Concen-Training

Vibration Module to Assist in Maintaining Focus

Divide and Conquer 2.0

Group D

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1.0 Project Narrative

1.1 Motivation

The problem of paying attention is one that everyone has experienced. From normal students faced with less exciting learning materials, to students with attention disorders struggling to focus even when they want to, there is always room for a safety net for one's concentration. To solve the problems of students losing focus or being unable to pay attention, our team intends to create a device that alerts the student when their focus drifts.

In the age of smart devices and social media we also find ourselves distracted more often than not, often phone in hand and unable to focus on anything but the latest message. An additional function of our device will be to seal our smart phones away during tasks we'd like to focus on, unsealing only when we've hit a certain amount of time spent focusing.

1.2 Goals and Objectives

The overarching goal is to design a device that helps students pay attention but within that goal lie several smaller ones. One initial goal is to identify software that can help us track whether or not a student is paying attention. Currently we are investigating eye tracking software for this purpose but generally investigating all software that may lend itself to this task is a goal for us. Another goal is determining the best kind of feedback to remind students to pay attention. Between both positive and negative feedback there are a multitude of options for us to choose from, including haptic or vibrating feedback through a wearable device or chair as well as potentially more positive feedback like dispensing a piece of candy when a student reaches a certain milestone in time spent focused. When we have identified the attention tracking software and feedback type we would like to use, there is an additional goal that arises in finding ways to connect the two, writing custom software so that the attention tracking device can talk to our feedback device as well as determining reliable thresholds for when students should be given feedback. After our device is settled upon, further goals include optimizing cost so that the device can be accessible to individuals and students especially who have less money to spend. In addition to cost, optimizing the size of the device and attached software will also make it more available, so that is a goal of ours as well.

At the moment our goals are focused on identifying and testing software for eye tracking and achieving a software response from periods wherein the eye tracking detects no activity. Parallel to that effort are goals in developing an additional pressure sensor for the seat of the chair to make sure the user of the device is seated in their chair. Alongside both sensory devices is the research of our feedback options, one being a vibrating device attached to the chair that responds to bluetooth signals and the other being a device for the desk of the user that is able to restrain their phone.

1.3 Function

Ultimately the function of the device will be to remind students to pay attention when their focus drifts. Currently we expect that to be determined using eye tracking software to see when a student looks away from their screen for an extended period of time. We will also use a pressure sensor to make sure students are seated in the chair as an additional form of detection. When we have determined that a student's focus has lapsed, we will then administer feedback in one of a few ways. One primary method is to vibrate the chair the student is sitting on to grab their attention again.

We will also be helping students prevent their attention from drifting by sealing their smart phone away in an accessory device that locks for the duration of the study period the user sets and unlocks only when they have reached that amount of time of detected activity from the eye tracker.

1.4 Similar Products

Currently there is a device called Revibe Connect that is wearable and uses vibration feedback for students. This device however is based on a fixed timer and will alert students whether or not they are currently paying attention; in fact it may even become a distraction to a focused student. By pairing our device to eye tracking software, we may be able to create a more customized experience for each student as well as one optimized for online learning.

There is also an app called Pocket Points that rewards students for not using their phones in class with points they could redeem for coupons at local vendors. This is the most similar device in function and purpose to the smart lock application of our device that seals away the user’s phone for a predetermined period of time for them to study. Based on experience using the app, it is a very loose barrier between the user and the device, and easily dismissed. While our device would still have a release button for emergencies, it would be slightly harder to become distracted by the device and that added difficulty would hopefully cause fewer distractions. In current times the Pocket Points system that requires students to be on campus to take advantage of their services is in a way outdated. Our product would be usable from the user’s own house where most of their learning takes place these days and where most studying takes place in general.

1.5 Consumer Perspective

Ultimately the consumer in this case would need to be one of a few classes. Ideally, a student that realizes they have an attention problem would benefit most from this tool. If they understand that they need the reminders to pay attention then the device will take care of those reminders and help them remember to focus when their attention drifts. Another consumer may be a parent that wants their child to focus. For that parent, the device can be helpful alongside other parenting measures in encouraging their child to focus on their education and rewarding them for doing so in a more automatic fashion or punishing them for not doing so. Similarly, schools can take advantage of the device as well, especially with the emphasis on online schooling these days. Children with attention disorders may have a harder time than ever focusing in the virtual

environment. A device like this could aid teachers in keeping those students alert. If the associated software was built to record information on areas the student focused on and areas their attention drifted more on, it could also help teachers design more compelling learning assignments. We would like to build a device that is usable across a variety of chairs and computers, thus being inclusive to this wide market of different potential consumers.

