GNG 2101

Design Project User and Product Manual

A Helping Hand

Submitted by:

A Third Hand-Z22

Sean Tsang 300169816

Daniel Deiros 300166389

KC Ezrim 300194524

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1. Introduction

The Helping Hand was created because our client requested that the team make a solution for people who would like to use grabbers however do not have the required hand strength or dexterity to squeeze the trigger. The team assumed that the users have the hand mobility to put on straps and buckles for both the device and them. Additionally, it is assumed the user has a grabber that can fit in to our device, not a grabber with a unique or obscure handle/trigger design. This document contains an overview of our product, cautions and warnings, system setup and navigation on how to use the device, maintenance, device behavior, and product documentation. The purpose of this document is to provide the reader with in-depth information about our device that the user should be aware of to safely and effectively use the device, any users of this device should read this document to familiarize themselves with the information on how to use the device properly. Some potential security issues are the grabber not being strong enough to carry a heavy object and dropping it on the user, or the grabber breaking and parts of it falling on the user. There are no serious privacy considerations for our device. A great perk of our device is that it is quite safe.

2. Overview

The issue with conventional grabbers is that people with physical disabilities, especially those with a lack of hand strength and finger dexterity cannot use them. Thus, it is important to come up with a device that allows such user to operate the grabbers even when they lack the physical capabilities to do so. The device needs to be lightweight, ergonomic, safe to use, and automatically squeeze the trigger for the user. The device our team provides is like none other, our single-handed device is an attachment to almost any conventional grabber. The Helping Hand provides wrist support using a strap that goes around the forearm as well as an ergonomically placed handle, which maximizes comfort for the user. Additionally, the Helping Hand can squeeze a conventional grabber automatically with the push of a button.

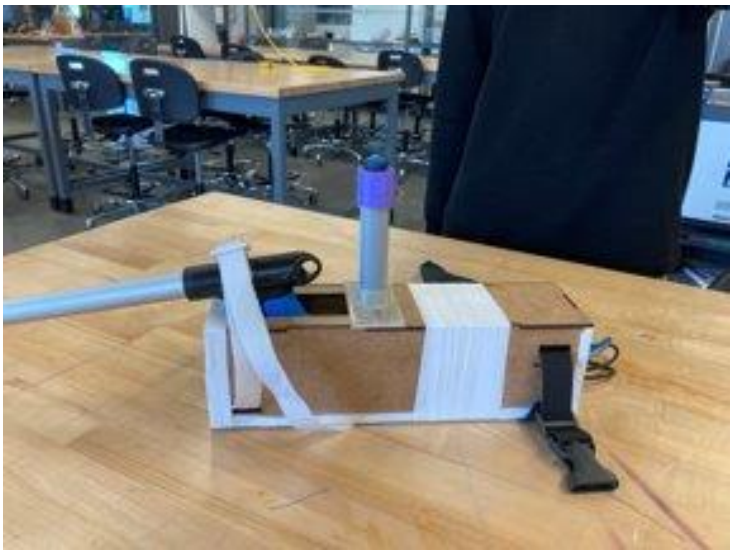

Figure 1: The Helping Hand

Our device uses and off the market grabber and its automatically squeezes the trigger of the grabber with the push of a button. How the grabber is squeezed is manually controlled by the user, the user pushes the button to control the claws of the grabber. The Helping Hand is in the shape of a rectangular prism with a handle in the middle for the user to grab on to and it is where the button is located for the user to press. There are two straps near the front and back of the device, one that straps the user's forearm into place and the other to strap the grabber. There is no special condition for the device.

2.1 Cautions & Warnings

On the current model of the Helping Hand users should be cautious of the exposed wire at the back of the to charge the battery of the Helping Hand. If you were to get a bracelet or long hair caught on the wire it may cause harm, to the user. Additionally, if a person were to put their hand in the opening of the box where the grabber is supposed to, they may be hurt, or it may cause damage to their hand. Users should be cautious of the linear actuator as it a mechanical device which can harm the user if used incorrectly.

3. Getting started

To set up and initialize the Helping Hand, begin by first observing the back of the device. Located at the back is a rectangle cut out that allows access to the battery pack. Push the switch to turn on the Helping hand.

