GNG 2101 Project Report

Project Deliverable F: Prototype 2

Submitted by

GNG 2101 - Lab C 02, Group 2.4

Avery Lai, 300224907

Kenneth Lorbetskie, 300013409

Dongyu Wang, 300114760

Zhema Wen, 300087146

March 06 / 2022

University of Ottawa

Table of Contents

List of Figures

List of Tables

Abstract

This deliverable is intended to demonstrate the conceptual design, produce the second prototype and include the prototype testing plan. Additionally, this Deliverable F discusses the feedback acquired at the third client meeting.

1. Client Feedback

The client meeting was very useful since it could test the prototype II and give feedback on the design. The client mentioned that the nosepiece of the polarizing glasses needs to be adjusted. Perhaps, the nose section can be curved in ward more and/or that the frame is curved more. Also, the glasses have some distortion due to the cheap lenses, which can be fixed with better quality lenses. The client expressed that the glasses fog up as well. Meanwhile, she liked the functionality of the prototype and that the glasses fit over her hat. Nonetheless, the shape of the frames should be changed to fit her face better. Additionally, the bright light that passes through the window is still bright for the client. This could be improved by having further darkness of the polarizing lenses. Her peripheral vision on the right side is blocked, which is unfavourable. The rear windows on the glasses could be made smaller to aid with the peripheral vision. The client suggested that the wideness of the lenses assist with her peripheral vision. Correspondingly, the lenses' wideness can be re-designed as well while limiting the amount of light that seeps into her eyes from the bottom of the glasses. In terms of the group's reflection, the weight of the board on the polarizing glasses needs to be balanced out on the left and right side.

2. The Most Critical Product Assumption

The outcomes of Prototype II are rather impressive, although certain issues remain. The initial prototype can modify the tint of the glasses lens automatically or manually using the button on the right glasses' leg. However, client feedback indicates that prototype I exhibits both distortion and fog, and while the bright light passing through the window is still too bright for her, she was unable to see anything. In other slightly darker areas with this tint scenario, which may be the most demanding and critical issue. To solve this problem, the polarizing lenses are required to reduce unnecessary light while maintaining the suitable tint on the front of the glasses, which will be addressed before the final prototype.

Prior to replacing our glasses with polarized lenses, we conducted Lens VLT Testing on lenses with a goal specification of 4% VLT, but the result is 9.4% (more details in the Test part). In addition to the VLT testing, two other tests are required to be done. According to the feedback, prototype I's architecture is not ergonomic, implying that the frame itself has a variety of small flaws including: an inability to adapt to a client that wears a hat, light leaking behind the glasses, folding problems, being excessively thick and the frame needs curving. Another essential exam is the battery life assessment. According to comparable competitors on the market, the battery life should be up to 12 hours. Yet, after three rounds of testing, the average battery life is slightly above 9 hours. This also implies that the Final Prototype will require a larger battery to achieve the desired endurance.

3. Description of Prototype II

The primary focus of prototype II is to produce a preliminary frame design that can be used to house the electronics and assess the ergonomics of the product. SolidWorks was used to create sunglasses frames.

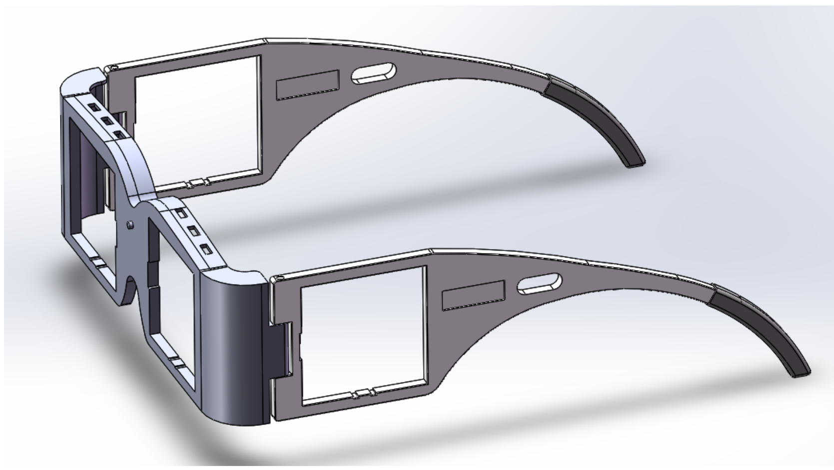


Figure 1: Prototype II CAD Model

The original frame we made is exquisite and looks like normal sunglasses. The initial SW frame is shown below.

