GNG2101

Design Project User and Product Manual

Wireless Eye-Gaze Camera Cover

Submitted by:

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04/11/2021

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Table 1. Acronyms

Acronym	Definition
IR	Infrared
LED	Light Emitting Diode
MOSFET	metal–oxide–semiconductor field-effect transistor
PLA	Polylactic acid
RF	Radio Frequency

1 Introduction

This User and Product Manual provides information necessary for people that cannot manually open a camera cover to effectively use the wireless eye-gaze camera cover and for prototype documentation. The device was designed for use with the Tobii I12+, an eye-tracking device used for communication. The camera cover is a wireless servo-operated device that is designed to use 433-Mhz RF transmission. The following document describes how the device was designed to be used as well as the team's efforts to execute the planned design. It outlines the ways the user should interact with the device and then shifts focus to the documentation of materials and testing.

2 Overview

The client is an occupational therapist who works with a 12/13-year-old boy who has difficulty communicating and using his motor skills in his arms and legs. He uses multiple devices to achieve a level of independence and autonomy not possible on his own. To move around, the user uses a power wheelchair which is controlled by buttons that he pushes with his head. One of the devices he uses is a Tobii I12+ which is an eye-tracking device that allows him to speak by moving his eyes over letters to form words and sentences. This device uses very bright Infrared LEDs to track eyes. His other devices which he uses to do school work or play games use a similar technology to track a removable dot which he places on his forehead. The Tobii's bright LEDs cause interference when it is used in close proximity with the other devices. This is the problem the team is aiming to solve.

The user is in need of a portable, low-power, remote-operated cover for the LEDs on the Tobii I12+ device. It should be activated by the user's head and should stop all interference that is caused by the Tobii's lights.

Figure 1.1 - [From left to right] Tobii I12+ with camera cover and 3D printed button

The final prototype which has been created is a 3D printed cover made of PLA filament. It is actuated by a small servo motor which pushes the cover side to side, sliding inside of a small sleeve. It is connected to the Tobii using 3M removable adhesive strips which allow for a secure connection between the product and the Tobii. The servo is powered and controlled by an Arduino Uno microcontroller. A button is used to activate the cover and move it to either an open or closed position.