2.0 Project Specifications

2.1 Deliverables

Table 1: Specifications Table

Spec Number	Item	Specification
1	Eye-Tracking Accuracy	>90%
2	Eye-Tracking Registration Distance	2 meters
3	Weight Limit	Withstand 200lbs
4	Set-up Time	<10 minutes
5	Chair Module Size	<1 Square Foot
6	Bluetooth Connectivity	Within 3 meters
7	Inactivity Threshold	~1 minute
8	Alerting Threshold	~30 seconds
9	Vibration Module Power	3.3-5 Volts
10	Communication Module Power	3.3-5 Volts
11	Vibration Module Battery Life	>=8 hours
12	Smart Lock Box Size	8” x 5” x 2”
13	Pressure Sensor Weight	>=90 lbs
14	Cable Length (Computer to Smart Lock)	~1 meter

2.2 Specification Descriptions

1. The eye tracking software needs to be accurate in order to fulfill the function of the design.
2. Distance between the camera and user’s face in which the eye-tracking software is able to register eye placement.

3. A limit on weight for the chair attachment device: It must be able to effectively alert the user directly without the device being crushed.
4. Set-up time in terms of attaching the vibration device to the chair, wiring the apparatus to the computer/laptop, and starting up the focus software.
5. Maximum size able to be attached to the chair in question, whether it be on the back or cushion of the seat.
6. The connectivity distance maximum between the chair attachment device and alerting module.
7. Time it takes for the eye-tracking software to measure a period of inactivity/"lost focus".
8. Time after inactivity threshold where inactivity continues: after threshold, vibration module is alerted for focus stimulation.
9. Power required to run the vibration module.
10. Power required to run the communication module.
11. Lifespan of the battery for the chair vibration module.
12. Phone lock needs to support sizes of different phones.
13. Pressure sensor on the chair module should sense weights of at least 90 lbs.
14. Length for cable connecting the Smart Lock to the USB port of the laptop should allow the user to set it on their desk.

2.3 Constraints

- The battery life of the device needs to be long enough to support extended sessions of use.
- The device needs to have a strong connection with the laptop/computer within 3 meters.
- The device needs to be able to support the weight of a user without being crushed.
- The device needs to have a quick response time so that the user can be alerted and come back to focusing quickly.
- The eye tracking software may have problems detecting where the user is looking if they wear glasses due to potential glare off the lenses.
- The pressure sensing and vibrating device requires some sort of ventilation to prevent overheating of the user's bottom.
- The phone lock box will need an emergency release in case of software malfunction.

2.4 House of Quality

The House of Quality is a visual tool used to incorporate design, manufacturing, sales and marketing of the product in question, and it contains matrices that relate aspects of the development process. Figure 1 shows the House of Quality created for this project, taking into consideration things such as Customer Requirements, Technical Requirements, Development Process and Requirement Weights.

Below the House of Quality is a key for what the symbols used in these matrices represent. Correlations are between two engineering design requirements, relationships are between engineering requirements and customer requirements, and "Direction of Improvement" is for determining our optimal level of performance for each specification. The requirement weighted sum takes the weight given to each customer requirement and multiplies it by its respective

relationship, allowing the customer to see the importance of each engineering requirement (the higher the score, the more vital it's functioning is).

