A Foot-Operated Computer Keypad

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Abstract - This paper presents the development of a foot-operated computer keypad that can be mounted on the foot rest of a wheel chair. The keypad aims to serve as an alternate computer input device for disabled individuals who can only enter data with one foot.

I. INTRODUCTION

Access to computers by people with disability is primarily an issue of input technology. The use of a standard keyboard for computer data input can only be accomplished by an individual who is dexterous in typing. Often, a customer-designed input device is the only solution for a disabled individual to be able to get access to a computer. Examples are foot-operated computer keypads [1], voice-activated input devices, head-mounted pointing devices, etc. [2].

A foot-operated computer keypad that can be mounted on the foot rest of a wheel chair is currently being developed at Louisiana Tech University's Center for Rehabilitation Science and Biomedical Engineering. The keypad aims to serve as an alternate computer input device for disabled individuals who can only enter data with one foot; for example, amputees and those who suffer with cerebral palsy. The construction of the first prototype of this computer keypad has been completed. The basic structure of this keypad and its design principles are presented in the following sections.

II. KEYPAD DESIGN

A. Mechanical Structure Design

The body of the keypad is composed of three parts: the surface plate, the base plate and the side. The surface plate and the base plate are made of aluminum. The aluminum is selected due to its strength and light weight. The side of the keypad is made of polycarbonate which also has great strength. The keys are mounted on the upper plate of the keyboard in three arc rows as shown in Figure 1. This semi-circle structure design reduces the travel time required to move from one key to another.

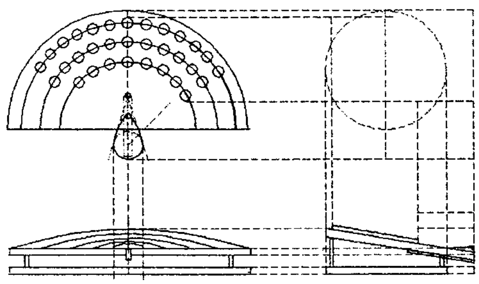

Fig. 1. Keypad Structure

Momentary switches of 1.5 cm in diameter are chosen as the input switches due to the large contact area they provide [3]. These switches are fixed on the upper plate of the keypad by washers and screws, as illustrated in Figure 2.

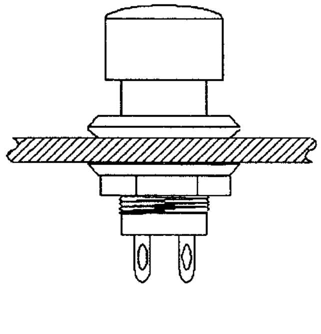

Fig. 2. Key Switch Assembly

B. Circuits

There are two small circuit boards inside the keypad: the Keytronic microprocessor-based circuit (KMBC) and the key interfacing circuit. The key switches are connected to the key interfacing circuit through a cable. The key interfacing circuit is further connected to the KMBC as shown in Figure 3. The keypad plugs directly into a commercial keyboard interface circuit and requires no extra power supply.

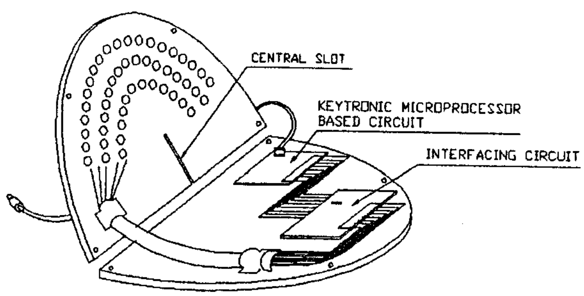

Fig. 3. Keypad Circuit Boards

The interfacing circuit has three functions. First, it enables multiple characters input by the combination use of the function key and the toggle shift key. Second, it allows only one activation per key press through a special deactivation circuit. This eliminates the endlessly letter repeats even when the key is pressed for a long time. In addition, it interfaces the key switch matrix with the KMBC.