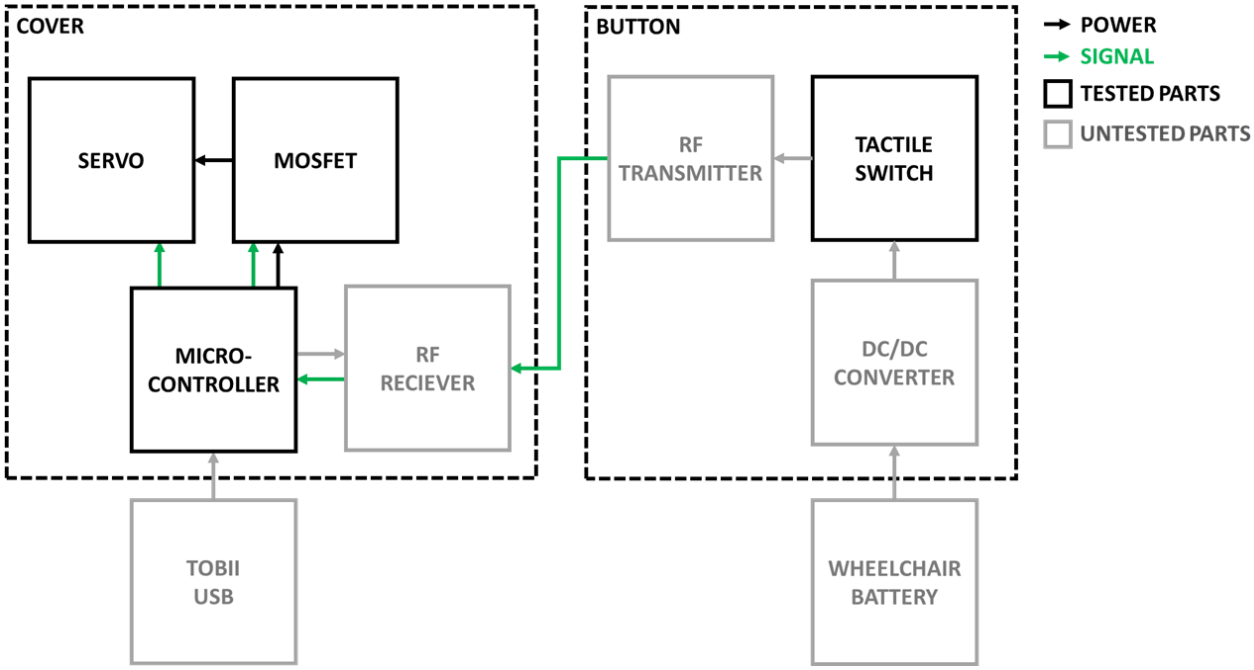


Figure 1.2 - Wireless Eye-Gaze Camera Cover system block diagram

2.1 Cautions & Warnings

If the system's battery is cut the servo will remain in the position it was last put in and can be manually changed.

3 Getting started

The CameraCoverCo. comes with two main components; the button/transmitter and the servo motor LED cover/receiver. The servo LED cover can be set up to fit a Tobi I12+ using 3M command picture hanging strips for easy removal if necessary. The electronic components of the LED cover can be charged using the Tobii device or an external battery source. The button is made to clamp on to pre-existing wheelchair head equipment setups. The wires connected to the button can be attached to the power wheelchair battery supply or an external battery source. First, attach the command strips and put the LED cover in place around the Tobii. Once it is attached, connect the receiver wire to a power source. Secondly, install the button clamp on the pre-existing arm and adjust for comfort, connect wires to desired battery supply. Once both components are in place and connected to a power source they can be used.

3.1 Set-up Considerations

The CameraCoverCo. consists of two pieces of equipment, the button and the arduino operated servo LED cover. When the button is pressed, the transmitter sends a signal to the receiver that activates the servo motor. The motor will slide the cover in order to block the lights. Once button is pressed again it will move the servo and return it to its initial position.

3.2 User Access Considerations

Users of this product are people that have physical impairments that are unable to use their arms, hands, legs and feet to operate electronics. This product is operated using the user's head to push the activation button. The restrictions on system accessibility are that the servo LED cover fits only for a Tobii I12+ or any monitor that consists of the same dimensions and placement of the IR LEDs.

3.3 Accessing the System

In order to turn on the system, the user should connect the Arduino Uno to a power source that can be an electric wheelchair or an external battery. The servo should attach to the Tobii I12+ using 3M command picture hanging strips and can be powered using the Tobii I12+ battery or an external battery source. Once the components are connected to a battery source the LED cover is ready to be turned on and should be able to perform.

3.4 System Organization & Navigation

The product is organized into two main systems: the button and the LED cover.

3.4.1 Activation Button

A small button is placed inside the 3D printed button case and, when pressed, activates the 433MHz transmitter.

3.4.2 LED Cover

The LED cover is composed of an attached housing for the servo, a fixed part and a sliding part.

3.5 Exiting the System

To properly exit the system the user needs to press the button to open the servo-operated LED cover and unplug from the battery power and the wheelchair. The button and servo cover has the ability to be turned off or removed.

4 Using the System

The following subsections provide detailed, step-by-step instructions on how to use the various functions or features of the Wireless Eye-Gaze Camera Cover.

4.1 LED Cover

The LED cover is the first subsystem which is designed to block the light interferences. It is attached to the bottom of the Tobii device and uses a servo powered motor to slide between 2 positions in order to block the light.

4.1.1 3-D printed sliding camera cover unit

The servo horn, attached to the servo, will rotate 45 degrees in either direction whenever the button is pressed. The horn is then inserted into the cover connecting into the hole. As the horn rotates 45 degrees, it pushes the cover left and right.

