Hardware Single-Switch Keyboard and Mouse Replacement for Computer Control

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***Abstract*— A practical, low-cost device is constructed to emulate a computer keyboard and mouse through a single-switch input. Most of the current single-switch computer interface designs focus on simplified hardware implementations with a major portion handled on the destination computer in software. Our device called the PowerKeyboard provides an operating system independent, hardware, single-switch interface for persons of limited mobility or a form of paralysis. A combination of scanning and scrolling techniques provide the available keystroke and mouse control commands on an Liquid Crystal Display (LCD). The triggering of a switch transmits the selected action or executes a stored configuration command of the PowerKeyboard, such as scrolling rate. In this paper, we present the design of the PowerKeyboard and compare it to existing designs.**

I. Introduction

Computers are a of technology of many uses and, in society today, they are required for certain tasks. For the physically impaired, computers can provide a means of communication, education, entertainment, and most importantly, more independence. This document outlines a device that allows persons with restricted movement, which can operate a single switch, an interface to access a PC. With a scrolling, menu-driven display, users can emulate keyboard and mouse functionality. Our device called the PowerKeyboard replaces and connects in the place of a keyboard and mouse. A single switch computer interface is not a novel idea, but our solution is hardware based without software requirements, such as operating system.

Currently, solutions exist for a single-switch computer interface. Products such as [1] provide a simple single switch that connects to a computer and relies completely on the software to provide the interface and options. Due to the large amount of viewing area on a computer monitor, WiViK on-screen keyboard displays all operations on the screen at once and scans through them one at a time. Numerous products are modelled around this software approach with scanning and similar visual layouts and features.

The PowerKeyboard provides another alternative by taking low level control of the computer through hardware replacements of the keyboard and mouse, and providing a separate display mechanism for feedback. In this paper, a discussion of the hardware and software implementation is given.

II. Methods

The construction of the PowerKeyboard is based upon two main components: hardware and microcontroller software implementation. In the following sections, these two topics are discussed.

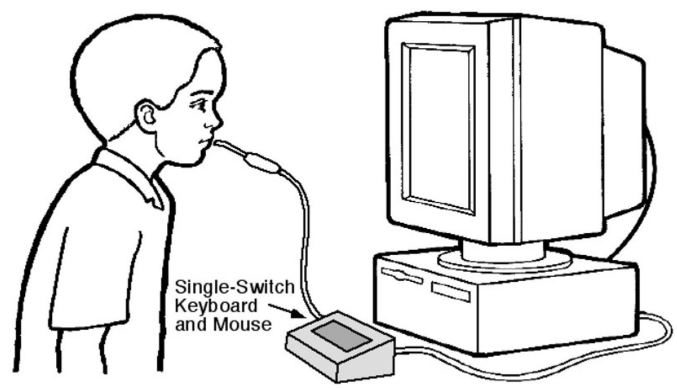

Fig. 1. The PowerKeyboard provides a connection between a computer and an individual as depicted above.

A. Hardware Implementation

The PowerKeyboard is a simplistic hardware design with easy adaptation to particular needs. The most significant and costly parts contained in the circuit are the serial LCD module and the PIC microcontroller (Microchip Technology Inc., Chandler, AZ), as can be seen in figure 2. The 18F452 PIC microcontroller with In-Circuit-Serial-Programming (ICSP) is chosen to provide an easy mechanism for updating the device's firmware and ample resources for this application. In addition, a 2x16 character serial LCD display visually relays the commands available. Due to the large number of commands available, multiple lines are needed and scrolling is performed to cycle through them. Since each individual may have different physical limitations, an 1/8" phono jack allows any normally open single switch to be attached whether it be a tounge, hand, finger, or electrocular switch to name a few.