Figure 2: Initial CAD Model

After a group meeting, it was decided not to use the initial frame since the liquid crystal lens could only be sourced in a square shape. Thus, I made changes to the frame of the lens including the peripheral lens. The shape was changed to square and the size is the same as the lens(36x36x2). The overall width is 14 centimeters, since the client's sunglasses are about 14 cm to 16 cm wide. For the air holes, we decided to change them to small and inconspicuous holes that are arranged on the top of the front lens and the temple position.

Using the created CAD model, the frames could be produced using a 3D printer. The initial frame design was printed with PLA filament as seen below.

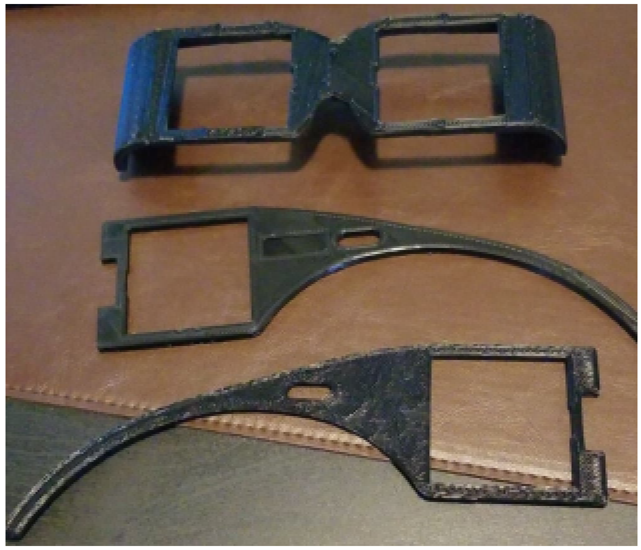


Figure 3: 3D printed frame using PLA filament

A secondary objective for prototype II was to add a power supply to the electronics. This objective was very important to test, since one of the major design requirements is that the glasses can be used all day. As shown below, a 100mAh battery was added to the electrical design in order to power the microcontroller and the electrochromic displays. In addition to the power supply that was added to the electrical schematic, tactile buttons were also added. These buttons will allow the user to manually increment and decrement the amount of visual light that can be transmitted through the lenses. Finally, a new, smaller microcontroller called the Trinket M0 was used to replace the Arduino Uno that was used for prototype I. This makes the electronics footprint significantly smaller.