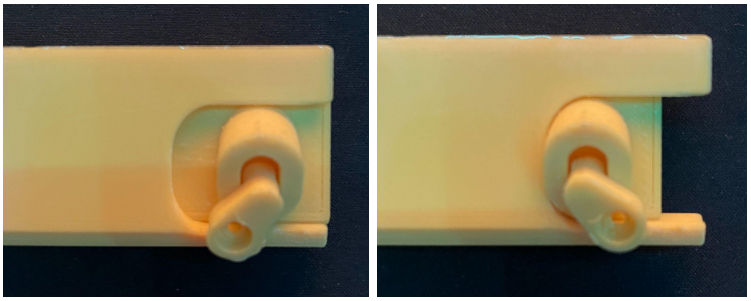


Figure 2.1.1 - Servo horn in closed (left) and open (right) position

As the cover slides along its rail, it allows the cover to be active or inactive, either letting light pass through onto the Tobii or blocking it off.

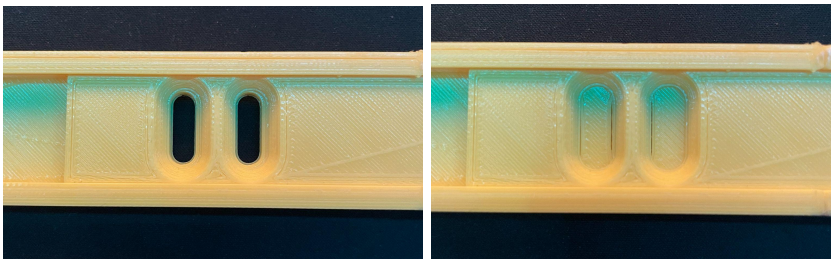


Figure 2.1.2. - Cover in Open and Closed Positions

4.1.2 Servo and Microcontroller Circuit unit

The LED cover is actuated by a servo. This servo and other electronic parts make up the circuit board held within the box to the side of the cover (Figure 2.2.1). The circuit has two main functions: to power and control the servo motor, and to receive the RF transmission given off by the activation button. The circuit draws power from the Tobii I12+ device through one of its USB ports. The circuit also uses a MOSFET to control the amount of power the circuit draws from the Tobii I12+. The circuit diagram can be seen below (Figure 2.2.2).

