The Accessible Interface Project

ABSTRACT

The goal of the Accessible Interface (AIF) project is to develop a computing environment that is useful for those with cerebral palsy and focuses on ease of input, minimal user fatigue, and streamlined task accomplishment. The keyboard and mouse were replaced with a two-button interface designed to work within the AIF software environment. In its current state the software includes two modules: notes and trivia. Both modules use a contextual rotating menu designed to utilize the two-button interface. Users make selections by scrolling through the options using one button and selecting an option using the other. Future improvements include further contextual recommendation algorithms for word recommendation and an intuitive interface redesign. Although user testing is critical to produce an effective product, this project is still in pre-beta and has not yet been tested with potential users.

Author Keywords

Accessibility, usability, software, hardware, interface

ACM Classification Keywords

H.5.2 Information and Interfaces and Presentation (e.g., HCI), User Interfaces.

INTRODUCTION

There are not many computing solutions available for people with cerebral palsy. A Google search for "Cerebral Palsy, Software" returns a vast number informative online communities dedicated to providing cerebral palsy education and resources but unfortunately does not return much information about actual software.

Our proposed solution is the Accessible Interface Project (AIF). AIF is the result of an upper level computer science course taught at the University of Michigan that challenged students to create a usable computing environment for children with cerebral palsy. The goal was to provide some basic functionality of common computer applications via an efficient and convenient medium to users with motor impairments.

WHAT IS CEREBRAL PALSY?

Cerebral Palsy, which is often simply referred to as "CP", is a broad term used to encompass a group of chronic disorders that impair motor capabilities. While there is no one direct cause of CP but it is sometimes associated with lack of oxygen to the brain during birth (Hypoxia), traumatic births, brain infections such as bacterial meningitis or viral encephalitis, head injury in early development, or shaken baby syndrome [1].

Symptoms

Involuntary muscle movements are the result of many CP symptoms, the effects of which can manifest in many different ways: Seizures, muscles contractions, motor-mental retardation, speech problems, visual problems, spasticity, etc… Someone with CP may have difficulty controlling the movements and accuracy of their limbs and facial muscles. Varying degrees of mental retardation are often in combination with the symptoms aforementioned [2].

CONSIDERATIONS

Given the degree of difficulty for those with CP to accurately control the movements of their limbs, an alternate input device that would not require precise movements would be more appropriate than a standard keyboard. As C.E. Shannon demonstrated in his 1948 article entitled "A Mathematical Theory of Communication" as complexity is added to a system entropy increases [3], so in this case we could greatly reduce the possibility of error due to motor inaccuracy by limiting the types of inputs. Though a high degree of input combination complexity, such as that provided by the keyboard and mouse, elicits a rich computing experience, these input devices require a high degree of motor dexterity, something most CP users do not possess. The issue of how to provide the maximum amount of functionality using the fewest and simplest inputs is central to the AIF project.

Ease of use has been another central consideration during the development of the AIF project. Hyperkenesis[1] necessitates that CP users exert a great deal more energy to accomplish any controlled movement when compared to those without motor impairment issues. The degree of user fatigue is proportional to the number of precision movements needed to accomplish a task. The necessity of precision movements would therefore need to be minimized in order to maximize ease of use

Varying degrees of mental and behavioral abilities accompany those with CP. Attention Deficit Disorder (ADD) and Attention Deficit Hyperactivity Disorder (ADHD) are two somewhat common behavioral disorders associated with CP [4]. A simplistic, relevant and focused interface would be the most effective means of addressing these behavioral disorders. To minimize distracting

Fig

[1] The hyper stimulation of muscles in the body that cause varying degrees of involuntary movement.

elements a few guidelines should be followed: only information relevant to the current task should be displayed; available options should draw the most attention; and when a selection is made it should be apparent what that action accomplished. Additionally, a method of directing the user's attention to an "action required" or "action taken place" area of the screen should be implemented to make the next step in the process of accomplishing a task apparent.

Visual impairment is also fairly common among people with CP [4]. Strabismus, or "Lazy Eye", which causes one's vision to be blurred or otherwise impaired, often occurs due to muscular control deficiencies. Here again a simple interface coupled with easy-to-decipher visual elements will increase accessibility.

CURRENT IMPLEMENTATIONS

The current version of the AIF project is comprised of two major parts: the hardware and software.

The Hardware

Precision movements are not among the affordances for CP users. The degree of accuracy required to press a single key among many other tightly packed keys is more than most CP users possess. With this in mind the small and numerous buttons of the keyboard have been replaced with two large Bluetooth-enabled buttons. Since the distance the receiver is the only notable spatial limitation of Bluetooth devices, these buttons can be placed wherever it is most comfortable and convenient for the user.

The two Bluetooth buttons are a tremendous asset to this project. Although user testing has not yet been performed, this minimalistic approach will likely decrease the probability of input error when compared to standard 104 key keyboards. Since the AIF project only uses two buttons the probability of performing an intended action is 50%, which is approximately 49.994% higher than with standard keyboards. When considering Fitts's Law, which states that time required to rapidly move to a target area is a function of the distance to the target and its size, the comparison to 104 key keyboards also reveals that the time it will take a user to press a buttons will be reduced. Further, user fatigue due to performing precise movements will also decrease since extremely precise movements are not required to input information into the system.

Each of the two Bluetooth buttons has a unique input: one functions as 'TAB' and the other as 'ENTER.' Although the types of inputs are thus severely limited by this uncomplicated approach, the combination of this hardware configuration and software provide a usable navigation and selection entry system.

Figure 1. The rotating, mono-direction carousel.

