Deliverable C

Submitted by:

Group C31

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31/01/2021

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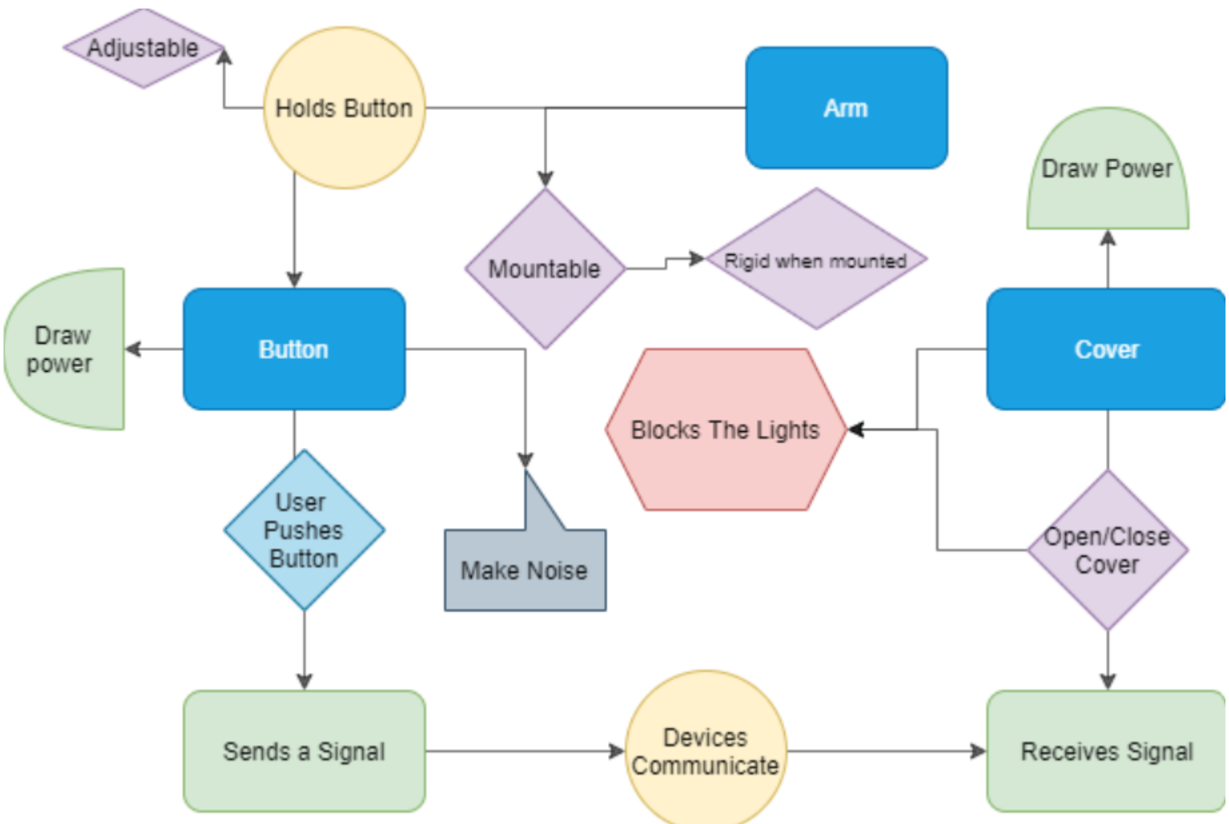
Introduction

Due to the increasing need for students to have access to technology, people with impairments that limit their motor skills are put into a more difficult situation. Our team has taken on the task of designing a camera cover. The user will be a 12-13 year old boy named Oliver who uses an eye-gaze camera to verbally communicate through a Tobii device as it reads his eye movements. The user also has to rely on other devices for school work and electronic communication, as well as a power wheelchair. The program he uses requires the software to track the movement of a dot on his forehead in which the camera will pinpoint the position, translating it to words, then sentences. Furthermore, Tobii's eye gaze light interferes with other devices he uses. The team was able to extract valuable information from the client, allowing us to design a potential solution to the problem. The following document will discuss the transition to the next step in the engineering design process: Concept development. Based on the translated customer needs from the previous deliverable, the team will break down the main required functions of the solution, sub-functions as well as the existing boundaries (functional decomposition). Once finished, each team member will generate different concepts to the solution, focusing on quantity. These generated concepts will then be evaluated following the decision matrix, to choose, or help design one final concept from the group. The document presents our approach to this final design concept, provides illustrations and discusses its relationship with our set target specs, as well as its advantages and limits.