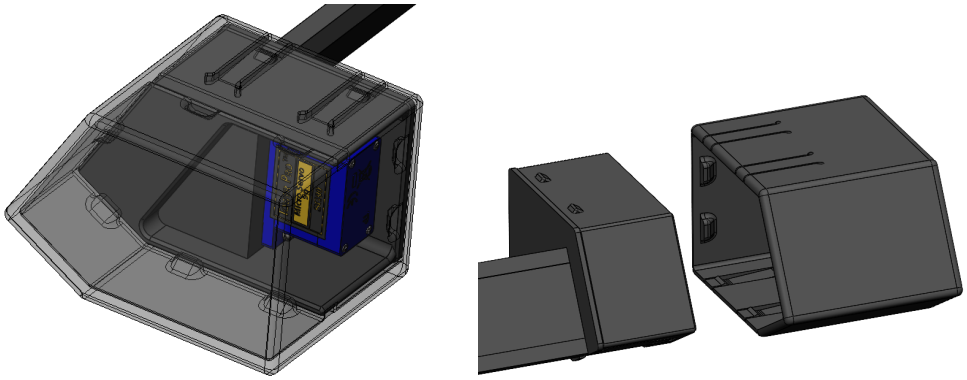


Figure 2.2.1 Servo and Microcontroller Circuit Housing Case

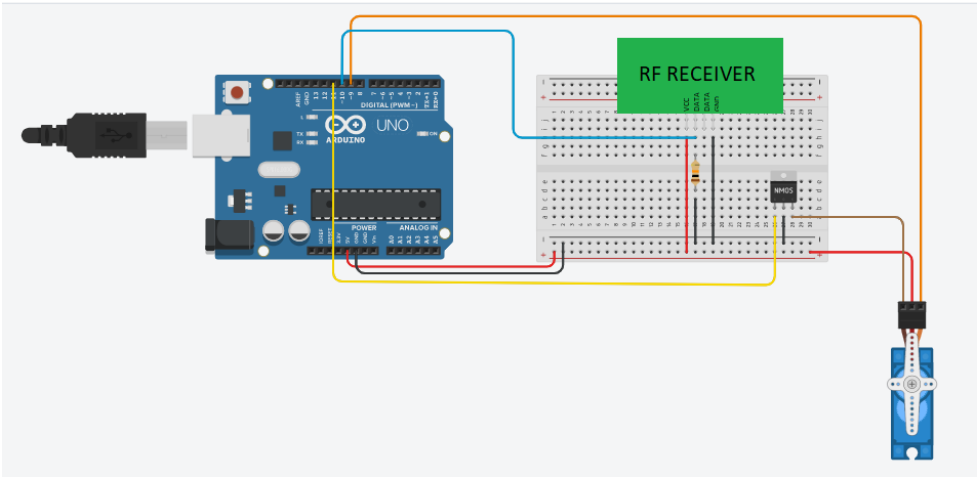


Figure 2.2.2 - Servo and Microcontroller Circuit Diagram

4.2 Activation Button

The activation button is the second subsystem which is designed to allow the user to remotely activate the LED cover. It is a 3D printed casing which houses a circuit board containing an RF transmitter, and a tactile button.

4.2.1 3D printed casing

The 3D printed case is designed to mount onto the joint of an arm used to steer and drive a power wheelchair. It was constructed of PLA and had room inside for the electronics. The main point of the casing is to protect the electronics as well as create a user interface for the device. It is designed to allow the user to easily push the tactile switch inside without the need for pinpoint precision. The large round pushbutton is placed in just the way where it will, when pressed activate the tactile switch inside.

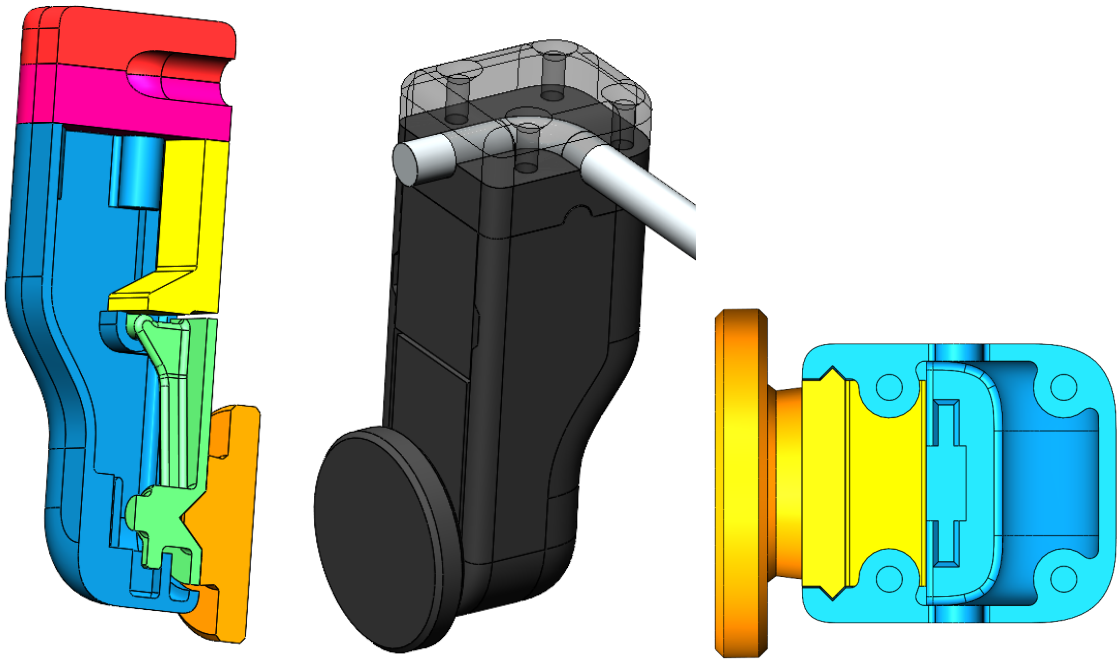


Figure 3.1 - 3D Printed Button Casing

4.2.2 Transmitter and Button

The transmitter and button is a simple system. It is a combination of a simple tactile switch, a pull down resistor and a RF transmitter. It is connected to a 5v DC power supply pulled from a wheelchair battery through a DC-DC buck converter. This circuit uses a tactile switch to

