Alternate Design #2

Alternative Mouse Trial and Assessment System for Adaptive Computer Control

Head and Arm Mounted Art Instrument

Game to Improve Speed and Accuracy of Name Recall

NSF Sponsored Project

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1. Alternative Design 1

1.1 Introduction

This report describes the first alternative design for the alternative inputs for adaptive computer control. This design is for those who suffer from upper extremity disorders from the School of Hearing, Speech, and Language at Ohio University. These disorders limit their hand and arm movement, therefore making it difficult and most times impossible to use a standard mouse for computer control. Along with the input devices are two interactive games that will score the accuracy and speed of the user for each game and compare those scores for each input device. This will aid in research for graduate students in the field of speech-language pathologists. The NSF has sponsored this project in hopes of creating a low cost, highly efficient alternative to the normal mouse input for a computer that will aid those in need.

The first alternative input device is the optical foot mouse. An elliptically shaped unit will act as the mouse part of this device. Optical sensors will be used to control the directional movements of the computer cursor. The mouse will be moved easily using the foot in a comfortable position. A separate unit will accompany the mouse and act as the clicking portion of the device. The box will contain two buttons that will be used to operate the clicking functions of the foot mouse.

Both the foot mouse and button box housing will be constructed from lightweight plexiglass material. It will be sturdy to withstand constant use and accidental damaging. The housing will hold the components needed for the operation of the foot mouse and its button functions. This device will be lightweight and easily moved and stored.

The second alternative input device is the joystick. The joystick will consist of a single unit with a joystick and two buttons. The joystick will control the movement of the cursor on the computer interface and the buttons will control the clicking functions. The joystick will be easily manipulated in all directions for cursor movement.

The joystick housing will also be constructed from a lightweight plexiglass material. The circuit components will be stored within this housing, keeping the device safe from accidents. The entire device will be lightweight and designed for easy storage.

This design is different from our previous design in regards to the inputs being used. The previous design had the two alternative inputs being a track ball mouse and a foot touch pad. This design is utilizing an optical foot mouse and a joystick. Also, instead of using C++ or Visual Basic as the programming language for designing the speed and accuracy games, a purchasable product called Game Maker will be used to design the games for the speed and accuracy. This allows for a more sophisticated design and more interactive gaming software.
Flowchart for the entire input system:

![Flowchart Image]

**Figure 1: Flow Chart of Entire System**

1.2 Subunits

The final system of inputs will allow for the use of a computer interface with ease and comfort. The subunits of each device will be described first, starting with the track ball input. After each device has been properly discussed, the interactive computer games will be explained. Finally the scoring and comparison programs will be illustrated.

1.2.1 Optical Foot Mouse
The foot mouse input device will utilize a USB connection to the computer for power. The standard specifications for a USB are as follows:

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<tr>
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<td></td>
</tr>
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<td>Isolation</td>
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**Table 1: USB Specifications**

The computer will provide the voltage to power the foot mouse through the USB 2.0 connection. This will allow for easy input into a desktop or laptop computer, as well as transfer from one computer location to another. Also, no external power supply is needed, allowing for more space for operation. The USB wire length will be standard at six feet, which will accommodate both inputs’ distance from the operating system.

The USB or universal serial bus uses three different types of data transfer in its processes. Those three are interrupt, bulk, and isochronous. When devices are connected using a USB, they are enumerated, or given an address. Using this address, the computer can directly communicate with each individual device. The first communication is which data the device wishes to transfer.
Interrupt mode is used by devices sending very little data, such as mice and keyboards. Bulk data is used by larger devices sending bigger amounts of data, such as printers. Isochronous data is found in speakers, in which a constant signal is sent using real time and there is no error correction. Control packets are used to send commands and query parameters from the host to the USB devices.