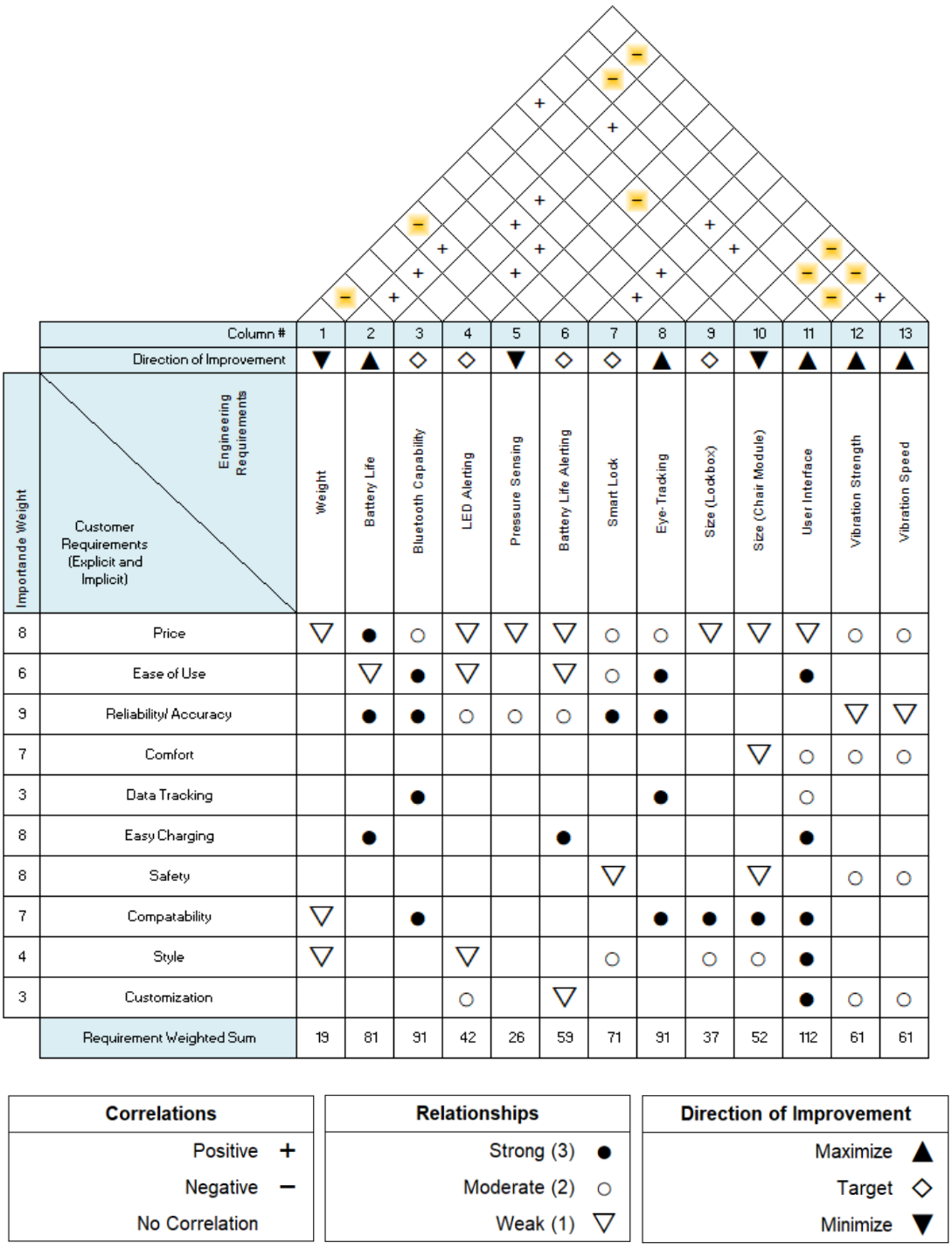

Figure 1: House of Quality

3.0 Block Diagrams

3.1 Hardware

The hardware design consists of a few key elements. The user will allow access to their laptop's webcam for the eye tracking software to work. This software will relay information via bluetooth to the microcontroller in the user's chair. From there the motors will be notified to turn the vibration mechanism on or off based on the eye tracking input. The hardware will either be attached to the back of the chair or inside the seat cushion. By attaching the mechanism to the back of the chair, this could be more easily implemented by consumers to their existing desk chairs. There will also be a lock box for the user to put their phone in while they are studying to be free of distractions. This box will lock for a desired amount of time and be unlocked as a reward for continued focus. It will also have an emergency release system in case of emergencies.