B. Microcontroller Software Implementation

Most important to the design of the PowerKeyboard is the microcontroller firmware. As is seen in figure 1, the microcontroller manages the input through the single switch, the visual feedback through the LCD, and the keyboard and mouse emulation. The numerous tasks performed require time sharing but normally does not arise as an issue in this case since all tasks require little processing time with a slow arrival rate of events. The events are handled through a polling mechanism with a polling interval of 5ms. The following events are managed: scrolling and scanning on the LCD,

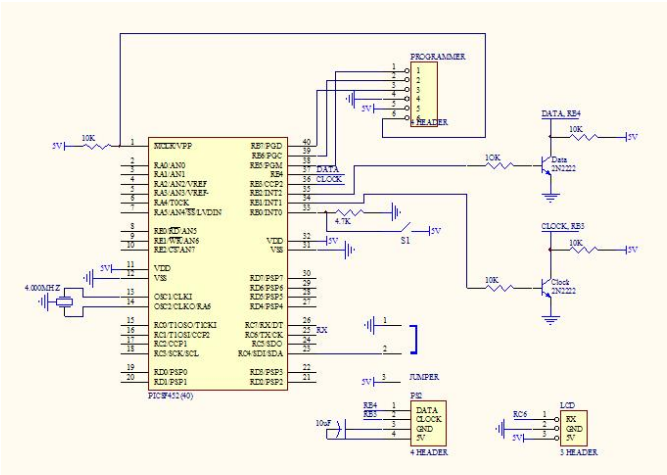

Fig. 2. PowerKeyboard schematic diagram

checking for keyboard or mouse commands from the host computer, and monitoring the activation of the single switch.

The LCD displays two lines of text where each line contains multiple commands and handles two mutually exclusive events: scanning and scrolling. The current design has 16 lines and successively scrolls through them by showing two sequential lines at one time on the LCD. Each successive scrolling event triggers the second display line to replace the first and the next line is appended in the bottom position. Upon the activation of the single switch, the scanning of the top line begins. A cursor flashes over the leftmost character and moves right at a specified scanning frequency. After another activation of the switch, the command under the blinking cursor is executed. Once execution completes, scanning from the same character continues. To exit scanning, the last command on each line is reserved and is denoted by a blank space.

Keyboard and mouse emulation is performed through communication over the standard PS2 ports found on a personal computer (PC). The PS2 interface is a bidirectional interface with a data and clock line for communication. The host computer will asynchronously send commands for device control. Even though the bus is bidirectional, the clock to transmit data is handled by the client adapter: the keyboard or mouse. When the host wants to transmit to the client, the host places a request by pulling the data line low. If the data line is not acknowledged within a duration of time, which seems to vary by computer, the client may be deemed non-existant being later ignored. These requests are considered events and vary from reading, writing, or reseting settings to restarting the device.

Lastly, the single switch activation is an event. Upon the triggering of the switch, which is realized by the polling of this input, the associated operation is executed for the current mode. If the PowerKeyboard is currently scrolling, the switch activation causes the scanning process to begin. Also, if the PowerKeyboard is currently scanning, the command at the position of the blinking cursor is executed and scanning continues. Since the type of switch used can vary and thus it's characteristics, an assumption is made that the mechanical switch bouncing can be ignored since the duration of handling the event is longer than the length of the bounce. If this assumption is not held, a debounce circuit could be added to eliminate this problem.

III. Results and Discussion

The computer interface provided by PowerKeyboard is a hardware replacement of a keyboard and mouse. With increased monitor viewing area and the ability to place the device where-ever is most convenient, this device imposes less upon the visual aspect of the computing experience. Among these benefits of taking a hardware replacement approach, this design allows for an ease of integration in a multi-user environment - just plug it in. Full screen applications will not cause issues as can be the case with software solutions. Future work is being performed to explore the benefits of audio feedback through a Text-To-Speech (TTS) synthesizer to minimize the visual attention needed for use of the PowerKeyboard. By auditorily relaying the available commands, the user can focus their attention on the computer. Also, a very active area of research lies in increasing the rate of communication. Compared to normal auditory communication, these AAC devices are a very slow means of communication. One common solution to speed up communication slightly is to integrate a dictionary of words which are used for automatic word completion. Using frequency of word usage data as collected by [3], automatic word completion can require less switch activations and inherently decrease time to communicate a message.

Acknowledgment

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References

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