send 5v power to the signal pin of an RF Transmitter. This transmitter will emit a signal for as long as the button is pressed. The button is meant to be pressed for approximately 1-2 seconds to ensure that the receiver will get a strong signal. Below is a circuit diagram of the Transmitter and Button subsystem.

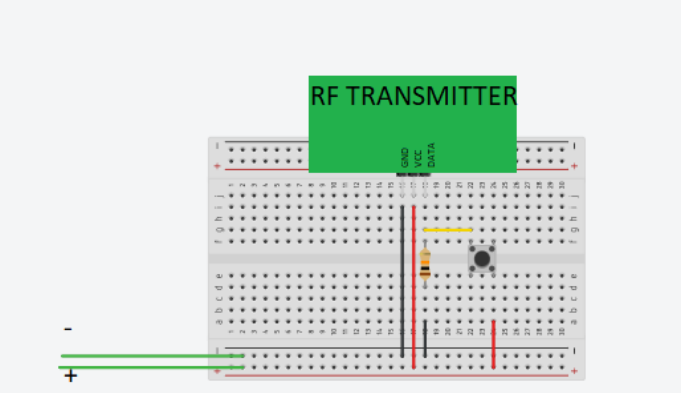


Figure 3.2 - Circuit Diagram for Transmitter and Button

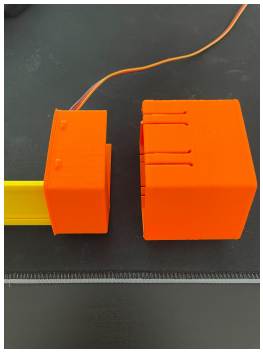
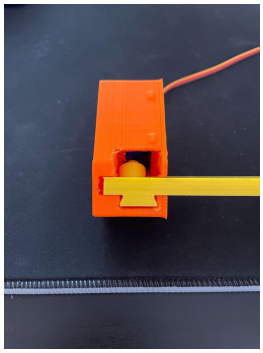
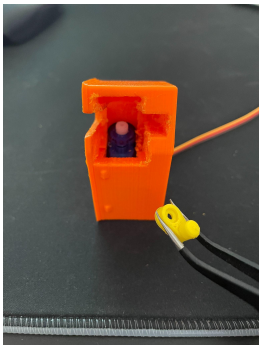
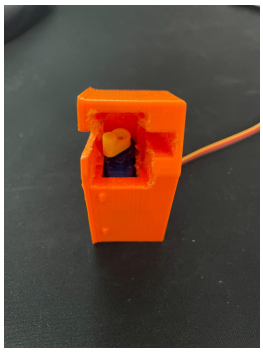
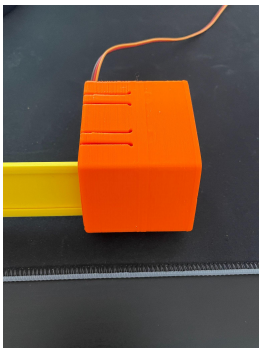
5 Troubleshooting & Support

5.1 Error Messages or Behaviors

5.1.1 Cover moving an incorrect distance

An error that may occur would be that the servo motor becomes out of place, moving the cover an incorrect distance. The servo will need to be realigned to ensure the cover slides the

Table 3 - Instructions for solving placement errors

		
Step 1: Remove casing around servo	**Step 2:** Remove sliding cover from housing	**Step 3:** Use tweezers or pliers to remove horn from servo
		
Step 4: Insert horn back on servo about 22.5 degrees in the direction the servo is facing	**Step 5:** Put the sliding cover back into the casing and attach to the servo horn. Test out the servo and if it slides the correct distance then put the housing back together. If the cover slides an incorrect distance, repeat steps 2-4 and test again.	