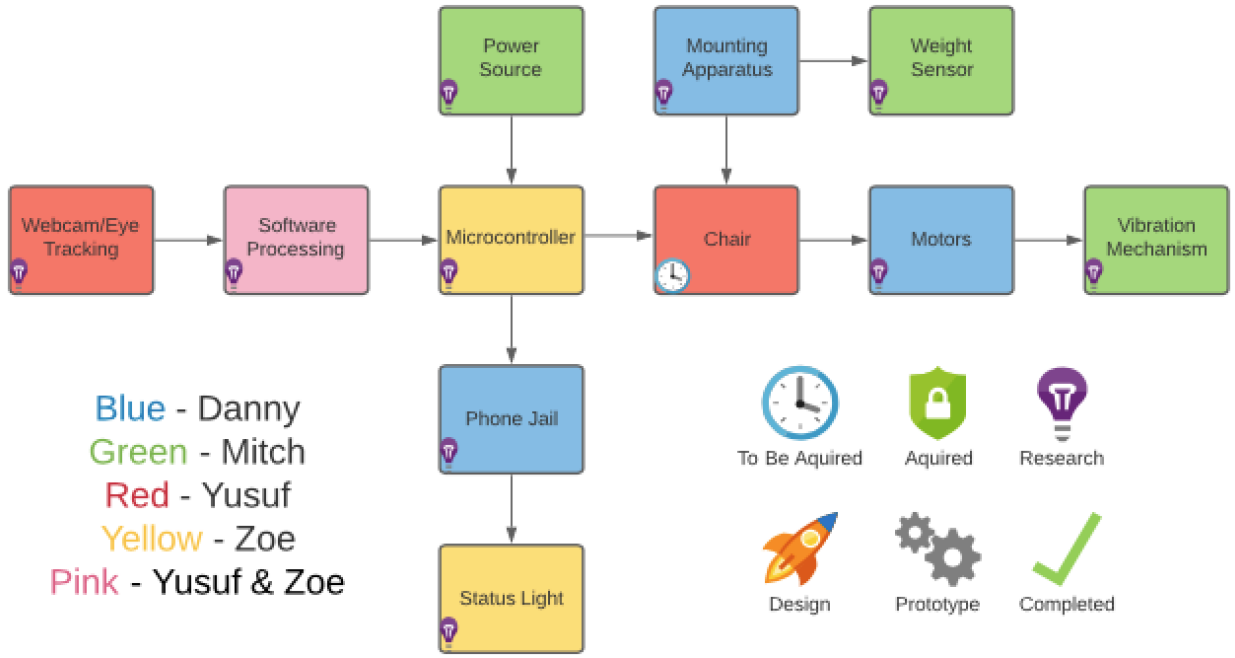

Figure 2: Block Diagram of Hardware Components

3.2 Software

The design will include a settings menu for the user to access. The menu will include the ability to turn the software on or off along with other variable settings. The user will be able to set their unique specifications regarding how long they can look away from their screen. For example, if the user is taking notes, that might require a longer interval than watching a lecture or video. If positive reinforcement is being used, a minimum time requirement will be set that the user can adjust. Once the user has focused on the material presented for the desired time, they will be rewarded or reminded to take a quick break. The current design implements a place to lock the user's cell phone away on their desk to help them focus without distraction. To regain access to

their phone, they will have to accrue a designated time with their eyes on the screen. A timer will start once they're focused with their eyes on screen and will pause every time they look away. The software will be designed to continually take input from the webcam to determine if the user is focused on the materials on screen or not. If the user is looking away from the screen there will be a time limit for them to return their focus to the screen. If that time elapses and their gaze is still off the screen, this will trigger the vibration in the chair to remind them to return to their laptop.