Interrupt and isochronous data are allowed up to 90% of the 480 Mbps of bandwidth of the USB, regulated by the host, after which access is denied. The remaining bandwidth is used by the bulk data and control packets. The bandwidth is split up into frames, which are 1500 bytes and a new frame starts every millisecond. The interrupt and isochronous data are allotted their guaranteed slot, and the bulk and control packets fill up the rest. The input devices for this design will be utilizing the interrupt data from the USB connection.

The USB will connect to a circuit board wired to a series of components, which include the ADNS-5020-EN along with the ADNS-5100/ADNS-5100-001 lens, ADNS-5200 clip and HLMP-ED80 LED to form a complete optical mouse tracking system. The ADNS-5020-EN contains a digital signal processor and an image acquisition system, which creates the optical mouse sensor used to detect the reflections caused from the HLMP-ED80 LED shining on the tracking surface.

![Figure 3: Optical Track Ball Mouse Component Flow Chart](image)
The foot mouse will consist of a box which will contain two large buttons for clicking functions and a separate device that will act as the optical foot mouse. The foot mouse will have dimensions of:

Length: 8 in.
Width: 4 in.
Height: ≤ 2 in.

The housing of this device will be made from plexiglass because of its durability and lightweight characteristics. Underneath the housing of the mouse unit will be small felt pads to decrease the friction between the bottom of the foot mouse housing and the surface it is being used on, easing the movement of the mouse by the user. The mouse will be able to be used on most surfaces, with the best surface being tile or hardwood floors. Also mounted on the foot mouse will be a Velcro foot strap that will hold the user’s foot onto the mouse.

To track the movement of the foot mouse, the optical sensor mentioned above will be used. As the LED light is reflected by the surface the mouse is being used on, the ADNS-5020-EN reads the images and processes the differences between each image. The differences are transferred to the computer as coordinate changes, which control the movement of the cursor on the screen.

Next to the foot mouse will be a separate housing that will have two large buttons for clicking functions for the input. The dimensions of this unit are as follows:
Length: 9 in.
Width: 5 in.
Height: 2 in.

The button unit will also be made from lightweight plexiglass, but underneath the unit there will be small rubber pads that will prevent the box from moving during operation of the foot mouse. The buttons will each be three inch circles that will rise from the housing approximately one centimeter. The two buttons will represent the right and left click options of a standard mouse. Holding the left click button down and moving the cursor with the foot mouse will result in the drag function. Pressure switches will be used initiate the clicking functions of this unit.
Figure 4: Foot Mouse Design
1.2.2 Joystick

The joystick will also be powered by a USB driver. The same specifications will be used for the USB driver for the joystick. The USB will connect to a circuit system inside the joystick and power the circuit. This circuit will include an A/D converter and a microprocessor that will process the information gathered from the movement of the joystick.

This unit will utilize optical sensor technology to measure the direction and speed of the joystick movement. The joystick will be set in a track that will pivot the stick left and right, the X direction, and forward and back, the Y direction. Connected to the pivot track are shafts that are connected to slotted wheels. An LED is attached to one side the slotted wheel and on the other side are two photocells.
Light is emitted through the slot when the joystick is at rest, hitting the photocells. The photocells create a current when the light from the LED is shining on it. As the joystick is moved, the slotted wheels rotate and cause breaks in the LED’s beam. The broken light from the LED cause the photocells to create pulses of current.

A microprocessor then processes the pulses of current from the photocells. Using the number of pulses generated by the photocells, the processor can calculate how far the joystick has been moved. This would allow for the speed of the cursor on the computer interface. By comparing the data received from each photocell monitoring the one wheel, the direction the joystick has moved can also be figured. This will control the direction of the cursor on the interface.

The dimensions of the joystick unit are:

Length: 6 in.
Width: 4 in.
Height of Box: 3 in.
Height of Joystick: 5 in.