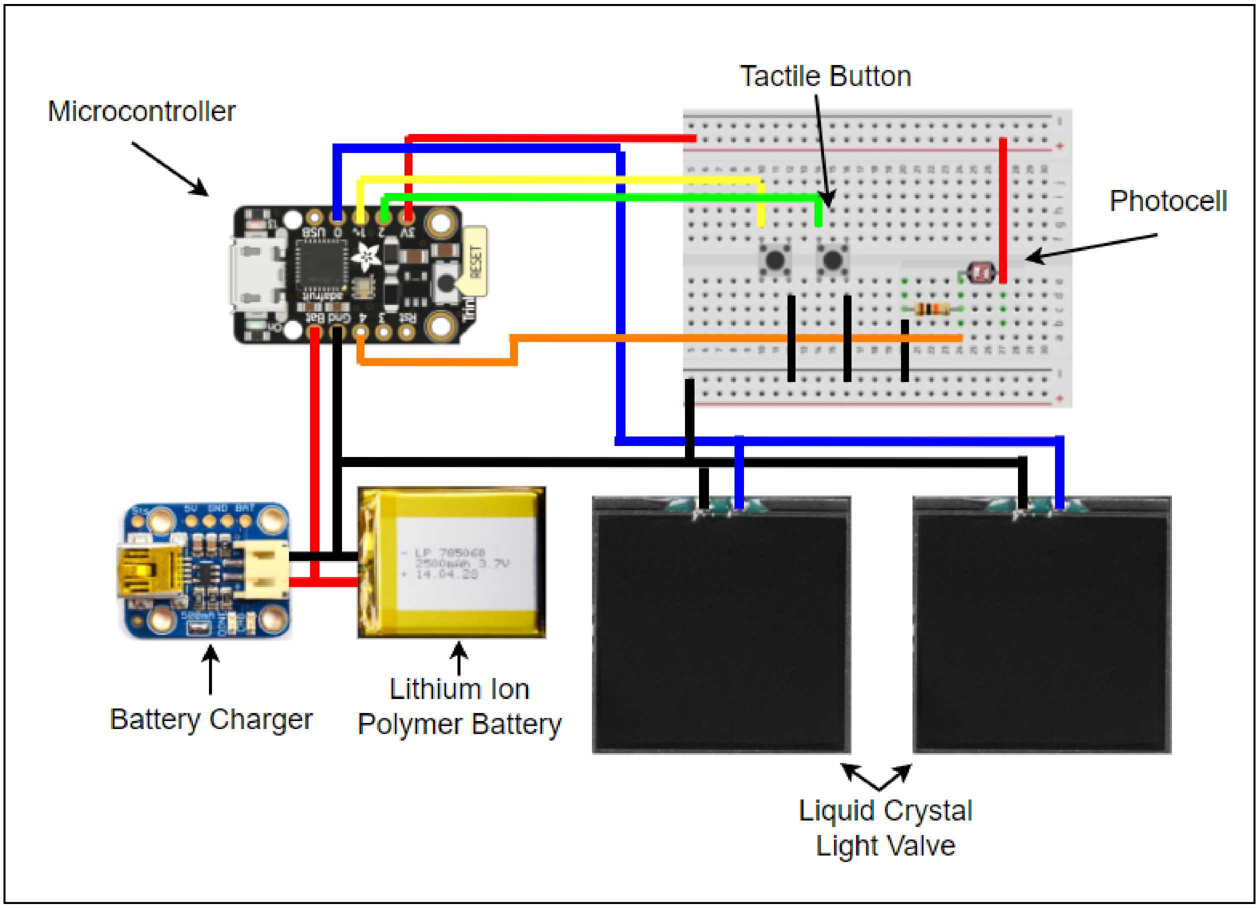


Figure 4: Electrical schematic of prototype II

The software for prototype II has also been updated in order to accommodate user input via the tactile buttons. The following flowchart illustrates the software:

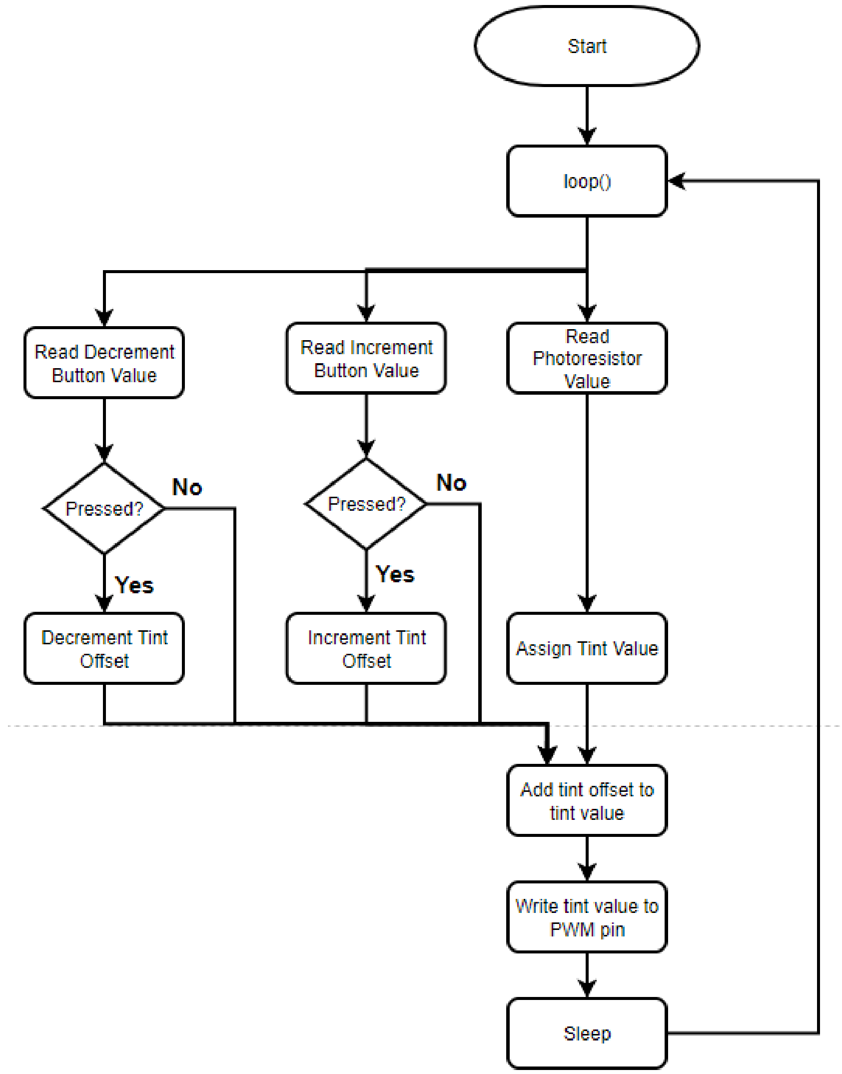


Figure 5. Software flow diagram for prototype II

When the system is supplied with power, the microcontroller will initiate a loop to control the brightness of the sunglasses. The data from the photoresistor and the two buttons will be read. The software will first store the latest ambient light intensity measurement in a variable. Then it will check if the buttons have been pressed. If the increment button is pressed, a positive offset will be applied to the tint value. This will cause the lenses to become darker. If the decrement button is pressed, a negative offset will be applied to the tint value. This will cause the lenses to become brighter. Once the tint value is applied to the displays, via PWM signal, the microcontroller sleeps for a short period of time. Finally the program restarts over again.

The electronics and 3D printed frames were combined together to create a wearable prototype that the Client could put on and test. The finished prototype II can be seen below:

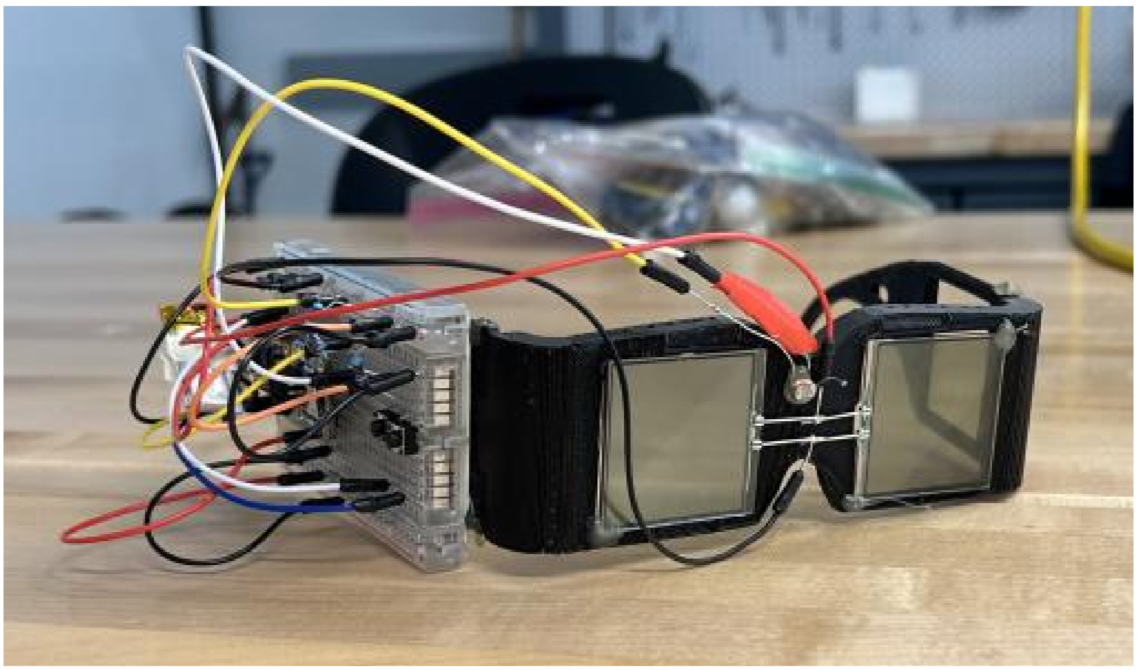


Figure 6: Finished prototype II

4. Prototype Testing

4.1 Ergonomics Testing

Since prototype II was finished in time for the client meeting, the client was able to wear the product and assess the ergonomics.

First, the client expressed that the legs of the frame were too long and unstable. The leg type and joint part will be changed: moving the peripheral lens forward 5 mm.

Second, the client expressed discomfort with regards to the nose-piece since prototype II was missing a proper nose pad. A nose pad attached to the frame, similar to the illustration below, will improve the comfort of the nose-piece.

Figure 7: Glasses with nose-piece

4.2 Battery Life Testing

One of the main changes to the electronics for prototype II was the addition of a battery and charger. In order for the product to provide the most value to the client, The battery life of the product should last the duration of the day. The specification that was decided based on benchmarking other products on the market was a battery life of 12 hours. The following test involved charging the battery to its maximum capacity and then measuring the duration of time to deplete the battery. The test was conducted three times and then the average battery life was computed.