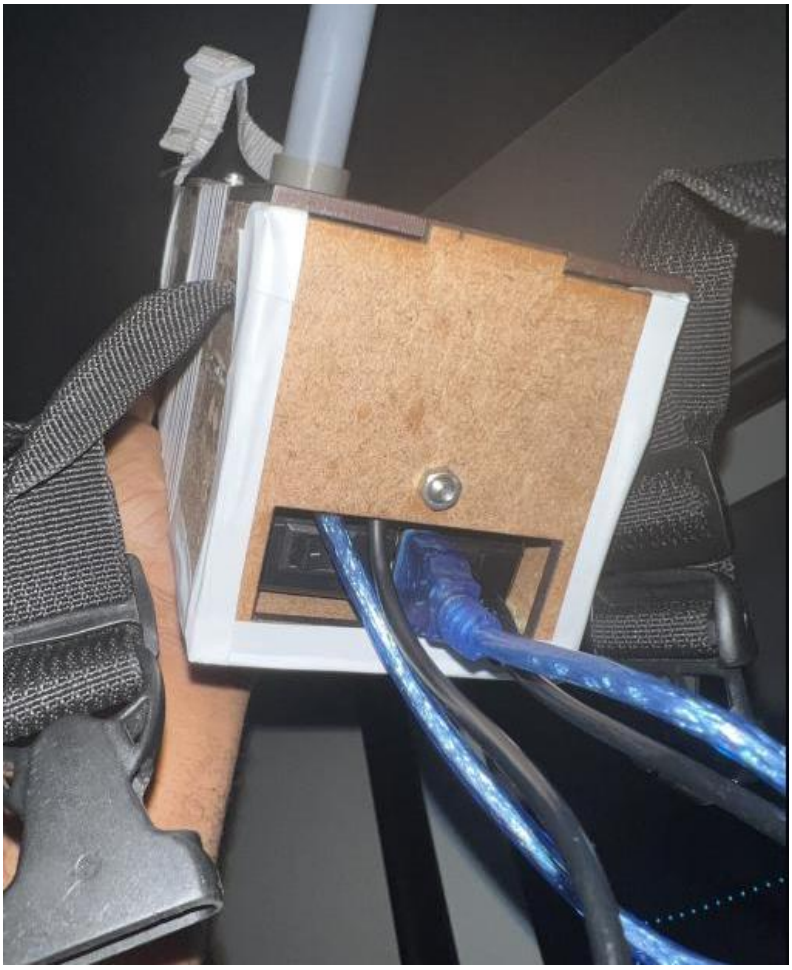

Figure 2: Back of The Helping Hand

Once on, adjust the forearm strap to size, the strap is located near the back of the device, to tighten pull on the loose piece connected to the buckle, both the male and female parts of the strap can be adjusted to size. Once the desired size is attained connect the buckle together so the forearm can be slide in and out of the strap.

Figure 3: Wrist strap properly secured.

Next put the grabber in the cut out that is near the front of the box, make sure the grabber goes through the whole device including the metal loop, once in, strap the grabber in place and tighten accordingly.

Figure 4: Hole where grabber goes in.

Once the setup, put your arm through the strap and grab the handle; when the object that is desired to picked up by the grabber is between the claws, press the button once, this will begin to close the claws of the grabber.

Figure 5: The Helping Hand being used properly.

When the grabber has a sufficient grip on the object the button can be pressed again to lock the claws in its current position. Move the object to its desired location; once there press the button to open the claws and move the grabber claws away from the object. Finally, press the button to stop the claws and the object is ready to be picked up by the user using their hand.

3.1 Configuration Considerations

3.2 User Access Considerations

The user of our product could be divided into two; the person with physical disabilities and someone to assist. It might be difficult for just the disabled person to put on the device themselves, like strapping themselves or strapping the grabber. But for a non-disabled person it can be done in a minute or less.

3.3 Accessing/setting-up the System

To set up the user would need to turn on the switch at the back of the product and strap in the grabber and then the arm.

3.4 System Organization & Navigation

There are 2 main parts: the main device and the commercial grabber. The grabber is connected by a strap for now but could be improved by placing a clamp to hold the shaft of the grabber.

3.5 Exiting the System

There is a switch inside of the box, facing the back, that can be reached through a hole to simply turn off the power source of the system

4 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of The Helping Hand.