The housing of the joystick will be constructed from lightweight plexiglass. This will give the unit a low weight and also high durability. The joystick will be an optical joystick purchased and adapted to this design. Underneath the base of the joystick will be rubber pads to keep the joystick in place during use. The buttons will be one inch squares, raised approximately one centimeter from the joystick box. The buttons will
utilize pressure switches to operate the clicking and drag functions of a standard mouse.

The movement of the joystick will trigger the movement of the cursor on the computer interface. How far the joystick is pushed in each direction will determine the speed the cursor moves on the screen.
1.2.3 Accuracy and Speed Game/Comparison Program

The inputs described above will be tested and scored using two different computer games. These games will be programmed using the Game Maker software. This software claims to allow users with limited computer knowledge to effectively design and program advanced stylish games. The Game Maker software also saves us from hundreds and thousands of lines of code. The drawback to this software is the cost, which is about $150 USD. However, this software will allow for greater appeal by the user, so the decision has been made to incorporate the software into the game programming design.

The first game will be a generic pong game. The user will use the input device to operate his/her pong paddle in an attempt to hit the ball back towards the computer. Each hit will denote an addition to the user’s score and will result in an increase in the speed of the pong ball. The user will continue playing until he/she has missed the pong ball. The current level and score will be sent to a file to be analyzed after the second game has been completed.
The second game will be a hedgehog game in which the user will have to click on the circle that has changed color before time runs out. As the player progresses through the game, the time will count faster until the player fails to click the circle until the time has run out. The score of the user will be calculated using the time it took for each click of the correct circle and the progress that was made through the game. The results of the user will be sent to a file for future analyzing.
Each game will have its own score computation program built-in. These scores will be compared using another separate program, also using the Visual Basic code, which will load the scores from the two stored files and compare them through the speed and accuracy of each input. Each score will be shown to the user and compared to the score from the other game. This will be done for both inputs and will not be shown until both inputs have been used and completed each game.

Once we start experimenting with the Game Maker software, the interfaces will most likely be changed due to the designs that come with the Game Maker software package. The pictures of the game interfaces above are rough designs of what we think the actual interface will be. The layout of the games will be similar, but visually, they will be more appealing. Also both games will be able to be operated using both laptops and desktops.
2.1 Realistic Constraints

The engineering standards for designing a biomedical device are very important. For the input devices described in this report there are many standards to be met. There are required mathematical calculations of voltages, pressures, and circuitry for correct operation of the devices. Proper programming of the systems as well as the computer games is required for function of the entire system. The materials used must be safe and dependable for the client. Overall this project will be effective and efficient while maintaining the safety and control of the client.

**Economic**
The main economic constraint is the budget of $750 USD which only allows for certain purchase of items and materials for this project. Also, the economic considerations of the client must be taken into account because this design must be affordable to that population.

**Environmental**
Environmental constraints deal with the concerns of weather and the environment. Temperature and humidity are the biggest factors in this design because of the
circuitry involved. The project must be able to withstand reasonably high
temperatures and high humidity’s without malfunctioning. Materials found in the
facility of the client should also have no effect on the encasing of the device.

**Sustainability**
This project must be able to sustain consistent use by different users. The
durability and overall last of the design are critical. The materials used must be
rigid and have the ability to withstand accidents when they occur.

**Manufacturability**
The manufacturability of this product must be high rate and low cost. Since this
product is universal and is not built with a specific design, there are not any
limitations from mass production.

**Health and Safety**
The device should in no way be harmful to the user. There should not be any
sharp edges or open wires that will cause damage to the user or others. The
materials used must not give off any harmful vapors or gases. Also, the materials
should not be involved in any allergic reactions of the user.

**Social**
Socially the user should feel like one of the norm. This device should not make
the user feel out of place. The design is centered around not only functionality and
effectiveness, but also about the feeling and comfort of the user while they are
operating it.

**Political**
All policies should be followed according to the preset government regulations.
Patent infringements are also a concern and this device should not mimic on those
already filed.

