to this Special Thematic Session

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Abstract. We summarize the "Interaction Techniques for Motor-Disabled Users" Special Thematic Session (STS) at ICCHP 2024. The session includes three papers which are also summarized. The papers in order present a mouth-controlled joystick, a method to predict the most-likely next words in a keyboard, and single-switch scanning techniques for target selection.

Keywords: Special thematic session · ICCHP · accessible computing · motor-disabled users · single-switch scanning · word prediction · mouth input · mouth-controlled joystick · Fitts' law · target selection · text entry

1 Introduction

The use of digital tools (PC, smartphone, tablet, etc.) is essential in today's world. We use them every day, whether in professional or personal surroundings. It is therefore important that these devices are accessible by everyone and on all platforms. Prior work has addressed the problem of accessibility of digital tools for motor-disabled users. However, despite progress, interaction performance (speed and accuracy) remains poor, and accessible interaction techniques often causes fatigue or increased cognitive load. Much remains to be done to improve accessibility for interaction techniques.

This Special Thematic Session (STS) solicited recent experiences and contributions on approaches, methods, models, techniques and empirical or experimental work for enhancing interaction accessibility for people with motor disabilities. Submissions were considered in all areas of research on interaction techniques for motor-disabled users, including (but not limited to) the following:

- Measures and models
- Entry devices and techniques
- HCI design, implementation and testing
- Evaluation of interaction techniques
- User experience

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2 Papers in This Session

This STS is relatively small with just three papers. These are now summarized.

2.1 Mouth-Operated Joystick

The first contribution is Veigl et al.'s "Development and Evaluation of a Low-Cost, High-Precision Sensor System for Mouth-Operated Joysticks" [5]. Their research examined the use of a joystick operated by the user's mouth. The goal was mouse emulation to enable people with limited mobility of the upper limbs to control computers and other digital products.

The target users are persons with restricted head movement or low muscle strength. In this context, highly sensitive sensor systems are required. Current devices are expensive or do not provide sufficient sensitivity. Their work exploited the phenomenon of piezoresistivity in SMD thick film resistors to create a low-cost force sensor module for mouth-operated joysticks.

A proof-of-concept implementation, which they call FlipMouse, is shown in Fig. 1.

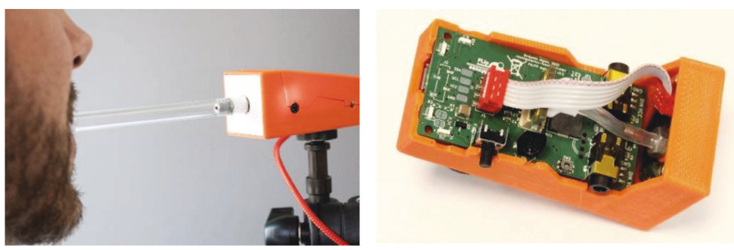

Fig. 1. FlipMouse: Veigl et al.'s proof-of-concept mouth-controlled joystick (left) with opened enclosure (right).

FlipMouse works with strain-gauge sensors or piezoresistive sensing elements. The mouth-operated joystick was tested in a validation study with five able-bodied participants and then in a user study with five participants from the target audience. In the latter case, the conditions were Multiple Sclerosis, Spinal Muscular Atrophy Type II, Muscular Dystrophy Type Becker, Multiple Sclerosis, and C5 Tetraplegia.

The evaluation used a 2D Fitts' law target selection task and two sensor variants, a strain-gauge sensor and a surface-mount SMD sensor.

In the validation study, they obtained throughput values in the range of 1.5 bps with the able-bodied participants. In the user study with persons with motor disabilities, the throughput values were lower. Due the variability in the participant pool, results in the user study are reported separately for each participant.

2.2 Predicting Most-Likely Words

The second contribution is Raynal's "WordGlass: Additional Keys to Present the Most Likely Words" [2]. Raynal reminds us that people with motor impairments have difficulty accessing text input devices. In response to this, some keyboards are enhanced with linguistic prediction modules attempting to make text input faster.

The paper introduces WordGlass, a system of additional keys that are dynamically added as the user types. WordGlass uses the same principle as an earlier technique, KeyGlass [1], where characters are suggested on additional keys. These keys appear around the last character entered and suggest the four most likely characters. The keys are arranged so as not to obscure the other keys on the keyboard. WordGlass adopts the principle of placing additional keys with the most likely words close to the last character typed. The keys have been spaced out on the keyboard so that one key can be displayed above and another below the last key pressed, without obscuring the keys already present (Fig. 2).