Functional Decomposition

The following section discusses the precise goals we have for the function of our product. This is illustrated in Figure 1. where a flowchart is used to describe how each of the three distinct parts of our design will interact with each other and the user. A flow chart works well for this functional decomposition as it is not being interacted with by numerous users on a regular basis. Functional decomposition is an important step when coming up with concepts for our product as it allows the team to really focus on creating ideas that solve our problem.

Figure 1.1 Function Decomposition Flowchart



Functions and Boundaries

The project design can be broken down into 3 main parts, with different functions, sub-functions, and boundaries; The **button**, the **arm**, and the **cover**. Each of these parts is equally important to the overall execution and effectiveness of the final design. The below figure tabulates the information from the functional decomposition and describes the boundaries of the functions. These boundaries are based upon customer needs and on target specifications from the previous deliverable (PD B).

Figure 1.2. Functions and Boundaries

Parts	Components	Functions	Boundaries

Button	• RF Transmitter
	• Button and arm attachment
	• Wired component
		• Activate the cover
		  ○ Send a close cover signal
		  ○ Send an open cover signal
		• Be pushable
		  ○ Makes a noise
			• Button needs to be near head
			• Can be activated by head
			• Transmitting signal consumes minimal energy
			• Noise has to be loud enough for user to hear

Arm	• 3D Clamp
	• Pivot joint
	• Metal tubing
		• Hold the button in place
		  ○ Is rigid
		  ○ Mountable
		  ○ Adjustable to be able to be activated by head
			• Needs to be adjustable
			• Has to be attachable to chair/other existing buttons
			• Has to lock in place

Cover	• Receiver
	• Tobii and cover attachment
	• Servo motor
		• Block the lights
		  ○ Receive signal
		  ○ Close cover
		  ○ Open cover
			• Cover needs to be durable
			• Needs to cover both lights
			• Time it takes to open cover
			• Receiving signal consumes minimal energy

Button

Through the client's needs, the team was able to narrow down and find the main functions needed in each part of our product's theoretical design. The button is composed of two main functions. The first function is that it needs to be able to activate the cover.. The button must be able to send a signal that will either open or close the cover. The button must also make a noise when activated to show that it has been clicked. The next main function of the button is that it must be a physical pushable button. Oliver needs something that he will feel when activated to give him more confirmation that the action of hiding the camera will take place. Along with these functions that need to happen with the button, there will come some boundaries as well. Since Oliver will be sitting in his chair not using his fingers to push the switch, the button will have to be near or around his head in order for him to reach the button comfortably. The button must also be able to be activated by his head and not be too rigid or stiff for him to press. One of the biggest boundaries is that this button must use a minimal amount of energy. Oliver should not worry about recharging this product or his chair anymore than he does already. This product should make his life easier, not less convenient.

Arm

The main function for the arm component of this product is that it must hold the button in place. This function is split into three sub-functions to give more detail and clarity as to what is really needed. The first sub-function is that it must be rigid. If the arm is not rigid, it will move whenever Oliver tries to press the button making the entire system ineffective. The next sub-function is that it must be mountable. The arm will need to mount somewhere on the chair for permanent access. Along with it being mountable, it must be adjustable as well. Since the dimensions of his chair can't be measured in person, the arm should be adjustable for Oliver to put the button wherever he feels is most comfortable for him. The boundaries with the component of the arm follow directly with the functions. The arm must be adjustable but will also need it to lock in place wherever he wants. Although adjustability is ideal, it is very important that the arm will be able to withstand repeated pushes without much effect. Another boundary is that this arm must be attached somewhere on the chair whether it be on the back plate or by attaching it to another existing arm.