4.1 User Switches Battery On

First, in order to turn on the product, the user must switch on the battery. This will be easily accessible on the back of the box (the side with the wrist strap) through a hole. Refer to the figure below.

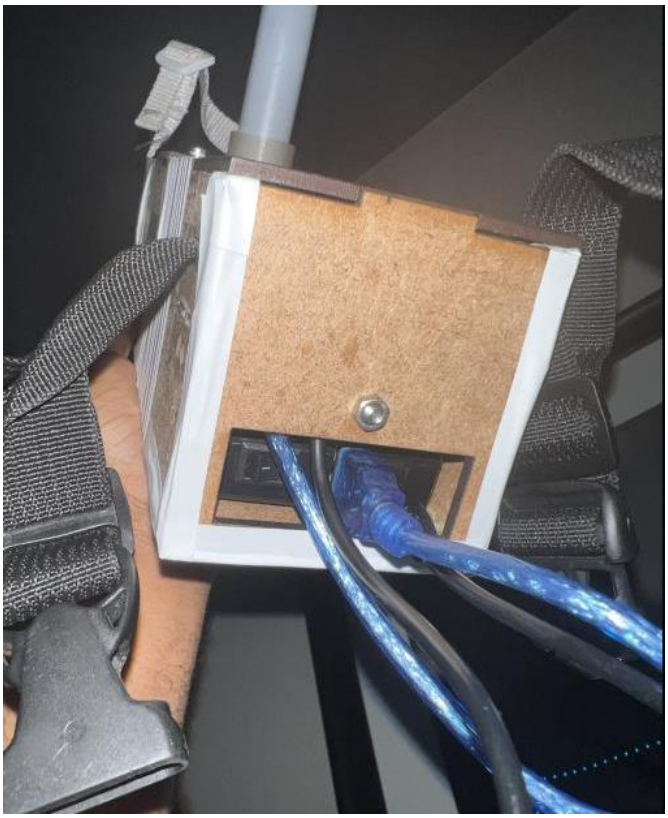

Figure 7: The back of The Helping Hand.

4.2 User Presses Button

Graciously, The Third Hand only requires the single button on top of the box to open and close the claws of the grabber. Depending on the stage of the sequence, the linear actuator will behave different. Let us define each stage of the sequence. The start of the sequence assumes a grabber with open claws.

1. Stage 1: The claws close.
2. Stage 2: The claws stop closing.
3. Stage 3: The claws open.
4. Stage 4: The claws stop opening. Now, we are back to stage 1.

Using the button, the user can use the grabber to pick up objects and release them wherever necessary.

Figure 8: The Helping Hand being used properly.

4.2.1 Linear Actuator Moves Backwards

The linear actuator here moves backwards in order to pull the loop wrapped around the trigger of the grabber. This causes the trigger of the grabber to be squeezed, and so the claws of the grabber close. This refers to stage 1 of the sequence.

4.2.2 Linear Actuator Stops

The linear actuator stops moving. This causes the loop to stop moving and stay in place. The claws can either stop closing or stop opening. This refers to stages 2 and 4 of the sequence.

4.2.3 Linear Actuator Moves Forwards

The linear actuator moves forwards in order to push the loop wrapped around the trigger of the grabber forward. This causes the trigger of the grabber to be released and let go by the loop, which in turn allows for the claws of the grabber to open. This refers to stage 3 of the sequence.

5 Troubleshooting & Support

In this section, troubleshooting and correction procedures will be included when using the product.

5.1 Error Messages or Behaviors

The user should always make sure the linear actuator is facing the right direction which would allow the grabber to go through the metal strap that would pull the trigger. There would be a weird static kind of noise that is coming from the linear actuator. This indicates that the actuator cannot go any further and should click the button.

5.2 Maintenance

No maintenance is required for the product. Nonetheless, the user should prevent water from touching the device as it was not tested if waterproof. Make sure the battery is charged every second day if used regularly to ensure that the linear actuator functions with mac power.

5.3 Support

If the product doesn't work and the issue is found to be the linear actuator, the issue is most likely to be the battery, as when the team tested the battery has a tendency to fail occasionally. To contact our support team, send an email to stsan066@uottawa.ca with any questions or inquiries about the product.