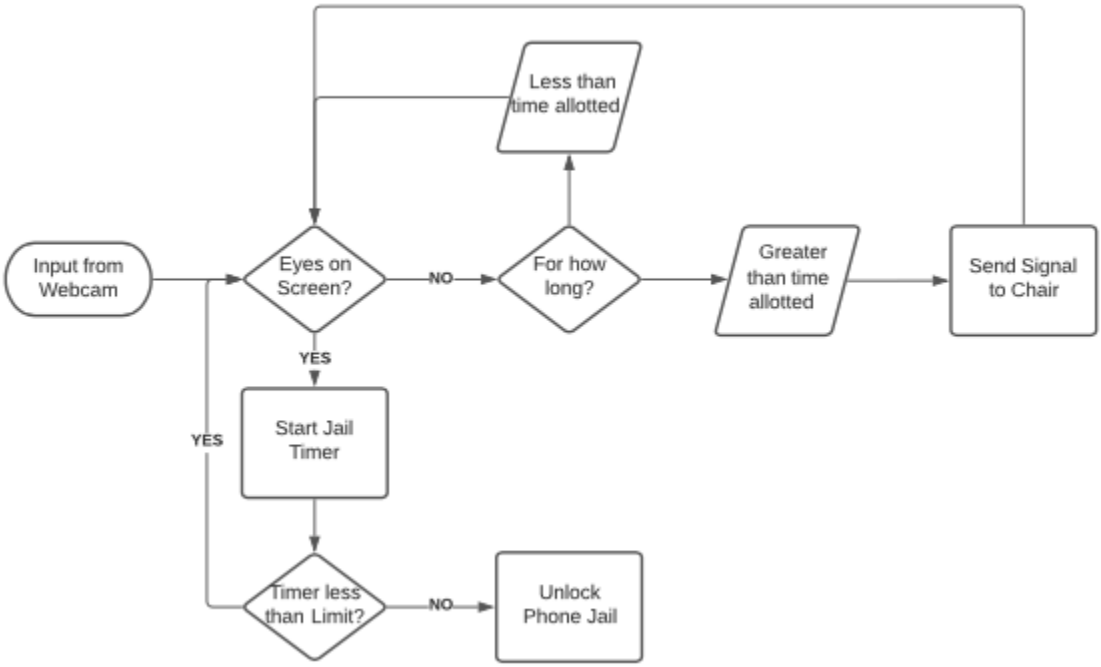

Figure 3: Block Diagram of Software Components

3.3 Prototype Sketch

As previously stated, our software will be utilizing the webcam already implemented in the user's laptop/computer. After a period of inactivity, the sensor sends a message to the communication module, which then either waits for another signal cancelling that inactivity (eyes return to the screen and the sensors record it), or a period of time passes past inactivity and focus stimulation must be applied (the vibration jolt). To experience the fastest communication between sensor and communication module, the communication module will be linked via USB connection to the computer in use.

Once a vibration signal is needed according to the sensor's message, a bluetooth message on the communication device will be triggered, sending a signal to the vibrating module on the chair/stimulation apparatus (which should be physically separate from the communication device for ease of setup and streamlined appeal). Once this message is received, a slightly uncomfortable vibration will be triggered on the chair in order to remind the user to maintain eye

contact with the material on the screen. The figure below is a pictorial representation of how the product environment shall be portrayed.

In addition to these modules, extra reinforcement and deterrent tools will be utilized. A smart-lockbox will be implemented to hold the user's phone for certain amounts of time (pictured in green). If they have been focusing for a certain period of time, the box will flash green, indicating a small phone break is allowed, and the box will unlock. When the break is over, the box will flash red, requiring the phone to be placed back in the box.

To ensure that the user is sitting in the chair, there will be a pressure sensor in the cushion of the chair. This ensures that the user is in contact with the chair vibration module, allowing for optimal usage of our focusing system.

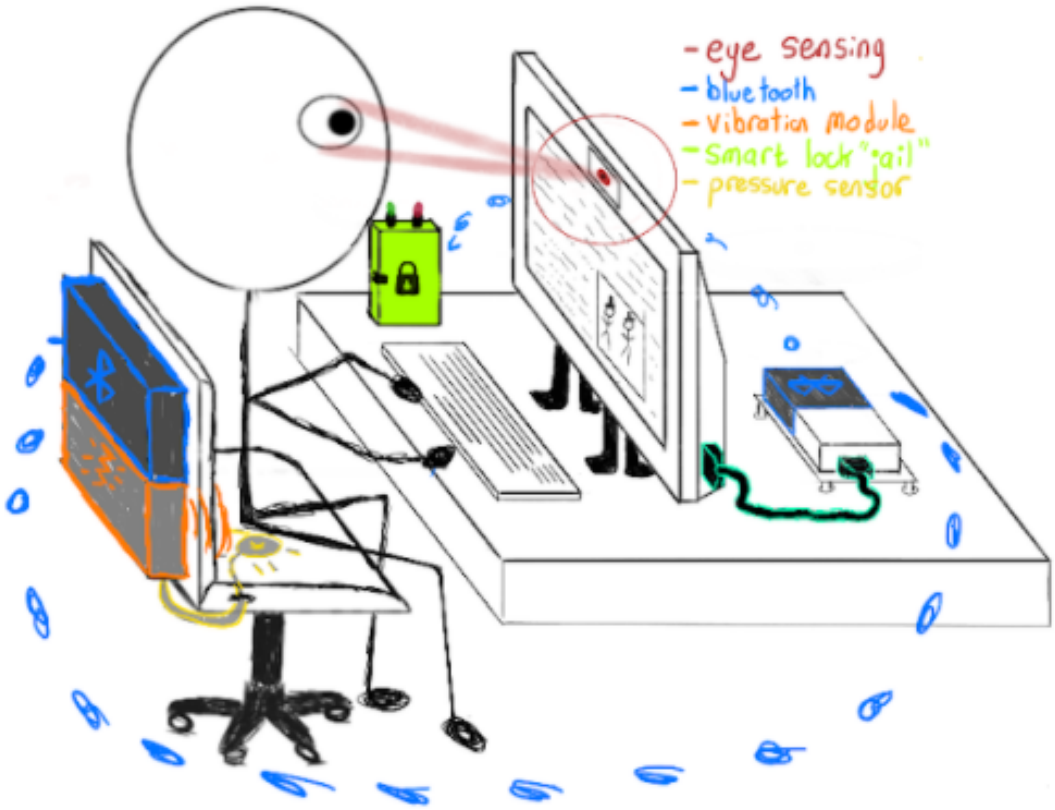

Figure 4: Prototype Sketch

4.0 Budget

The maximum budget for our design project was agreed to be $600 ($150 by each student for contribution). No sponsors are currently funding this project, and all funds have been provided by the students.