5.1.2 Cover stopping halfway

Another error that may arise is the cover stopping halfway. This will result in half of the lights being blocked and the other half not being blocked. This could happen due to the length you push the button for. To operate this button properly you must push it for around a second each time.

5.2 Maintenance

Maintain the servo cover component as well as the button component clean regularly to ensure a smooth performance. Carefully plug and unplug power from the wheelchair when unused to keep wires intact. When not in use, carefully remove the camera cover from the Tobii to not damage either of the devices.

5.3 Support

If you are in any critical emergency situations please call the emergency phone number in your region.

If you are encountered with any problems relating to the circuits or coding information, please contact our electrical department. We will reply within 24 hours to help solve the problem you are experiencing.
Phone: +1 (613) 123-4526 (Mon-Fri, 9am-5pm)
E-mail: electrical@camcovco.ca

If you are experiencing any problems in regards to the physical sliding cover and/or 3D printing of the different pieces, please contact our mechanical department. We will reply within 24 hours to help solve the problem you are experiencing.
Phone: +1 (613) 789-0123 (Mon-Fri, 9am-5pm)
E-mail: mechanical@camcovco.ca

6 Product Documentation

The sliding cover and button were designed to make extensive use of 3D printed parts. The servo cover cover uses snaps for attachment and the servo block wedges onto the sliding cover with tapered dovetails, eliminating the need for additional fasteners.

The electronics were designed for reliability and to minimize power use. RF communication was selected instead of IR due to interference concerns. The 433 RF transmitter and receiver pair was chosen for its low power consumption. In addition, a mosfet was used to switch off the servo while not in operation.

See the MakerRepo listing for details.

6.1 Sliding Cover

6.1.1 BOM (Bill of Materials)

Table 4 - Bill of materials of the sliding cover

Part	**Qty.**	**Notes**
Servo Housing (Cover Size)	1	Use file COVER_HOUSING in configuration COVERSIDE
Servo Housing (Servo Size)	1	Use file COVER_HOUSING in configuration SERVOSIDE
Sliding Cover (Cover Side)	1	Use file SLIDING_COVER in configuration COVERSIDE
Sliding Cover (Servo Side)	1	Use file SLIDING_COVER in configuration SERVOSIDE
Servo Mount	1	Use file SERVO_MOUNT
Servo Cover	1	Use file SERVO_COVER
Servo Horn	1	Use file SERVO_HORN

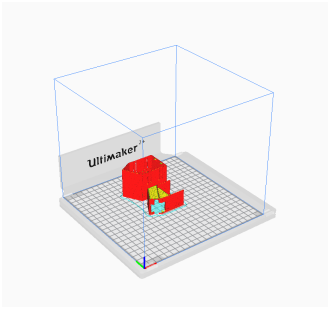
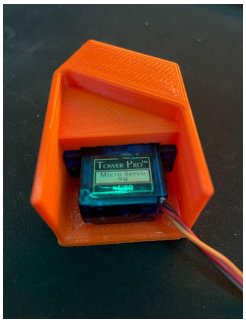
SG90 Micro Servo	1	
Servo Horn Screw	1	Screws may be included with servo
Servo Mounting Screw	2	Screws may be included with servo
3M Command Adhesive Strips	4	Use 3M Command brand picture hanging strips. The strips should have velcro backing.
Adafruit Trinket Microcontroller	1	
Perfboard	1	
N-Channel Mosfet	1	Logic-level mosfet
433MHz RF Receiver	1	