6 Product Documentation

Our product contains different aspects like: mechanical, electrical and software system. For the mechanical, it is a simple linear actuator connected to a sort of metal clamp shown in the figure below.

Figure 9: Metal clamp (left) and linear actuator (right).

How we connected it was with the screw that was given. There are two screws on for the back that is to keep it stable and rigid while the other is for the front side of the actuator which connects to the metal clamp shown above. The clamp has a large width, so we filled the front side.

The next aspect is the electrical system which could be easily illustrated by the diagram shown below.

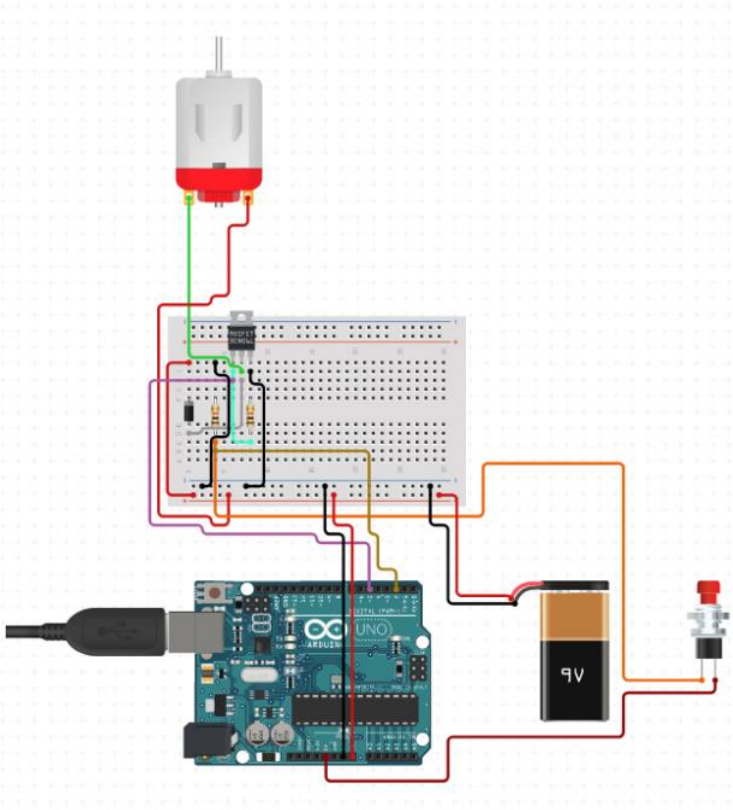

Figure 10: The electrical configuration of the product.

The next aspect is the software system. We used a microprocessor which acts as the brain of the device. The microprocessor is called an Arduino, so we used the programming software Arduino to set the actuator to respond to the button signal.

