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User Manual - JAAC Box

Group 13

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Abstract

The group was given the challenge of utilizing the iterative design process to design and manufacture an augmented adaptive communication (AAC) device. Following the instruction and needs of the client, the "JAAC Box" was created as a foot controlled mouse controller to allow users with little-to-no movement in their hands to interact with a personal computer/communication device in either a sitting or lying position. The JAAC Box was designed using inkscape and a laser cutter, using ¼ inch medium density fiber (MDF) board. The final dimensions of the enclosure are 30.5x15.24x6.99 (cm^3). Two coats of paint and enamel are used as sealant and decoration on the box to personalize and waterproof enclosure. Inside the enclosure, the components consist of an Arduino Leonardo, Arduino joystick, electrical wires and a custom perfboard-Arduino shield. Computer mouse functions enable micro-based boards to control cursor movement on a computer through a micro's native USB port. The Arduino Leonardo allows for interfacing between the JAAC Box's foot mouse and a personal computer's cursor, and the personal arduino shield allows for a reliable connection between soldered components and the microcontroller. The 3D-printed foot controller which selfcenters using resistance springs encloses and interacts with the internal arduino joystick. The bed mount system is bolted directly to the JAAC Box and can be repositioned towards or away from, and left or right of the user to find a comfortable operating position. The bed mount is intended to prevent the movement of the JAAC Box while the user is operating it in a bed.

Figure 1: Final Prototype of the JAAC Box

Table of Contents

List of Figures:

Introduction

Accessible devices used to help disabled individuals overcome the limitations of their disabilities. These devices are often customized to suit an individual user's needs because disabilities are unique and present different challenges. The Augmentative Alternative Communication (AAC) device is a device which uses an on-screen keyboard text-to-speech software and allows users to select words and phrases to communicate. This allows the user to "speak" when unable to use their voice. In this case, the user uses the mobility of their left foot for operating an AAC device from their wheelchair. The users current AAC device, similar to a basic computer mouse, uses a foot-controlled cursor to select desired words and phrases. The user currently uses the heel of their foot, which fits snugly into a concave groove and slides 360 decrees horizontally at the base of their wheelchair to move the cursor and click with a large button above their controller.

As requested by the client, the JAAC Box was designed to be used while lying down, while maintaining a design that resembled that of their current AAC device. As a result, the general design of the current AAC device is kept the same, with the exception of the bed attachment and the location of the clicker button. Furthermore, the device is placed on an angle for better access to the device, as well as being portable and easy to set up. It is also customizable in terms of cursor speed, and bed position.

In terms of competition and similar products on the market, they are very limited. Through benchmarking and pricing our product, it was difficult to find comparisons as devices like this are made on a case by case basis to solve a unique problem. The few similar products that were found include the Footime Mouse;
(Fentek Industries, n.d) and the Xbox Adaptive Controller (Microsoft, n.d). While each of these solutions can be used to solve the client's need, it is believed that the JAAC Box is a better solution due to its simplicity, ease of use, and lower cost of manufacturing and retail.

Functioning Capabilities

Concave Foot Controller:
A cylindrical groove which narrows with height and then stops to form a smaller circular base. This serves as a comfortable base for the heel of the user which can be moved with 360 degrees of motion. The movement of the heel cup corresponds to an on-screen cursor which can be used to hover over selections in an AAC device, or other similar devices.

Select Button:
A large red button with an easy clicking mechanism, acting as a standard left click on a computer.
1. Use the heel cup to hover over desired object.
2. Click once to select object.

USB Connection:

Micro USB to USB A connection. To connect, insert the USB-A connection into the USB-A port of the desired projecting device (computer, TV). This connection provides power and data transmission from the connection into the device.

Waterproof:

Moisture resistant, but not for underwater use. One should aim to keep the product in dry conditions as much as possible to avoid damaging electronic components.

Assembly And Prototyping:

1. The prototype was initially brainstormed on paper using rough sketches.
2. Once a satisfactory design was generated and determined using a decision matrix, the CAD prototypes were made for the heel cup, arduino bases, and screws, as seen in figure 4-8.
3. Next, the housing unit generated using a CAD software, as seen in figure 9. All models and their dimensions can be downloaded at https://makerepo.com/SamG/gng2101a13jaac-box (Gilmore, 2019).
4. The housing unit cut from MDF in a laser-cutter. All laser-cutting specifications can be found at https://makerepo.com/SamG/gng2101a13jaac-box (Gilmore, 2019).
5. Housing assembled using epoxy at the secure edges, and magnets at the bottoms so that the bottom lid could be lifted to give access to the internal electronic components. Two bolts were added as the base to prevent accidental opening during use.
6. Micro USB connection made to the arduino which connects a USB-A port at the other end.
7. The Arduino code was made using the Arduino "Mouse" example found in the given Arduino example libraries. This example allowed for basic mouse functionality. Adding on to this basic functionality, the cursor directions and speed were modified by measuring the distance the joystick has been moved from the origin or original position of the joystick and moving the cursor of that calculated distance. The code is provided at https://makerepo.com/SamG/gng2101a13jaac-box (Gilmore, 2019) uploaded into Arduino through Arduino IDE 1.8.10: https://www.arduino.cc/en/main/software (Arduino, n.d)
8. Internal electric components soldered into their respective ports. Several tests were then done to insure the prototype was functioning correctly.
9. The bed attachment is made of 6 aluminum flat bar pieces slotted and tapped using ¼-20 taps and threaded with custom cut ¼-20 bolts. The flat bar lengths are 10, 12 and 5 ¾ inches.
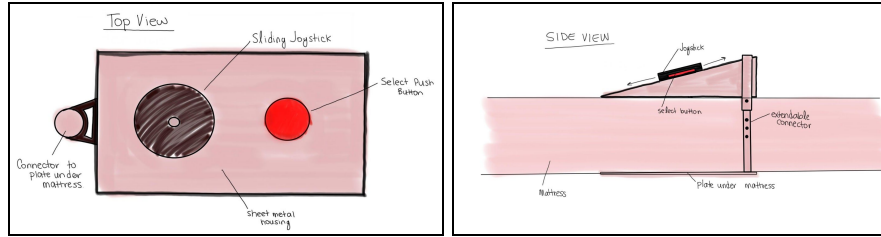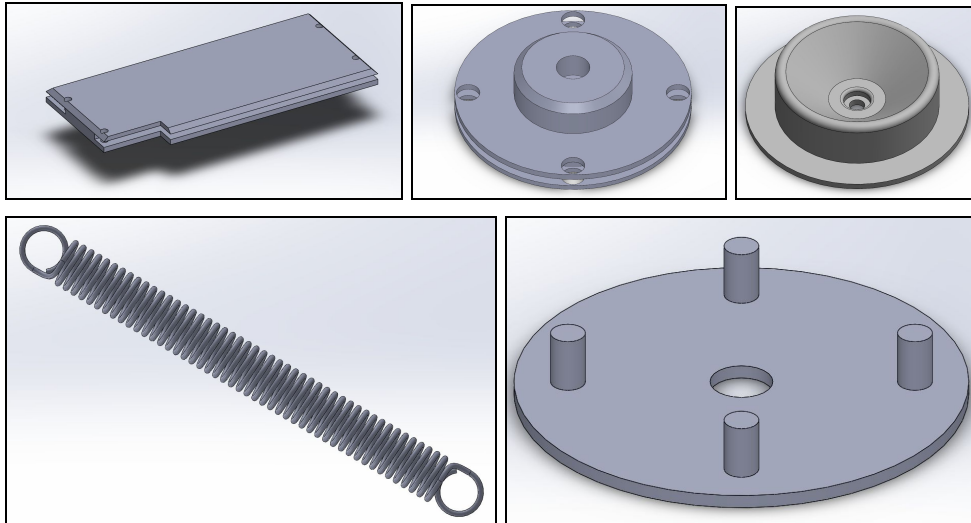
Figure: 2-3: Prototype one concept drawings

Solidworks Prototypes:

Figures 4-8: Sample Solidworks prototype images, custom PCB shield, joystick actuator, heel actuator, spring, spring attachment.

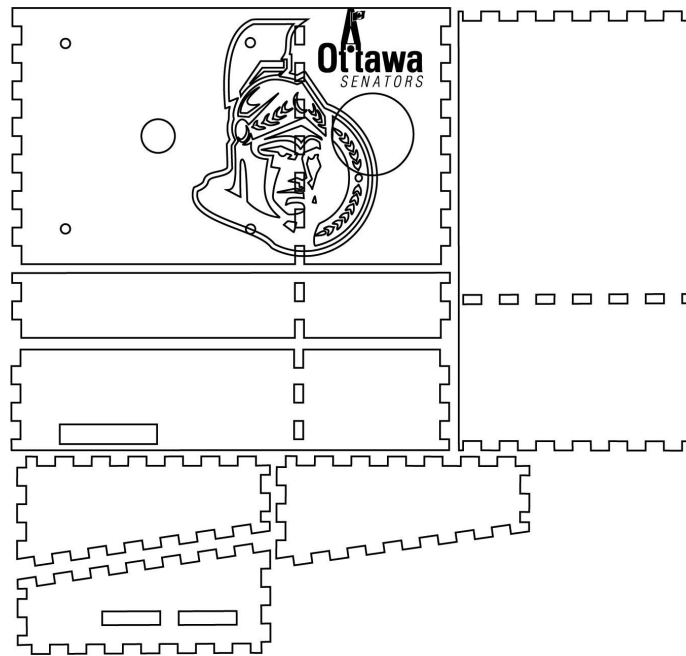Figure 9-10: Bed mount attachment

Inkscape Laser Cutting Model:

Figure 11: Inkscape laser cutting outline

Installation and Operation Instructions:

The JAAC BOX is designed so that assembly can be done by any assistant in an efficient manner. The device can remain completely assembled while in its storage bag for easy transport. When required, a nurse or assistant can remove the device from its travelbag and set it onto the base of the bed. The vertical aluminum pegs can be simultaneously slotted between the base of the mattress and the footboard/rails for device stability. The device can be positioned in a comfortable position across the width of the bed. Then, loosen all four wingnuts to release the sliding mechanism that will bring the device closer to, or further away from the users feet. Once a final comfortable position is found, the wingnuts can be tightened and locked in place. Finally, USB cable (ten feet long) can be connected to the user's communication device that is within view and the JAAC BOX should take control of the device mouse as soon as the connection is made.

Maintenance Instructions:

The JAAC BOX is designed to require very little to no maintenance. The box is powered directly through its USB connection and does not need to be opened to charge. If any internal maintenance is required, two square robinson bolts are located in each corner of the base of the device to prevent accidental opening of the device. Once the bolts are removed the base is held on by magnets and can be easily separated with some applied pressure.

Health and Safety Guidelines:

- Avoid spilling any liquid substance on the device to avoid electric shock.
- In the case of water spillage on the device make sure to quickly unplug the device to avoid any electric shock.
- Be careful when using the device since there are some sharp edges to avoid injuries.
- If the device overheats then unplug the device and leave to rest and cool down.
- Any wires from the device to the computer should be placed in positions not to be walked on or caught in to avoid any tripping over wires.
- If there is some smoke or an unfamiliar smell coming out of the device then unplug the device to avoid any complications and contact our team immediately.
- Do not attempt to insert any metallic objects of any kind through the open parts of the device to avoid any electric shock.
- Do not keep any flammable substances near the device to avoid any fire hazards.
- Keep device in an open space to avoid accumulation of dust and dirt near open spaces.

Troubleshooting:

Cursor Speed is Too Fast/Slow

In the event that the cursor speed is too slow or fast for the user, the speed can be adjusted using one of two methods. Firstly, adjust the speed of the cursor within the computer settings. To do this, refer to the system manual of the computer being used to adjust the cursor speed. If this does not produce the desired effect, the next course of action would be to adjust the speed of the cursor within the Arduino code. Note that this method can be done using any computer. To modify the code, it is necessary to have the Arduino software which can be obtained from Arduino's website. Once the Arduino application has been acquired, the joystick code must be downloaded from the MakerRepo website: (https://makerepo.com/search?q=JAAC+box/) (Gilmore, 2019). Once this code has been downloaded, open it using the Arduino application. From here, the second line has a global integer variable defined as "cursorSpeed". By replacing the integer value associated with "cursorSpeed" with a higher value will result in a slower moving cursor. Conversely, lowering the value of "cursorSpeed" will result in a faster moving cursor. Once the desired cursor speed is obtained, the Arduino code must be verified and uploaded to the board, then connected to the computer by usb.

Problem With Connectivity

When faced by a connectivity problem, attempt to plug the USB into another port on the computer. If this does not fix the problem at hand then proceed to unscrew the bolts on the box taking off the lid and ensuring that the Arduino Leonardo is turned on and the wires are properly plugged with no damage to them. If the problem persists then attempt to contact the team for further instructions.

Button Not Properly Operating

In the case were the button seems to show no to limited functionality while the heel cup/cursor is working, unscrew the bolts found at the bottom of the device taking off the lid and ensure that the leads are properly attached to the button, and if so, then take them out and carefully plug them back in.

Device Exposed To Water

If the device is exposed to water on its exterior, immediately unplug the device and dry the exposed surface using a cloth or other absorbent media. If, however, water leaks into the device, remove the lid of the device and allow the electronic components to air dry for a period of minimum two days. Plug in device to power source and attempt to use as usual. Be cautious when using device, as damaged components may behave unpredictably. Note that Footmouse Inc. is not responsible for any water damage related issues.

Bed Attachments Are Loose

In the case that the bed attachments come loose, tighten the bolts on the device in a clockwise direction until attachment is stable.

Conclusion and Recommendations for Future Work:

        To conclude, the JAAC box is an effective device that can be utilized to control a cursor with the use of one foot. The user is provided with Assembly instructions, prototyping models, maintenance instructions, installation and operation instructions, health and safety guidelines, and troubleshooting assistance which allow the user to understand, operate, and modify the device as needed. In the future, the device can be modified to be adjusted in more directions to provide a maximum level of comfort. Moreover, different shapes for heel cups may be explored depending on the needs of the user. Future testing with clients would be essential in making meaningful change to the product and helping patients in need of accessible devices.

Bibliography and Appendices

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