The KMBC scans the signal status changes in the transistors of the interfacing circuit and converts them into characters or symbols that can be viewed on the screen of the computer. When a key is pressed, a 5 volt direct current is activated on the capacitor and gives a pulse to the transistor to change its input status. The transistor is working on the saturated switching mode which is usually used as a replacement of a mechanical switch or relay. The microprocessor detects the key pressing by monitoring the output status change of the transistor and translates it into corresponding key data. The data of the same key press can be changed through multiplexers which are controlled by the function key as shown in Figure 4.

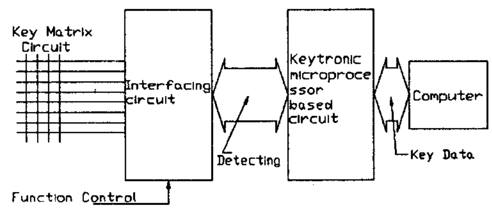

Fig. 4. Keypad Circuit Design

C. *Key Switches Arrangement*

The key switches are arranged in three arc rows with an overall span of 90 degrees - 40 degrees to the left and 50 degrees to the right measured from the center line (see Figure 5). This would allow a right-footer to type more effectively with one heel resting on a fixed point. (The situation would be reversed for a left-footer.) In addition, the user can easily reach the switches that are mounted in different rows by short distance heel movements.

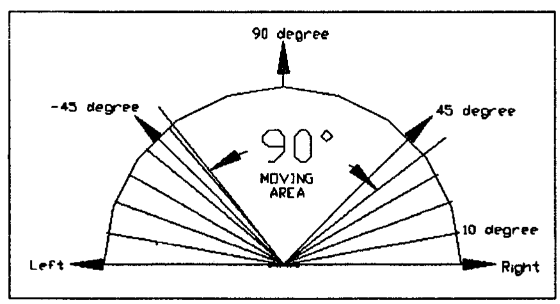

Fig. 5. Key Switches Range

The letters assigned to the key switches are based on their frequencies of use. Table 1 shows the study results based on a sample of 8000 excerpts of 500 letters that contain 5 million alphabets [4].

According to Table 1, letter "E" has the highest frequency of use while letter "Z" has the lowest frequency. The frequency sequence of the letters, when arranged in the descending order, appears to be: E-T-A-O-I-N-S-R-H-L-D-C-U-M-F-P-G-W-Y-B-V-K-X-J-Q-Z.

Tab. 1. Individual Letter Frequency

a	Freq (a)	P(a)	a	Freq (a)	P(a)
A	321712	.0804	N	283561	.0709
B	61472	.0154	O	303844	.0760
C	122403	.0306	P	79845	.0200
D	159726	.0399	Q	4226	.0011
E	500334	.1251	R	244867	.0612
F	92100	.0230	S	261470	.0654
G	78434	.0196	T	370072	.0925
H	219481	.0549	U	108516	.0271
I	290559	.0726	V	39504	.0099
J	6424	.0016	W	76673	.0192
K	26972	.0067	X	7779	.0019
L	165559	.0414	Y	69334	.0173
M	101339	.0253	Z	3794	.0009

P(a) = Freq(a) / 4,000,000

Therefore, the key switches are arranged in a way that most frequently-used alphabetical keys are mounted on the central area of the keypad. Upper case and lower case letter inputs are controlled by a toggle shift switch.

In addition, each key switch is assigned with a special symbol or character, such as @, #, etc. The change from a alphabetical character input to a special symbol or character input is controlled by a toggle function key switch.

III. TEST RESULTS

The keypad was plugged into several different personal computers for typing tests for two months. Initially, some input errors were found due to defective switches and bad connections. However, no input error has been found after these problems were corrected.

IV. RECOMMENDATIONS

A workable and portable foot-operated keypad has been developed. The tests results show that the keypad is feasible to serve as an alternate input device for disabled individuals who can only enter data with one foot. Further improvements of the keypad may be made by adding a track ball to the keypad. In addition, studies on the learning rate and error rate of use of the keypad should be conducted.

ACKNOWLEDGEMENT

The authors of this paper would like to thank Louisiana Tech University's Center for Rehabilitation Science and Biomedical Engineering for supporting this research activity.

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