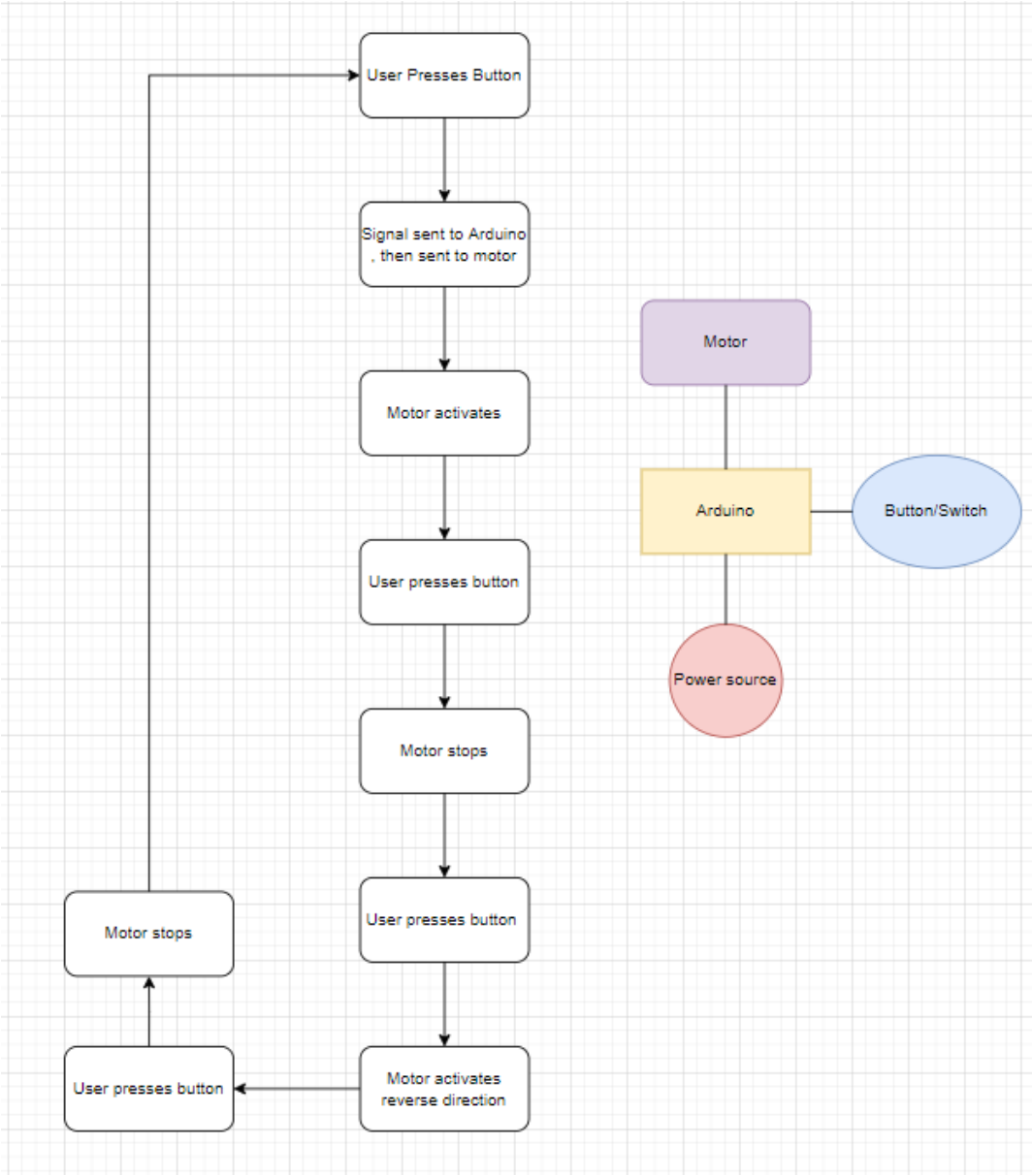

Figure 11: Block diagram

The program should make the linear actuator first extend by pressing the button once and then press the button again to stop extending. If the user doesn't press the button before the actuator fully extends nothing would happen. The button would be pressed again to retract the actuator to the shortest length possible. The code used for the prototype is shown below.

```
// Adafruit Motor shield library
// copyright Adafruit Industries LLC, 2009
// this code is public domain, enjoy!
#include <AFMotor.h>
AF_DCMotor motor (4);
int a=0;
const char BUTTON_PIN = A5;
void setup () {
Serial.begin(115200); //Setup pin modes
pinMode(BUTTON_PIN, INPUT_PULLUP);
motor.setSpeed(200);
}
void loop () {
int currentState = digitalRead(BUTTON_PIN);
Serial.println(currentState);
if (currentState == 1 and a==0) {
Serial.println("Siuuu");
Serial.println(currentState);
motor.setSpeed(450);
motor.run(FORWARD);
```

```
}
else if (currentState==0 and a==0) {
a=1;
Serial.println(currentState);
Serial.println("Hola");
motor.run(RELEASE);
delay(500);
}
else if (currentState==1 and a==1) {
Serial.println("Hola");
Serial.println(currentState);
motor.run(RELEASE);
}
else if (currentState==0 and a==1) {
a=2; Serial.println(currentState);
Serial.println("Pessi");
motor.run(BACKWARD);
delay (500);
}
else if (currentState==1 and a==2) {
Serial.println("Pessi");
```

```
Serial.println(currentState);
motor.run(BACKWARD);
}
else if (currentState==0 and a==2) {
a=3; Serial.println(currentState);
Serial.println("Papa");
motor.run(RELEASE);
delay(500);
}
else if (currentState==1 and a==3) {
Serial.println("Papa");
Serial.println(currentState);
motor.run(RELEASE);
}
else if (currentState==0 and a==3){
a=0;
delay (500);
}
}
```