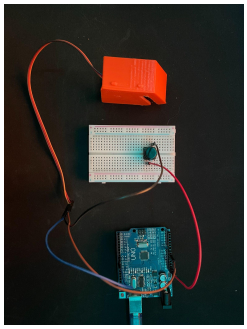
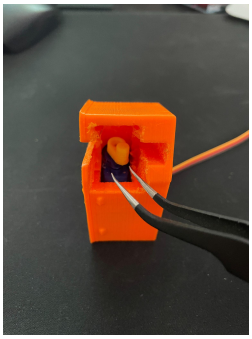
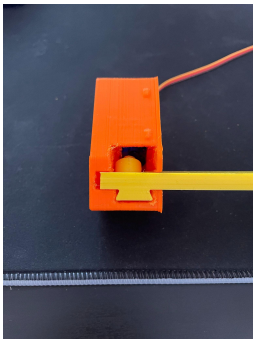
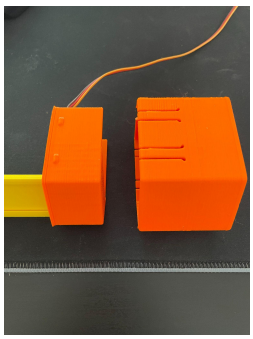
6.1.2 Equipment list

- Soldering Iron + Solder
- 3D Printer + PLA Filament
- #0 Phillips Screwdriver
- Glue (suitable for bonding PLA)
- Pliers

6.1.3 Instructions

Table 6 - Instructions for building the cover

		
Step 1: 3D print all parts	**Step 2:** insert cover into its	**Step 3:** Glue servo into

	rails	casing
		
Step 4: Create the circuit	**Step 5:** Insert servo horn	**Step 6:** Slide cover into servo casing
		
Step 7: Slide cap on the servo casing		

6.2 Button Arm

6.2.1 BOM (Bill of Materials)

Table 5 - Bill of materials for the Button Arm

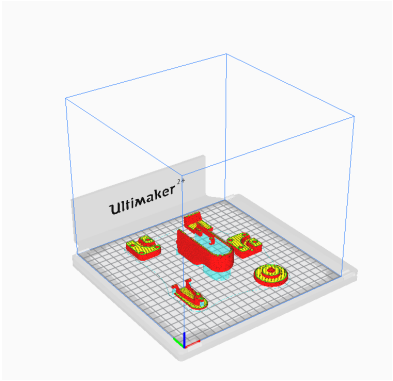
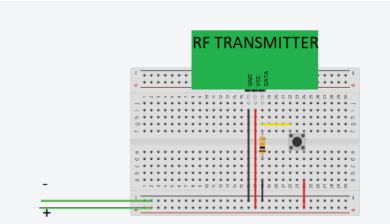
Part	**Qty.**	**Notes**
Button Housing	1	Use file BUTTON_HOUSING
Button Rocker	1	Use file BUTTON_ROCKET

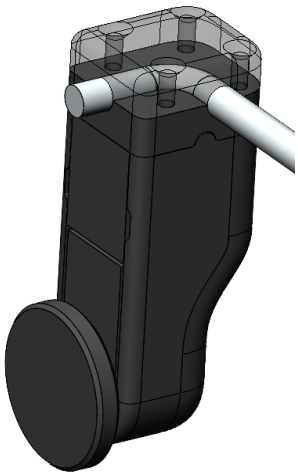
Button Disc	1	Use file PRESS_BUTTON
Button Front Cover	1	Use file BUTTON_FRONT_COVER
Button Upper Clamp Plate	1	Use file UPPER_CLAMP_PLATE
Button Lower Clamp Plate	1	Use file LOWER_CLAMP_PLATE
Mounting Screws	4	M3.8 x 18 self-tapping plastic screws
Tactile Switch	1	
Perfboard	1	
433MHz RF Transmitter	1	

6.2.2 Equipment list

- Soldering Iron + Solder
- #2 Phillips Screwdriver
- Pliers

6.2.3 Instructions

		
Step 1: 3D print all parts	**Step 2:** Insert button under pivot arm	**Step 3:** Create circuit connecting button to transmitter

		
Step 4: Assemble button		

6.3 Testing & Validation

6.3.1 Light Transparency Test

Component to be tested: the LED cover

Testing:

- Place the component between of an IR LED light source and an light sensor measurement tool
- Slide the cover from open to closed position
- we note that a very little (or none) quantity of light shone through.