Cover

The final component of the product is the cover itself. The main function for this component is that it must block the light in some way that prevents it from interfering with Oliver's other devices. This function is divided into three sub-functions to help elaborate more on just blocking the light. The first two functions are that the cover must be able to open, and it must therefore also be able to close. Oliver will need to access the Tobii often as well as be able to use his other devices. The last sub-function of the cover is that it needs to be able to receive a signal from the button. This means that the cover will need to have a receiver which will be able to tell the rest of the cover to do the desired task. The boundaries for this component are potentially the most important aspects of the product. The first boundary is that the cover must be durable. It can't be made out of cheap materials that will break if the cover falls. Oliver wants this product to last for years, so we will need to construct a cover that will abide by those needs. The most important boundary we must overcome is that the cover must be in front of both of the lights on the Tobii. If the cover is only in front of one of the lights, the product will not work and the cameras from the Tobii will still interfere with Olivers's devices. The next boundary is the time it takes to open the cover. This does not seem a priority since Oliver said he expected a time range less than 20 seconds to activate the cover, but it is still something to keep in mind for our final product. The final boundary for the cover component is that it must consume a minimal amount of energy when receiving signal as well as closing and opening the cover. The cover would be plugged into the Tobii to draw power from it. The objective is to make a product that does not consume much battery from the Tobii.

Group Design Concept

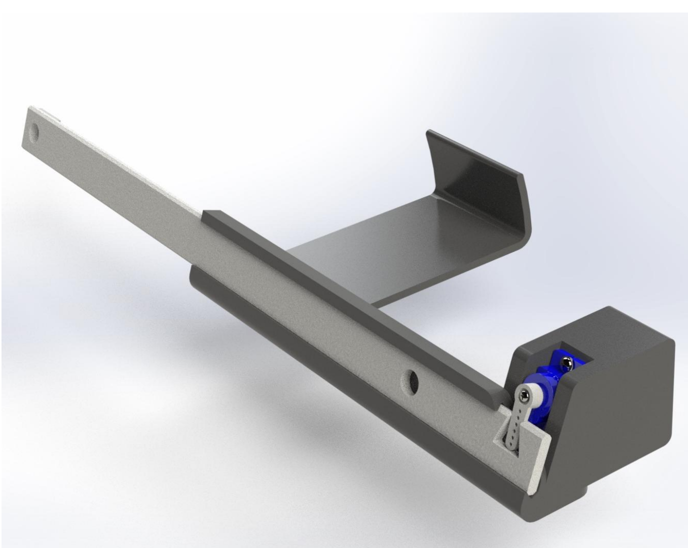
Approach

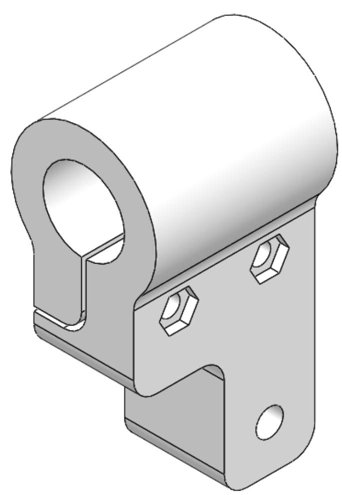
The approach the team decides to take on developing the final group concept is to build upon the already copious brainstorming session. The result of the brainstorming of each separated component is the ability to assess individual sections of the solution, allowing the team to deduce the advantages and limits of each concept, and to move forward with the most promising ones. After evaluating these generated concepts following the decision matrix, the final concept would be developed by picking and combining components with the highest final scores to help develop the final concept. The team figured that all generated concepts, while promising, still present some restrictions that will allow the system to run smoothly, thus to pick and combine the best ideas would generate a concept that represents our cooperative effort. The team would set aside the better ideas, as they could still be helpful, in case some components won't be compatible, or the results of the combination aren't as satisfying.