6.1 Materials and components used

6.1.1 BOM (Bill of Materials)

Item #	Name	Description	Qty	Cost	Total cost	Source
1	Outer case for Arduino	Laser Cut Wooden Box	1	3.00	3.00	MakerLab
2	Outer case for linear actuator	Laser cut wooden box	1	5.00	5.00	MakerLab
3	Arduino	Arduino Uno	1	9.00	9.00	arduino
5	Batteries	Reachable batteries	1	49.99	49.99	Battery 12V Rechargeable
6	Flange	Plastic 3D modeled	1	0.40	0.40	3D print
7	Linear actuator	Linear actuator	1	32.95	32.95	amazon
8	Strap for Handle	Buckle to keep grabber in place	1	1.99	1.99	
9	Button	Button from MakerLab	1	0.50	0.50	MakerLab
10	PVC Pipe (to support button)	Pipe for handle grip	1	0.40	0.40	MakerLab
14	Wires	Wires to connect motor shield with actuator	8	1.00	1.00	MakerLab
15	Shield	Motor Shield	1	20.00	20.00	MakerLab
16	Glue	Super Glue	1	6.00	6.00	Glue

17	Screws	0.25 inch	4	0.10	0.40	MakerLab
18	Nuts	0.25 inch	4	0.30	1.20	MakerLab
Total project cost:					$131.83	

6.1.2 Equipment list

The equipment used to create the project were laser cutter, 3D-printer, screwdrivers, hand saw, sandpaper, wire cutters, and solder tool.

6.1.3 Instructions

- To create 2 cad file: one for the flange and the other for the button adaptor and 3-d print it.

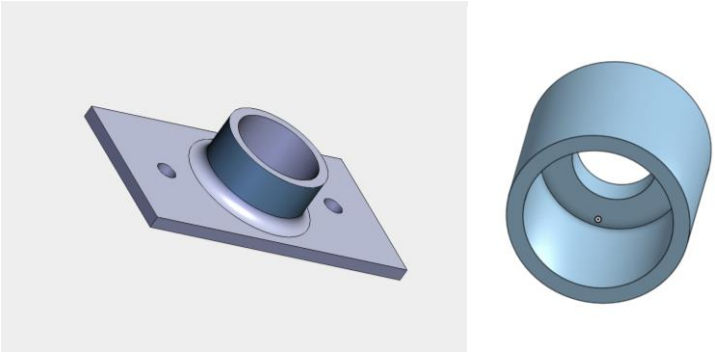

Figure 12: CAD files for the flange (left) and button adapter (right)

- Then also create a cad file and the drawing for the box parts. We use the drawing for laser cutting on a 0.125-inch wooden board

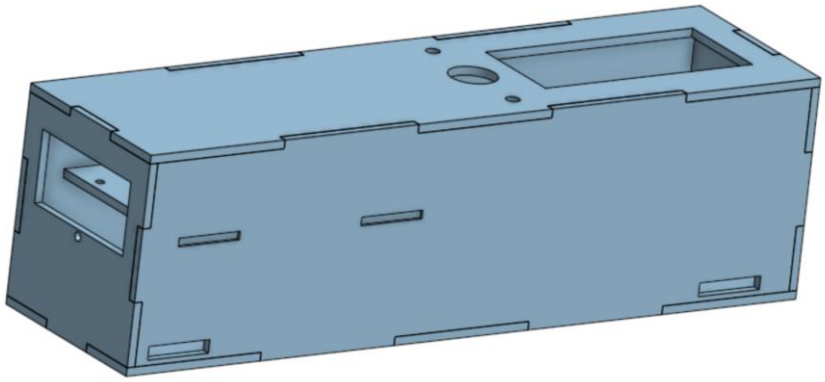

Figure 13: The CAD file for the box

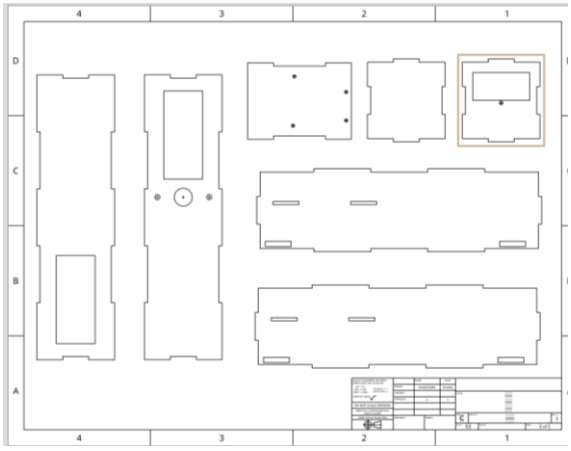

Figure 14: Engineering drawing of box.