The Software

Comprised of a series of modules, the software allows for some basic computing functionality. The modules include 'Notes' and 'Trivia', both of which are accessible via a three-dimensional carousel menu at the bottom of the screen (see Figure 1). The carousel presents a set of options through which a user can scroll and select using the two-button 'TAB' and 'ENTER' hardware interface. Menu items on the carousel change based on the module the user is currently using and the relevant options within that module.

Scrolling through the carousel is animated to promote the circular mono-directional navigation scheme; if a user passes the selection they intended to choose they could scroll through the options until it comes around again. Five carousel items are presented to the user at a time: the current selection is in the middle; the two previous selections are to the left of the current selection; and the two upcoming selections are to the right. Since a CP user may take several seconds to plan his or her next movement to ensure its accuracy the foresight given by this arrangement is crucial. Planning and foresight also reduce the likelihood that a user will pass their intended selection when scrolling through the carousel.

Among the modules, the text entry method within 'Notes' is of particular interest (see Figure 2). Using the same carousel menu a user can compose documents using an augmented T9 text entry system[2]. One Three-letter combination is presented on each carousel button. When a selection is made a list of likely words is presented above

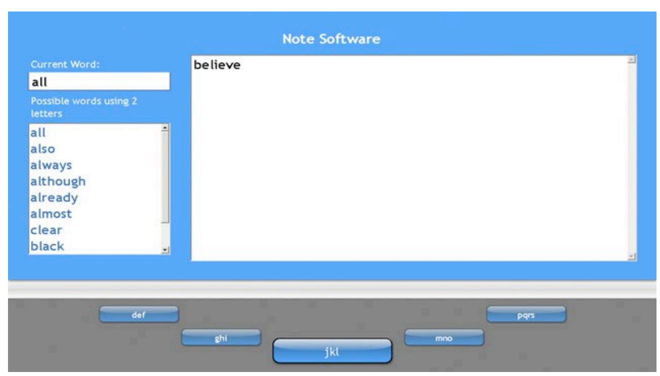

Figure 2. The 'notes' module using T9 text entry system.

[2] T9 is a predictive text technology for mobile phones that allows words to be entered by a single key-press for each letter.

and to the left of the menu and is marked by a thrice-blinking box. This attention focusing technique intuitively informs the user that their selection has been entered. The current selection on the carousel then blinks three times to re-focus the user's attention on the entry of the next letter in their intended word. The user can then continue to enter selections in this manner until their intended word appears in the prediction list.

In order to minimize the time it takes for the intended word to appear in the prediction list, a word popularity index was appended to the T9 database. This takes into account the popularity of a predicted word in relation to the other possibilities and then presents the most likely word choice at the beginning of the selection list. The implementation of the popularity index makes words like 'apple' appear ahead of words like 'appoggiaturas'.

Lastly, a high-contrast display option is present to the list of available color themes to partially address visual impairment issues commonly associated with CP. While high-contrast themes do not directly aid Strabismus users, it was implemented nonetheless for users who find it less distracting or easier to read.

The effort required by a CP user to enter meaningful input will theoretically be greatly reduced as a result of the implementations aforementioned. However, there are a number of ways the software could be further improved.

FUTURE IMPROVEMENTS

A goal of this project has been to create an environment in which users can accomplish tasks with the least effort possible. Since the user exerts the least effort by performing the fewest possible actions, reducing the number of steps required to achieve a desired state would serve to attain this goal. Additional algorithms to increase the word suggestion accuracy must be developed to reduce the number of required inputs. One method of augmenting the existing word prediction system is to design a supplemental system of algorithms that suggests words based on the context of the previous word, words, or phrase. For example, if a user entered "Apple" and then "p" the system would suggestion "Apple Pie" in the selection box. Further, recommendations based on linguistic rules could be implemented. For example, adjectives almost alwas precede nouns, so if a user types "blue" and then "b", the word "ball" might be one of the highest suggestions based on the fact that it is a noun, starts with the letter "b", and contextually makes senses after the word "blue". Both of these methods would add to the overall accessibility of the AIF project, but word recommendation is not the only area where the software could be improved.

An intuitive interface would greatly increase the usability and accessibility of the AIF software. Standardized and consistent behaviors throughout the software promote clear communication of status and intent through animated notifications, visual effects, etc… The AIF software currently uses the animated carousel, which intuitively rotates available choices in continuous loop, but that concept needs to be expanded beyond choice selection. For example, the AIF project's menu system is conceptually arranged hierarchically, but the user is not intuitively aware of this fact. So, if the user is in the note module and doesn't know their current location within the hierarchy, they might be confused as to why they are unable to locate something higher on the hierarchy such as the trivia module. This can result in feeling lost, frustrated, and eventually fatigued due to the effort required to become conceptually reoriented using the Bluetooth buttons. A possible solution to this situation would be to add a vertical animation of the carousel buttons that showed whether the user is climbing higher or lower in the hierarchy. Sony's gaming console, the Playstation 3, has an extremely intuitive configuration interface whose menu options glide, flow, and shift depending on the user's current position within its hierarchy (see Figure 3).

CONCLUSIONS

Using a computer has become a daily event for a many people and the ability to use a computer is required for many common tasks. It is the goal of this project to bring computing to those with Cerebral Palsy without attenuating functionality. The two Bluetooth buttons provide a usable physical interface that compliments the carousel circular choice methodology and by augmenting the T9 database with a popularity index CP users will be able to more quickly and accurately make word choices and compose documents. A CP accessible interface is starting to take shape but even with all these features and implementations there is still much work that needs to be done. The next phase of the project will involve user testing, the implementation of additional and more accurate word suggestion methods, and an interface redesign. Ever phase brings the project closer to being in the hands of those for whom it is being designed.

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Figure 3. The Playstation 3 configuration interface.

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