Final Concept

For the group concept, the team took a couple different approaches for the different parts of the design. For the cover, we have decided to move forward with the Servo sliding cover concept and refine the concept in the stages to come. We will be inquiring about mounting at the next client meet. However, our most promising plan is to design a clamp like case for the Tobii that will hold the cover. For the arm we have decided to move forward with two concepts, both being modifications to concepts presented in the appendix. A variation of the Chair Back Arm and Finger joint pivot arm will be moving on to a more detailed design phase. For the button and the wireless technology we have decided to move forward with a button which will be connected to a 433 MHz transmitter on the back of the chair where it will also receive its power from the chair battery. We plan on purchasing a button that will fit our needs and allow for simple modifications. A rendered image of the final concept can be seen below and more drawings can be found in the appendix.

Figure 4.0. Final Concept Design





Benefits, Drawbacks and relationship with target specs

The design that was decided on outweighs the other concepts that were suggested following the necessary criteria. A thorough examination of the benefits and drawbacks of the design is done taking into account the target specifications.

Benefits:
The servo sliding cover should be very easy to construct through 3d printing and a little bit of electronic work using a servo motor. Due to the servos functionality, it will be easy to program to make it do exactly what we want. This cover will also be using very low cost materials and parts such as 3d printed PLA plastic, a small servo, receiver and other inexpensive electrical components. Another benefit of this concept is that it will require a very small amount of power to operate. Since the servo will only need to be activated when the cover is opening and closing, the power consumption will be minimal. This cover will also be blocking the entire camera, guaranteeing no interference with the client's other devices. Depending on what arm will be our final product, we will have different benefits regarding each arm. The chair back and finger joint design will both be very stable due to the solid construction going directly into the chair and solid friction between arms keeping everything in place. Due to the low number of parts in the Ring and finger joint, they should both be relatively easy parts to construct and design. The wireless transmission that we have decided to use is RF transmission giving us very little drawbacks and many benefits. It has the most reliable transmission technology that we have looked at while being cheap and easy to use. Since we will be purchasing the button from a 3rd party company, it will be durable and effective. The button's wiring will also be connected through the arm of the chair giving us a sleek look while not impeding on the overall price.

Drawbacks:
The servo sliding motor will have a large base and or casing around the motor and the Tobii giving the product a bulky feel. If we end up going with the chair back concept, the extra range reaching to the back of the chair will make the price of the arm increase more than our other concept since we will need higher quality materials such as metal or carbon fibre. Due to there being more parts with the chair back concept, it may be harder to make and more problems may arise. The finger joint pivot arm concept is only reliant on two arms being connected by one another. This gives the arms very little adjustability as it can only move on one axis.

Prototyping Plan

The team's plan for prototyping will start small by creating a somewhat functional physical model with the basics of the dimensions and physical appearance. Many of the electronic aspects will be left out of the first prototype to allow for more research, refinement of the necessary parts. The first step moving forward would be to create a more detailed design through the Solid Works program using the specific measurements and sizes acquired through research and the next client meeting. The motor components will be analysed to ensure the functionality of the product before the electrical component is added. The budget is also being considered and portions of money will be allocated to the different sections as we see fit. We will be prototyping two different arms to ensure they are compatible and will be deciding on a final option based on stability and the users needs. The goal of the first prototype will be to find where our current design falls short and to adjust accordingly.

Conclusion

There were many conceptual designs that were generated in search of a solution to the eye gaze camera interference which the user experiences. Each team member created a minimum of three concepts for the final product design. The functions and boundaries were determined and analysed. Three main parts were created: arm, button and cover. Each part was separated into components, functions, subfunctions and boundaries. The generated concepts were then rated by the desired product criteria. Each part was then decided by the highest score. The final choice was the Servo sliding cover concept as well as two arm concepts to assure the users needs will be met. The benefits and drawbacks for the concept was analysed taking the target specifications into account. A plan for the next step towards a prototype was created by beginning with a more detailed design. In the week to come we will be meeting with the client again for further questioning. We will have prepared a more in-depth question list regarding our push towards our first prototype.

Appendix