3.1 Safety Issues

**Electrical**
Safety issues regarding electrical components are the main concern for this
project. The design is centered on circuitry and electrical devices that may short
out and cause electrical shock to the user and others surrounding the work area.
To prevent this from occurring, all electrical components will be properly housed
and insulated. Extra care will be used when building the devices so that there will
not be any concern with electrical shortages.

**Thermal**
Because of the amount of electrical components involved in this design, there will
be a certain amount of heat produce by the circuitry. This could create a hazard
with increased heat in the input system and also a fire hazard if one should occur.
The insulation that will be used in both devices and the materials used to house the designs should prevent this situation from occurring.

**Host Reaction to Biomaterials**

The reaction to the materials used for this project is always a concern. Allergies are the main cause of most reactions and these will be dealt with before construction can begin. The usage of non reactive materials, both to the user and their environment can safely avoid any problems.

4.1 Impact of Engineering Solutions

This design will bring a sense of independence to the user. The client will be able to freely use the computer without worrying if the input system is compatible with their abilities or not. Socially, they will feel as if they are part of the crowd and not someone standing on the sidelines watching in. This design will connect the client to the world through the use of computers.

Since computers are revolutionizing the world and are becoming more and more integrated into our lives, the need to be able to use one is becoming more important. Soon everything will be accessible trough computers, and those who suffer certain disabilities will be left behind. This design is meant to enable those clients to operate computers independently and to improve on their operation ability. In the future, these products could pave the way for more effective and efficient designs for use all over the globe.

Since the budget is limited for this design, the price is kept below a certain threshold. Other products on the market range from $500 to $1000 USD. These products offer the same functions as our design will, but at double and even triple the cost. Our design will improve on the efficiency of the previous designs as well as offer the products to a greater range of clientele due to the reduced cost of manufacturing.

The materials used for this design will be of no harm to the environment. Even after disposal and transport to a dump, the materials will remain non-reactive with the soil and the atmosphere. This will help maintain a healthy and clean environment.

The effects on society from this project mainly include the reactions of the client. Through use of this product, the client will feel more independent and more a part of society. Regardless of the fact that they have a certain disability, this product will help to maintain their grasp of future advancements. Technology in computers is growing and this product will help to keep our client base growing with those developments.
5.1 Life Long Learning

Throughout the research and designing of this project, many new concepts about materials and their functions were learned. Researching the optical joystick revealed the history of the joystick. In the beginning, the joystick was a simple design only using four touch sensors to control the movement. Soon the joystick evolved into a series of tracks that use a contacting rod along a resistor track. As the rod moves along the resistor track, the voltage changes depending on the resistance. The problem with this design is that the electrical signal obtained from the potentiometers must be converted into a digital signal. Thus the electrical signal is put into a capacitor. By measuring the discharge rate of the capacitor, a numerical value is obtained (digital signal). Eventually the joystick evolved into using optical sensors with slotted wheels as described above. This allows for a more precise measurement of speed and direction, without using much of the computer’s processing power to discharge the capacitor.

The operation of an optical sensor mouse was also discovered through the research for this project. Previous recognized information about the function of the optical mouse was the usage of an LED, but no other information was known. Upon researching the standard optical mouse, it is now acknowledged that there is a DSP or digital signal processor and a CMOS or complimentary metal oxide semiconductor sensor. As the light from the LED reflects off the desired surface (desktop, mouse pad, track ball, etc...) the CMOS receives the reflections and sends thousands of images to the DSP. The DSP processes these images and locates the changes between each image. This information allows the DSP to determine if the mouse has moved, how far, and how fast. This information is then sent to the computer as coordinates for the mouse cursor at hundreds per second. That is why the movement of the cursor is smooth on a computer interface.

The Game Maker software is something that is new to the whole group. Although it makes the designing and programming of interactive computer games easier, there is still a level of knowledge that must be known to correctly operate the software. Also, the advanced graphics and designing capabilities of this software will allow for a more sophisticated look and a more appealing gaming experience for the user.

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