Result:

Idea for improvement: Add opaque tape to the back of the sliding part on the cover to increase opacity of the material.

6.3.2 Tape Adhesion Test

Component to be tested: LED Cover

Testing:

- Mount the LED cover on a mobile surface using the adhesive strips
- Apply even pressure throughout the device to secure the fit
- Shake or move said mobile surface aggressively and observe result
- Check how secure the fit is after the test.

Result: The device is still mounted securely on the surface after the shake

6.3.3 Drop Test

Component to be tested: LED Cover and Button arm

Testing:

- Dropped each component from a height of two metres
- Observe result and check to damage sign

Results:

No breaks and/or signs of breaking from this height.

6.3.4 Current Consumption Test (not completed)

6.3.5 Wireless Range Test (not completed)

7 Conclusions and Recommendations for Future Work

Lessons Learned

Throughout the duration of this project, the team have developed various skills in different aspects of engineering design, as an individual or as a team. The group explored different aspects of the engineering design process, and to apply the theory learned in class into a customer-centric product development. Through the development process, the team has learned how to properly gather the client/user's information and needs, to draw out the requirements and from there to ideate a variety of possible solutions. The team also learned how to compromise with different opinions and to use a methodical approach to generate an overall solution to the problem. The group also learned to quickly adapt our solution to the given situation without giving any major compromises; from changing our final design concept accordingly when the correct dimensions weren't available, or to reach out to different sources to acquire the necessary parts. On top of that, all members of the group have learned a crucial lesson in time management, to stay on top of the deadlines by adhering to a pre-planned schedule using Wrike, a project management application.

At the end of the project, the team managed to generate an effective solution to the problem. The solution includes 2 separate components and the team was able to produce a

physical prototype of the sliding camera cover as well as the electronics, including the electronics from the button arm joint.

Future Work

Due to the lack of time and the given situation of remote working, the team weren't able to produce a complete final prototype; The button casing concept was designed late due to a communication problem with the client, as the team couldn't acquire proper dimensions and had to change our design in the final minutes; and the 3D casing wasn't printed on time due to Makerspace being closed, and for that the team could not assemble a prototype resembling the designed 3D model. If the case was to be printed on time, it would not be able to be tested on the client's chair, similar to the automatic sliding cover wouldn't be getting tested on an actual Tobii device due to the inappropriate given situation of COVID-19. On the topic of testing, the team weren't able to do all the tests planned out, as the parts were dispersed between members and potential link-up were difficult to realize due to the contemporary social distancing order, and members locating far away from each other.

Had the project been given more time, the team would have done more rigorous testing of the prototype, including but limited to: a power consumption test, a mounting test for all components, a functionality test, etc.. The team would acquire results and feedback from the client to furthermore refine our solution.

APPENDICES

8 APPENDIX I: Design Files

The following documents contain the design process, from empathizing with the client through the first meetings to making and testing the last prototype.

All design files (CAD, arduino code, etc..) can be found at:
https://makerepo.com/amandabrandao/853.wireless-eye-gaze-camera-cover

Table 7. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Project Deliverable B - Needs, Problem Statement, Metrics, Benchmarking and Target Specifications	PD-B	01/24/2021

Project Deliverable C - Conceptual design, Project Plan, and Feasibility Study	PD-C	01/31/2021
Project Deliverable D - Detailed Design, Prototype 1, BOM, Peer Feedback and Team Dynamics	PD-D	02/07/2021
Project Deliverable E - Project Progress Presentation	PD-E	02/14/2021
Project Deliverable F - Prototype 2	PD-F	03/07/2021
Project Deliverable G - Business Model and Economics Report	PD-G	03/21/2021
Project Deliverable H - Design Day Pitch and Final Prototype Evaluation	PD-H	04/08/2021
Project Deliverable J - Final Presentation	PD-J	04/05/2021