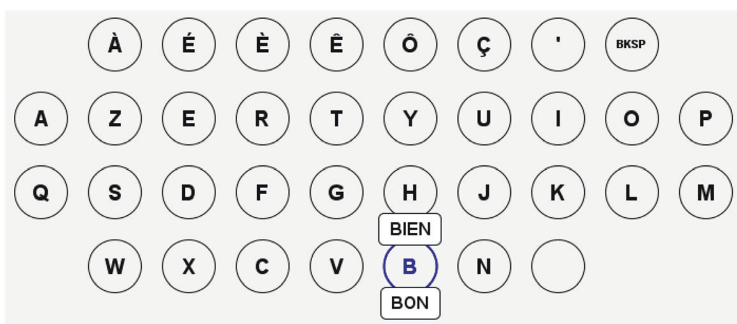

Fig. 2. WordGlass: Additional keys available after entering the 'B'

On average, participants covered 48% less distance with WordGlass than with a prediction list positioned on the right-hand side of the keyboard. Thanks to this reduction in distance travelled, the participants were 5% faster with WordGlass than with the list.

2.3 Single-Switch Scanning for Target Selection

The third contribution is Raynal and MacKenzie's "Automatic Bars with Single-Switch Scanning for Target Selection" [4]. This work extends the TBS^3 input method from ICCHP '22 [3].

They present and evaluate two point-select methods using automatic bars or regions and single-switch scanning. The first method, iButton (see Fig. 3), uses horizontal and vertical bars that move in sequence following switch selections with a final selection at the point of intersection. An additional feature over the method described at ICCHP '22 is the scanning of three buttons (instead of two) to set the direction the bars move: left/up, right/down, or none. The "none" button makes it possible not to move a bar when the movement doesn't require it, and therefore avoids the user having to press the single input switch quickly to stop the bar.

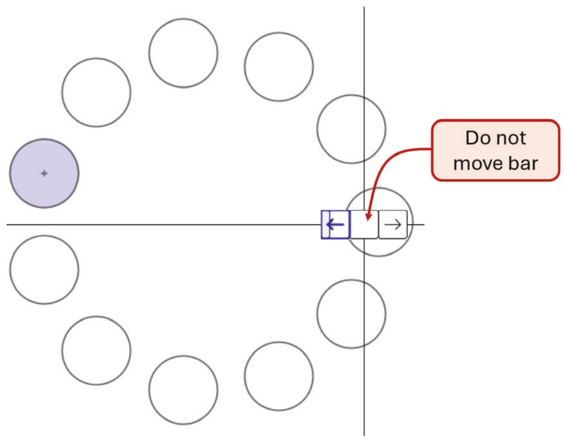

Fig. 3. iButton method. Adds a third button to not to move the bar if it is already positioned at the desired location.

The second method, CSSS for circular single-switch scanning (see Fig. 4), performs target selection in a three-step process with a switch selection terminating each step. The steps are (i) rotating a $\frac{\pi}{8}$ radian arc region, (ii) moving a line within the arc region, and (iii) advancing a pointer along the line to the desired target.

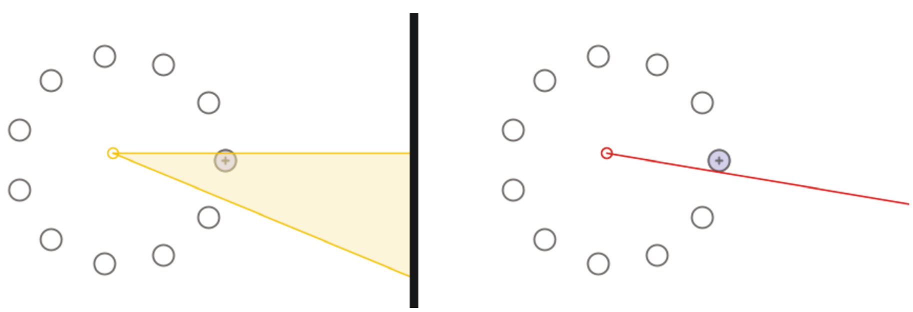

Fig. 4. CSSS method. At the left, the arc region of $\frac{\pi}{8}$ radians; at the right, a red line appears and moves within the arc when is stopped. (Color figure online)

In a Fitts' law user study with 10 participants, both methods exhibited similar throughput, about 0.35 bps. The iButton method was about 11% faster with selections taking on average 7.80 s compared to 8.74 s with CSSS. However, the CSSS method was about 35% more accurate with a 4.24% error rate compared to a 6.56% error rate with iButton. Eight of ten participants preferred the CSSS method. All participants reported that they felt faster with the CSSS method, even though the iButton method was objectively faster.

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