Table 1: Battery life test results

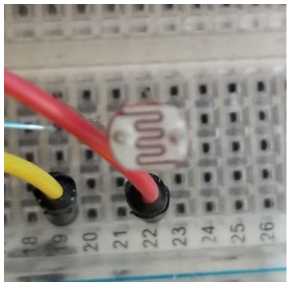
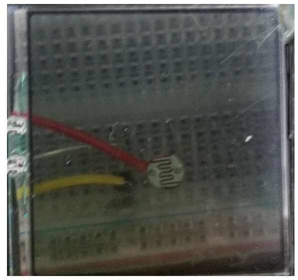
	Battery Life (Hours)
Test 1	9.05
Test 2	9.05
Test 3	8.98
Average	9.03

After conducting the battery life test several times, the battery life was determined to be slightly above 9 hours. These results suggested that the electronics are drawing on average 11.1 mA. The measured battery life is also slightly less than the target specification (12 hours). In order to meet the specification, a larger battery should be used. The next largest battery size that is readily available has a capacity of 150 mAh. Switching to the larger battery will increase the battery life to approximately 13.5 hours.

4.3 Lens VLT Testing

For prototype I, only qualitative observations regarding the visual light transmission (VLT) of the electrochromic displays were made to assess the performance. The test has now been repeated in an attempt to quantify the amount of light that is transmitted through the lenses. A CdS photoresistor was connected to an Arduino in order to measure the light intensity. First a control sample was collected using only the ambient light. Next, the electrochromic lens was placed on top of the photoresistor. When no voltage is applied to the lens, the lens transmits the maximum amount of light. Finally, a 5V PWM signal was applied to the lens in order to minimize the amount of light transmitted. The following table summarizes the results of the test.

Table 2: Visual light transmission (VLT) test results

	Control	**Maximum VLT**	**Minimum VLT**
Qualitative Observation			
Raw Sensor Data	Analog reading = 213 Analog reading = 213 Analog reading = 213 Analog reading = 213 Analog reading = 213	Analog reading = 78 Analog reading = 79 Analog reading = 78 Analog reading = 78 Analog reading = 78	Analog reading = 20 Analog reading = 20 Analog reading = 20 Analog reading = 20 Analog reading = 20
VLT (%)	100%	36.6%	9.4%

According to the results of the test, the minimum visual light transmission that the lens experiences is 9.4%. This value is slightly higher than our target specification (4% VLT). This test suggests that additional tinting will be required to achieve the target specification.

5. Project Plan

GNG 2101 C#02 Group 2.4

List | Table | Gantt Chart

All tasks | By Priority | Expand/Collapse

	Title	Assignee	Status	Start date	Due date	Duration
1	GNG 2101 C#02 Group 2.4	Dongyu Wang	In Progress			
2	Closing					
3	PD I: User manual		New	04/04/2022	04/10/2022	7d
4	PD J: Final presentation		New		04/05/2022	
5	Execution					
6	PD A.2: Client meeting preparation	Avery Lai, Dongyu Wang, Ken Lorbet...	Completed	01/10/2022	01/16/2022	7d
7	PD A submission	Avery Lai	Completed		01/16/2022	
8	Client meet 1	Avery Lai, Dongyu Wang, zhema wen...	Completed		01/17/2022	
9	PD B: Needs	Ken Lorbetskie, Dongyu Wang, zhem...	Completed	01/17/2022	01/23/2022	7d
12	PD C: Concepts	zhema wen, Avery Lai, Dongyu Wang...	Completed	01/24/2022	01/30/2022	7d
15	Client meet 2	Dongyu Wang, zhema wen, Ken Lorb...	Completed		01/31/2022	
16	PD D: Detailed design	Dongyu Wang	Completed	01/31/2022	02/06/2022	7d
22	PD E: Project progress presentation	Dongyu Wang, zhema wen, Avery Lai...	Completed	02/07/2022	02/17/2022	11d
23	Client meet 3	Avery Lai, Ken Lorbetskie, zhema we...	Completed		02/28/2022	
24	PD F: Prototype 2	Ken Lorbetskie, Dongyu Wang, Avery...	Completed	02/28/2022	03/06/2022	7d
29	PD H: Design day		New		03/30/2022	
34	Initiation					
35	PD A.1: Team contract	Ken Lorbetskie, Avery Lai, zhema wen	Completed	01/10/2022	01/16/2022	7d
36	Monitoring and Control					
37	PD A quality check	Avery Lai	Completed	01/10/2022	01/16/2022	7d
38	PD B quality check	Ken Lorbetskie	Completed	01/17/2022	01/23/2022	7d
39	PD C quality check	zhema wen	Completed	01/24/2022	01/30/2022	7d
40	PD D quality check	Dongyu Wang	Completed	01/31/2022	02/06/2022	7d
41	PD D projet plan update	Dongyu Wang	Completed	01/31/2022	02/06/2022	7d
42	PD E quality check	Avery Lai	Completed	02/18/2022	03/01/2022	12d
43	PD E project plan update	Dongyu Wang	Completed	02/07/2022	02/17/2022	11d
44	PD F quality check	Ken Lorbetskie	Completed	03/07/2022	03/23/2022	17d
45	PD F project plan update	Dongyu Wang	Completed	02/18/2022	03/06/2022	17d
	PD G quality check	zhema wen	New	03/21/2022	03/27/2022	7d
47	PD G project plan update	Dongyu Wang	Completed	03/14/2022	03/20/2022	7d
48	PD H quality check	Dongyu Wang	New	03/21/2022	03/30/2022	10d
49	PD I quality check	Avery Lai	New	04/10/2022	04/10/2022	1d
50	PD J quality check	Ken Lorbetskie	New	03/28/2022	04/05/2022	9d
51	PD J project plan update	Dongyu Wang	New	03/30/2022	04/05/2022	7d
52	Planning					
53	PD A.3: Project skeleton	Dongyu Wang	Completed	01/10/2022	01/16/2022	7d
54	PD C.2: Project plan	Dongyu Wang	Completed	01/24/2022	01/30/2022	7d
55	PD D.1.8: BOM	Dongyu Wang, zhema wen, Ken Lorb...	Completed	01/31/2022	02/06/2022	7d
56	PD G: Business model and economics report		In Progress	03/14/2022	03/20/2022	7d

