Soft Keyboard for the disabled

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Abstract. This paper discusses an investigation carried out in designing and evaluating a neurorehabiliatory communication interfaces for nonverbal Quadriplegic and other clinically brain injured persons. Research was conducted where brain-injured persons communicated using a brain-body interface and a computer program with simple text such as Yes, No, Thanks etc. This research was further developed into a soft keyboard, which gave a brain-injured person an interface to create simple sentences. The users used the soft keyboard with a brain body interface. This paper reports on the soft keyboard developed and the experimental results of this research.

1 Introduction

This study collected the information from neurologically disabled persons by conducting simple non-invasive communication tasks and created interfaces for communicating with the outside world for the very first time, after a brain injury. Soft keyboards have been designed and implemented for disabled users in the past but this study covers the new area of soft keyboards for the brain-injured. This group of nonverbal, quadriplegic users will manipulate the keys using a brain body interface. As medical technology not only extends our natural life span but also leads to increased survival from illness and accidents, the number of people with disabilities is constantly increasing. World estimates show that there are more than 500 million people who are disabled as a consequence of mental, physical or sensory impairment. This makes people with disabilities one of the world's largest minorities [1]. Approximately 5.3 million people, currently live with disabilities resulting from brain injury [12]. It is estimated that there are 2.2 annual hospital admissions for traumatic brain injury for every 1000 people of the population in the Western World [12]. A certain percentage of these brain-injured people cannot communicate, recreate, or control their environment due to severe motor impairment. At the 52nd meeting of the Third Committee, on 29 November 2001, the representative of Mexico introduced a draft resolution on an international convention on the rights of persons with disabilities and was adopted on 19 Dec. 2001.

2 Assistive Technology

Assistive technologies fall into various categories [11]. The research reported here only concentrated on communications for the brain injured, hence dealt with the electric signals emanating from brain waves, muscle contraction, eye movement or some combination thereof [9]. Having considered various assistive devices, we chose the Cyberlink™ as the ideal device for the brain injured non-verbal participants [2][3][4][5][7]. Cyberlink™ consists of three electrodes (non invasive) in a headband wired to an instrument that magnifies brain waves 500,000 times. Through biofeedback techniques and slight facial movements, patients can use the Cyberlink™ to communicate via a computer interface. The signals for communications are obtained by attaching a probe on the forehead of the patients. Basically it is 3 silver/silver chloride contact electrodes (non-invasive), which are placed on a headband and pick up EEG (brain waves), EMG (Facial Muscles) and EOG (eye movements) signals. These are then fed into an amplifier and then to the mouse port, so the computer just sees the device as a mouse, which controls the cursor [5][9].

3 Past Research

Past research involved using the Cyberlink™ with appropriate communicating interfaces. The design process went through various stages of development. It started with a simple interface written in Visual Basic, which gave the opportunity for this group of disabled people to say yes or no for simple questions [7][8]. This research proved beyond any doubt, that every disabled person regardless of having a particular type of disability was still an individual with his or her own characteristics. Hence each one needed an individual profile not a group profile. The next design problem encountered was the unintentional movements of the cursor when a brain-body interface is used. This identified a need for better control over the cursor. This was done by splitting the computer screen into tiles and configuring the time spent on each tile, size of tile, gap between tiles, time to reach a target etc to suit each individual user. Now this research has been taken a step further by changing the targets into a soft keyboard that uses cursor control and audio feedback to help participants make simple sentences.

4 The Soft Keyboard

A soft keyboard (Fig.1) is made up of alphanumeric keys (shown in blue), control keys (shown in green) and configuration keys (shown in grey). This is an on-screen keyboard that can be configured to suit and individual user. The keyboard can be used in two modes: normal and scan mode. In normal mode, the user moves the cursor to a key and keeps the cursor on a key for a pre-defined time. This will display the alphanumeric character, read the key in an audible voice and jump to the middle of the Starting Area. This will be repeated for each character. This is to cater for brain-injured users who can move the cursor but cannot perform a click. In the scan mode the keys will be scanned row by row and the user need to perform a click and choose
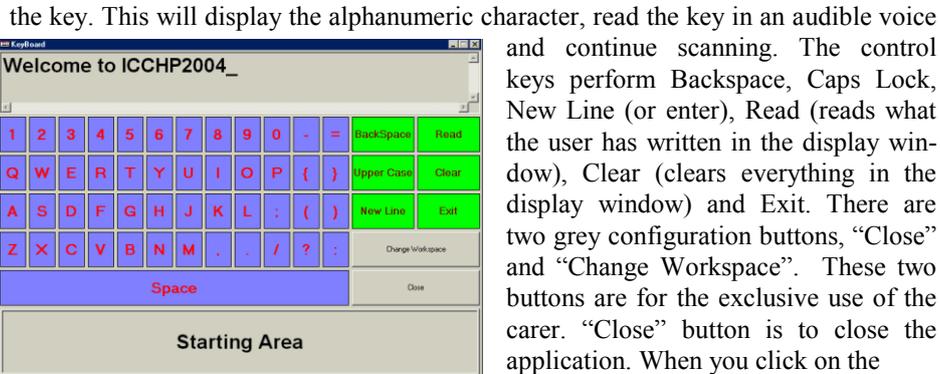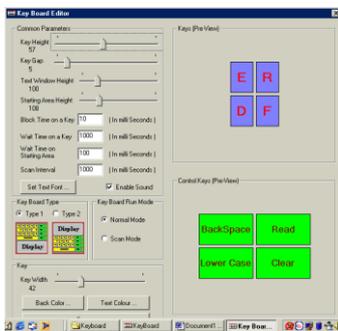
the key. This will display the alphanumeric character, read the key in an audible voice and continue scanning. The control keys perform Backspace, Caps Lock, New Line (or enter), Read (reads what the user has written in the display window), Clear (clears everything in the display window) and Exit. There are two grey configuration buttons, "Close" and "Change Workspace". These two buttons are for the exclusive use of the carer. "Close" button is to close the application. When you click on the "Change Workspace" button, it will open into window shown in Fig.2. This window enables the carer to change the following parameters of the keyboard:

Fig.1

Fig. 2

- Key Height/Key Gap
- Keyboard Layout
- Text Window Height
- Stating Area Window Height
- Wait time on a Key
- Wait time on the starting area
- Font
- Enable/Disable Sound

5 Experimental Results

The ethics boards at each institution approved this research, using Cyberlink™ as an assistive technology. It should be noted that the investigator obtained all permissions and informed consents from the institutions, participants and/or their guardians before research began. When it came to this research, there was no previous methodology so a new methodology was developed. The approach used was one of developing a prototype interface using non-disabled people as test subjects, then evaluating the interface with brain-injured participants. This allowed better feedback at the development stage and faster development. Many versions of the programme were developed to get the appropriate individual interface. The keyboard was tested with ten able participants for refining the prototype. Having designed the prototype, the keyboard was tested with five brain-injured participants. Two of the disabled participants (39yrs, 60yrs male), were able to make simple sentences e.g. "I am hot", "I am tired", "I can understand", "thank you" etc. There were carers who believed these two patients did have the capacity to understand but until this study there was no evidence to prove this. The next two participants (32 yrs, 43yrs, male) gave inconsistent results and one disabled participant (61yrs, female) was unable to use it at all.

6 Conclusions

This keyboard was evaluated with Cyberlink™ but can be used with any mouse or switch; hence the researcher hopes other users with motor sensory deficiencies will consider it [6]. The most powerful feature of this keyboard was the "Change Workspace" which offered configuration facilities for this keyboard to set individual preferences according to the level of disability.

Acknowledgements

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