Tongue-Computer Interface Technology - Hi-fi prototype 2

1. PROBLEM DESCRIPTION

Currently quadriplegics do not have a mobile, discreet method of finely controlling the technology used in their daily lives. We envision a tongue interface capable of controlling technology to enable more independent living. The tongue is one of the most sensitive and versatile muscles in the body, it is also concealed within the mouth. Though previous attempts of using the tongue as an interface for technology exist, none of them have succeeded in achieving a comfortable and lasting experience for the users while enabling control of multiple technologies.

2. SOLUTION OVERVIEW

We have created a tongue interface for mouse control with the long term goal of enabling greater independence through control of technology. Our base design is based off of the concept of the mouse. By taking a universal input device normally used by the hand and configuring it for the tongue, we enable SCI patients to use any technology normally facilitated by conventional mouse control. Our device is held in place by a retainer (our prototype, by a mouthguard), providing 2 buttons for commands and a trackpoint for navigation and direction. It has been contoured very carefully to fit the upper dome of the mouth and has established comfortable, simple control in testing.

3. SCENARIOS

With the addition of the mouse element, we have modified our scenarios to require the selection of the mouse button mapping in the macro menu. This workflow follows the final intention of the interface; the user selects an interface mapping for the task using the fine control touchpoint and performs the task quickly using the left and right mouse buttons. Our mapping selection program is "BetterTouchTool".
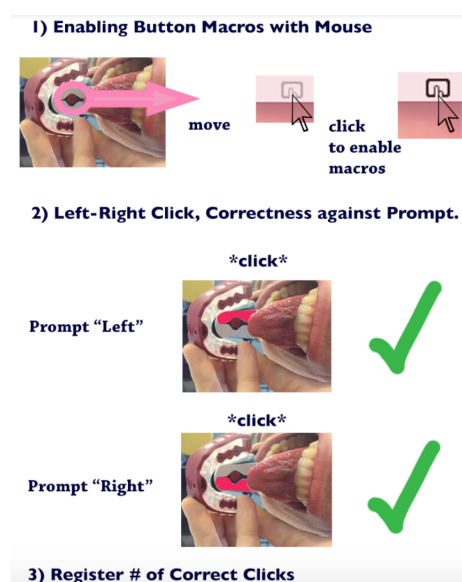

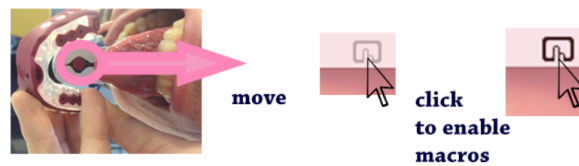Figure 1 - Basic Task: Correctness of clicks against prompt

1) Enabling Button Macros with Mouse

move

click
to enable
macros

2) Scroll Up and Down Document

click hold

Scroll Up

click hold

Scroll Down

3) Question comfort, Observe speed

Figure 2 - Intermediate Task: Scrolling down a document

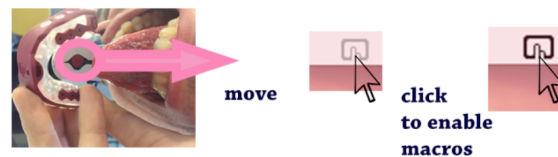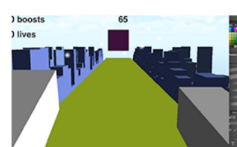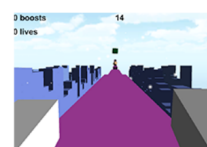**1) Enabling Button Macros with Mouse**

move

click
to enable
macros

2) Engage in Running Game

click varied hold

Jump!

Survive Game Obstacles

3) Question comfort, Observe point score

Figure 3 - Engage in a running game

4. FINAL INTERFACE

Final UI Design & Functionality

The final prototype possesses the functions of a mouse, except that instead of operating it with hands and limbs it sits on the roof of the mouth and is operated with the tongue. The design incorporates three elements. Two clickable buttons are mounted as large-area buttons on the left and right sides of the interface, and a pressure-sensitive trackpoint nub is mounted in between. The pressure sensitive nub can be pushed in all directions with a continuous spectrum of movement spanning a 2-D plane. (For reference, this "trackpoint nub" is the same as the red blip mouse found on most IBM thinkpad laptops). This nub controls a mouse cursor. The size and texture of the button clicks have been made tactile through lever motion of plastic and wide button caps. The trackpoint tip is concave, enabling the tip of the tongue to grip and better direct the cursor.