Figure 8. The updated version of the plan

6. Conclusion

In summary, Deliverable F entailed client feedback from the third meeting, a description of the second prototype and various tests on the prototype. For the final solution of the "Dynamically Polarizing Glasses", the nosepiece, weight, tintness, distortion and the wideness of the glasses must be improved upon. Regarding the prototype tests, the group tested for ergonomics, battery life (9.03 hours on average) and VLT test (9.4%).

7. Reference

Adafruit Trinket M0 - for Use With CircuitPython & Arduino IDE - Elmwood Electronics. Elmwood Electronics. https://elmwoodelectronics.ca/products/adafruit-trinket-m0-for-use-with-circuitpython-arduino-ide.

Clifden Matte Black Sunglasses | Oakley® CA. (n.d.). Retrieved January 30, 2022, from https://www.oakley.com/en-ca/product/W0OO9440

James, S. (2020, September 19). *These sunglasses are designed to *really* block light - & light-sensitive eyes rejoice!* Bustle. Retrieved January 30, 2022, from https://www.bustle.com/style/the-best-sunglasses-for-light-sensitive-eyes

Lithium Ion Polymer Battery With Short Cable - 3.7V 350mAh - Elmwood Electronics. Elmwood Electronics. https://elmwoodelectronics.ca/products/lithium-ion-polymer-battery-with-short-cable-3-7v-350mah.

Professional development/Design thinking/Detailed designs - CEED Wiki. https://en.wiki.makerepo.com/wiki/Professional_development/Design_thinking/Detailed_designs.

Small Liquid Crystal Light Valve - Controllable Shutter Glass - Elmwood Electronics. Elmwood Electronics. https://elmwoodelectronics.ca/products/small-liquid-crystal-light-valve-controllable-shutter-glass.

Tactile Switch Buttons (12mm Square, 6mm Tall) X 10 Pack - Elmwood Electronics. Elmwood Electronics.

https://elmwoodelectronics.ca/products/tactile-switch-buttons-12mm-square-6mm-tall-x-10-pack.

What do sunglass categories mean? Sunglasses For Sport. (2021, September 16). Retrieved January 30, 2022, from https://www.sunglassesforsport.com/2014/09/25/what-do-sunglass-categories-mean/

8. Personal Ethics Statement

a) I participated in formulating the standards, roles, and procedures as stated in this contract.
b) I understand that I am obligated to abide by these terms and conditions.
c) *I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.*

Signatures - - - - - - - - - - - - - - - - - - Date: March 06 / 2022

Avery Lai: Avery	Kenneth Lorbetskie: [illegible]
Dongyu Wang: DongYu Wang	Zhema Wen: Zhema Wen