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Using OnScreenDualScribe to Support Text Entry and Targeting among Individuals with Physical Disabilities

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ABSTRACT
This paper describes a study examining the usability of OnScreenDualScribe (OSDS), a tool to support individuals with physical disabilities with text entry and cursor movement. A portable numeric keypad is used to interact with the OSDS, which can either be held by the user, or can be affixed to a surface for interaction. A study to determine the feasibility of the system was conducted with three individuals with physical disabilities. While it was noted that the time taken was higher to complete a task compared to their existing methods of computer-based input, findings also indicate that the system offers potential for tasks involving a combination of text entry and cursor movement (e.g., completing online forms). Furthermore, as the keypad is smaller in size compared with a traditional keyboard, participants suggested that it offered potential to reduce effort spent in the fatiguing process of traversal.

Categories and Subject Descriptors
H.5.m. Miscellaneous

General Terms
Performance, Design, Human Factors

Keywords
Assistive Technology, Cerebral Palsy, Input Devices, Muscular Dystrophy

1. INTRODUCTION
Estimates suggest that in the US, up to 35.2 million adults with physical disabilities face limitations in their daily life activities [5]. For individuals with limited movement (e.g., Cerebral Palsy or Muscular Dystrophy), interacting with a traditional keyboard or mouse can be challenging. The lack of usability, or the complete absence of locus of control of one's ability to perform tasks using a computer can lead to stress, frustration, and anger [6]. By providing individuals with physical disabilities with practical and reliable tools to use standard personal computers (PCs) in order to access information and services, quality of life can be improved.

This paper examines the OnScreenDualScribe (OSDS) system designed to replace conventional input devices, such as the keyboard and mouse, with a small numerical keypad that offers the same functionality [2]. The OSDS system uses an inexpensive numeric keypad and accompanying software to provide users with a compact space to perform both text input, as well as all operations that can be performed using a mouse. The compact nature of the device offers potential benefits for users of limited mobility as they would be able to perform all standard interface operations without having to traverse the normal distances which traditional keyboard users would ordinarily perform. The keypad can be held in both hands for stability, or can be affixed to a surface (e.g. lap tray, wheelchair arm). User tests were conducted to examine the challenges faced by individuals with physical disabilities when performing input based tasks and determine the efficacy and merits of the OSDS tool.

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2. RELATED WORK
A range of assistive technologies have been developed to support individuals with physical disabilities. Individuals with limited hand movement can benefit from using speech-based input solutions (e.g., Dragon Dictate). For those unable to rely on speech, other novel approaches have been proposed enabling users to utilize the functionality available to them. Examples include eye-gaze tracking [1], tongue-based interaction [4] and head-based control of the mouse [3,7]. While these solutions offer considerable promise, they are often expensive to purchase, time-consuming to set-up, and may not be targeted to the user's specific needs.

3. OSDS SYSTEM DESCRIPTION
The OSDS (Figure 1) has been designed to provide an alternative to traditional modalities so that a user with a limited level of mobility can have a more positive user experience when entering text, while also supporting cursor movement.

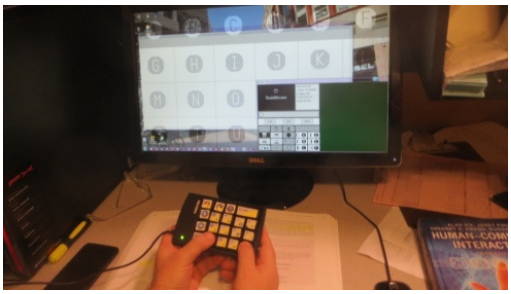

Figure 1: OSDS keypad and "DualMouse mode" screen

The numeric keypad used in conjunction with OSDS has the advantage of being both inexpensive and convenient to handle. Software intercepts keystrokes and sends input events to the active window enabling the user to enter data into a document or web-based form. OSDS operates in nine modes, each dedicated to a different task [2]. In this study, we focused on using two of the most commonly used modes, (1) basic text entry mode, and (2)

mouse mode, as these would be most commonly used by target users when interacting with computing technologies.