We also incorporated trackpoint sensitivity sensitivity within the source code allowing us to easily increase or decrease the sensitivity as desired. In fact, we can even scale sensitivity for a specific axis, X or Y. We found this helped greatly given the strength and precision of a tongue differs from person to person. Also the agility of the tongue is different from left to right contrasted with front to back.

Our tongue-mouse interface interacts with software (BetterTouchTool) to remap functions provided by the buttons to suit specific tasks.

Trackpoint to easily control the cursor of the mouse

Button clicks separated by tracepoint to make them more identifiable
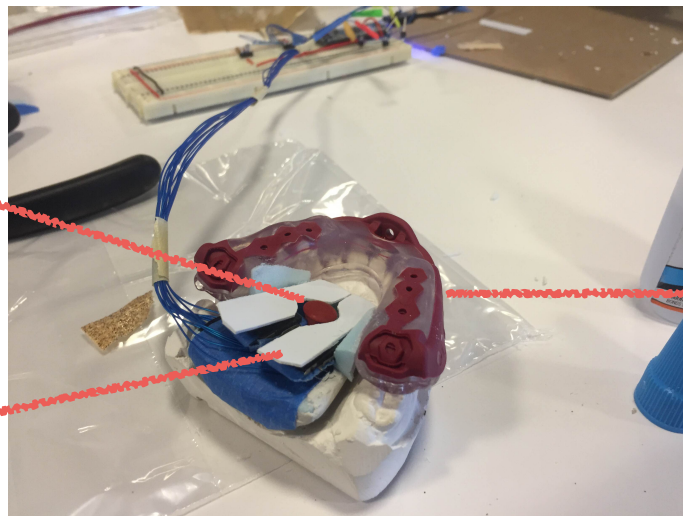
Mouthguard to fix the device inside the mouth

Figure 4 - New Hi-fi Prototype

Changes from previous Hi-fi prototype

Based on the feedback we received from the previous high fidelity prototype we added the trackpoint for more fine control and incorporated all elements into a fixed mouthguard retainer. This addressed two major concerns of not having the device fixed in place and not being able to discern the left and right side. The presence of the trackpoint further provides subtle intuition of the divide from left to right.

Additionally, the tactile feel of the buttons significantly improved over past versions; the new version incorporated the mechanics of a keyboard in order to increase the accuracy of button presses. Finally we designed the wire coming out the side of the apparatus and bundled it in a thin beige tube to be more subtle.
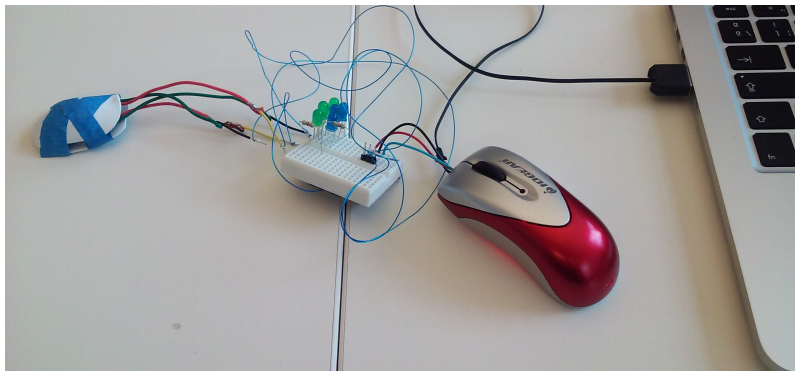

Figure 5 - Previous Hi-fi Prototype

Unimplemented functionality

For this final prototype, we sought to include the most essential functions of moving, clicking, and holding. A few functions that require more complex combinations of these functions were left out; namely click & drag. Furthermore, functions of greater engineering complexity such as wireless communications were also omitted for sake of available time and resources.

Our focus moving forward, is to both refine the basic (essential) functionalities we have imbued our interface through form and element positioning, and to develop and include the more complex functionalities we have discussed. At the moment, we are considering using macros to emulate complex actions such as click and drag. Holding down a button for a multi-second duration is intended to serve as its trigger.

We have no wizards left in our cupboards. But actually, in all seriousness, we have reached a point in our design where no Wizard of Oz techniques are necessary! Our interface plugs in via standard USB 2.0 and is recognized by a computer as a PS/2 mouse.