The following table describes a list of components to be included with this design project. The prices of these items are based on brief research of potential components to be utilized while

fabricating this project, and includes no specific part numbers or prices. These prices may fluctuate depending on availability, seller, and complexity.

Table 2: Generalized Budget Deconstruction

Item Number	**Component Name**	**Estimated Cost ($)**
1	Camera Sensors	200
2	Mounting Apparatus	20
3	Chair	100
4	Bluetooth Module	30
5	Vibration Module	30
6	Power Supply/ Power Converter	20
7	Remote Battery	20
8	Mounting Board	20
9	PCB	100
10	Microcontroller	0 (already owned)
11	Pressure sensor	15
12	Smart Locking Mechanism	30
13	Lock Box	15
Total Estimated Budget: $600		

5.0 Milestones

Described in the tables below is a collection of milestones designed to keep on track with the progression of Senior Design. Table 3 describes documents with specific deadlines to be submitted for grading. Table 4 describes group related milestones to keep on track with the development of the project overall. Table 5 specifies certain technical goals to be accomplished throughout Senior Design 1 in order to complete things in a timely manner.

Table 6 includes projected milestones for the second half of this course, Senior Design 2, which is subject to change based on what is completed in Senior Design 1.

Table 3: Senior Design 1 Deliverables

Document	Start Date	End Date	Status
Divide and Conquer 1.0	1/19/21	1/29/21	Complete
Divide and Conquer 2.0	1/30/21	2/12/21	In Progress
1st Draft (60 Pages)	2/13/21	4/8/21	Not Started
2nd Draft (100 Pages)	2/19/21	4/16/21	Not Started
Final Draft (120 Pages)	2/19/21	4/26/21	Not Started

Table 4: Senior Design 1 Team Goals

Task	Start Date	End Date	Status
Form Team	1/12/21	1/19/21	Completed
Brainstorm Project Ideas/ Decide Project Subject	1/14/21	1/29/21	Completed
Assign Project Roles / Define Weekly Meeting Times (M & F)	1/19/21	2/12/21	In Progress
Table of Contents	2/13/21	4/20/21	In Progress
Develop Stable Concept for Hardware/ Software Implementation	2/1/21	3/15/21	In Progress
Begin researching hard skills tutorials for Senior Design 2 Fabrication (EagleCAD, Soldering, AutoCAD, etc. . .)	2/2/21	4/26/21	In Progress
Develop Contacts List for references (professors, companies, etc. . .)	2/2/21	4/26/21	In Progress
Begin Ordering Components	2/28/21	4/26/21	Not Started

Table 5: Senior Design 1 Technical Goals

Task	Start Date	End Date	Status
Eye-Tracking	1/19/21	2/28/21	In Progress
Power Supply	1/19/21	3/15/21	In Progress
Bluetooth System	1/19/21	2/28/21	In Progress
Re-enforcement Apparatus Decision	1/19/21	2/3/19	Complete
Vibration System	1/19/21	4/16/21	In Progress
PCB Hardware Design	2/1/21	4/16/21	Not Started
Software Design	2/1/21	4/16/21	Not Started
Pressure Sensing	2/1/21	4/16/21	Not Started
Smart Lock Mechanism	2/1/21	4/16/21	Not Started

Table 6: Senior Design 2 Milestones

Task	Start Date	End Date	Status
Recap Meeting/ Project Review	1st week	1st week	Not Started
Gather Components	1st week	1st week	Not Started
Test All Components Individually	1st week	2nd week	Not Started
Fabricate and Test hardware apparatus (soldering, etc. . .)	2nd week	3rd week	Not Started
Construct Physical Apparatus	2nd week	3rd week	Not Started
Troubleshoot Software Implementation	3rd week	4th week	Not Started
Develop Project Presentation with Demonstrations, working results, etc. . .	1st week	4th week	Not Started