4. PARTICIPANTS

Three individuals (two female) with physical disabilities (identified here with aliases) participated in the study.

Participant #1: Kyle is a 23 year old male who has had spastic cerebral palsy since birth. He stated that he lacks fine motor skills, does not have very good hand-eye coordination, and has limited use of all 10 fingers. He tends to type using only a few fingers at a time. When interacting with his tablet device for about an hour, spasms occur. He also feels stiffness in his fingers. This can be a frustrating experience if he is required to complete a work deliverable within a short time period, as a period of rest is needed.

Participant #2: Rachael is a 39 year old female with carpal tunnel syndrome and muscular skeletal issues. She has limited wrist movement and experiences intense cramping. Repetitive motion leads to forearm pain and requires frequent breaks when using a computer for either typing or pointing operations. After about 2 to 3 hours of continuous use, she states that the pain is so bad that it makes her "want to stop using the computer".

Participant #3: Magda is a 31 year old female with Spinal Muscular Atrophy. She requires assistance for all activities of daily living. Her movement is limited, and she is only able to interact with a few fingers in one hand. She prefers a trackball for pointing as it affords more control compared with a mouse, and she requires assistance from her caregiver on placing her hand on the device and for repositioning when her hand slips. After about 1-2 hours using a virtual keyboard, she fatigues, and often feels "stiffness in her fingers". This requires asking her caregiver to submerge her hand in warm water for relief of the symptoms.

5. METHODOLOGY

Participants were presented with four tasks which were known to be challenging among some individuals with physical disabilities, due to the fine motor skills needed. These were: (1) Type a phrase with all 26 Roman characters; (2) Perform a web search for a term and select a result; (3) Fill out a web-based form; and (4) Navigate a menu with a deep hierarchy and sub-menus. All tasks were selected, as they were thought to be commonly conducted tasks which their peers without disabilities took for granted.

After the initial interview, the participants were asked to perform the tasks listed above using their own current assistive technologies, to establish a baseline. The participants were then given a five minute overview on how to use the OSDS system. The same four tasks were then repeated using OSDS. Each task was timed and the number of errors that occurred was recorded.

6. RESULTS AND DISCUSSION

Only two participants were able to complete the trials. Although P3 thought that it would be easier for her to interact with a physical keypad compared with a traditional keyboard, she was unable to exert pressure on the keypad buttons. P1 and P2 spent on average four minutes longer using OSDS to perform interaction tasks, compared with their existing methods of input and cursor movement. The results were in part attributed to the short period of training time, combined with the positioning of the device. Both participants favored laying the device flat on a table, rather than holding it in both hands for added stability. While participants highlighted that the time taken to interact with the device was slower than expected, they valued the ability to control the cursor and input using a smaller, portable device which could easily be used with either one or two hands. It would also help them perform tasks which could be more complex to undertake (i.e. moving through hierarchical menus without worries about slipping off and having to restart the task). Participants suggested that additional rehearsal time with the system would lead to less time being spent conducting tasks. It would also help to increase levels of confidence when using the system independently. It was suggested that the system would be beneficial for tiring tasks involving a combination of cursor movement and text entry (i.e. filling out long online forms).

Suggestions were made to improve the surface layer of the graphical interface by providing more informative icons, enabling users to target buttons more quickly (i.e. adding an indicator for the TAB key or having clear numeric characters to indicate the keys for character row selection). Providing additional auditory cues could help provide informative feedback to the user about system state, and whether data was ready to be entered.

7. CONCLUSIONS AND FUTURE WORK

This paper has described an approach to meet the needs of individuals with physical disabilities with text entry and cursor movement. An exploratory study has been undertaken to evaluate the feasibility of the solution. Based on the feedback of the study, we aim to refine the application to expedite the time taken to input data. The design of the interface would be simplified, to enable users to locate commands more easily, and more detailed on-screen help would be provided to support users during the learning process. A longitudinal study would then be undertaken with a larger sample of representative participants to determine whether the refined solution can help users in their day-to-day computing tasks.

8. ACKNOWLEDGEMENTS

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