- With the PVC pipe, a handle would be created using the button, button adaptor, the PVC pipe, and the flange. You will also use a screw to fasten the handle through the flange
- The Arduino is placed on the top part of the box while the battery and the actuator is placed on the bottom part of the box.

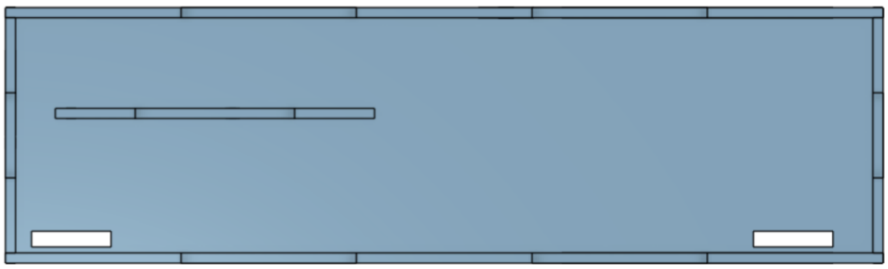

Figure 15: The inside side profile of the box

- The battery is placed on the bottom of the box while the actuator is placed on top of the battery and secured with a screw on the back of the box. A shelf would separate the Arduino and the actuator. The Arduino is also screwed to the shelf
- A metal clamp is attached to the actuator (we also used a screw to fasten it)
- With everything inside the box use a strong glued bond for the parts of the box.
- The last thing is to add the straps to the front and back side of the box

6.2 Testing & Validation

The tests performed on the 3rd prototype was to test the electronics specifically the connections between the button, Arduino, battery and the linear actuator. The test was to make sure that the linear actuator was performing all the commands that it was directed to do from our code. The next test to validate our prototype was to test Helping hand with the grabber, it was to make sure that the linear actuator can squeeze the trigger of the grabber. The first test was to lift light objects, the first object that was tested was to pick up a small empty cardboard box. It was to test the code to make sure the sequence of the linear actuator functioned accordingly. Moreover, the

validation for the test was to make sure the linear actuator had the force capacity to life the small box.

Figure 16: Test 1: The Helping Hand being used to lift a box.

The next test was to make sure the Helping Hand can lift heavier objects. According to the target specifications that were determined, the text test was to lift an object that is approximately one and half pounds. The test was to life a full water bottle, this would validate one of the target specifications as well as fulfil one of our clients' requirements. The Helping Hand was able to easily pick up a water bottle which was able to validate our tests.

Figure 17: Test 2, The Helping Hand being used to lift a water bottle.

7 Conclusions and Recommendations for Future Work

Overall, the group learned a lot during the production of The Helping Hand. The group realized why communication is so vital, as a simple misunderstanding near the start of the semester meant that the group had created designs for a product which the client was not asking for. Furthermore, the team comprehends how having backup plans can be very important. In engineering projects, it is very unlikely that there will be no updates or reiterations to an initial design. Our team had a backup plan, and we put it to use when it was needed and thankfully it worked.

As for those who seek to continue with the work observed in this deliverable, the group devised some pieces of advice. First, it is very important to consider the support of the wrist when creating the product. Recall that the device is designed for those with weakened grip strength, so having extra wrist support in the form of a strap is necessary. This is why the team believes that a box similar to ours is the best way to create an ergonomic motorized attachment. However, the size of the box should be reduced, and the hole where the trigger of the grabber is to go must be perfected. This is in order to prevent wobbling when moving around with the grabber. This is one of the flaws our group currently has with our box. Also, the box should be created out of lighter materials, such as plastic, in order to reduce the weight.

If the group had more time to work on the project, we believe that several things could be improved. The most important is to improve the stability of the grabber itself. The group could add another strap, or create another box with a smaller hole, or most likely perform both. Also, purchasing fasteners for the box rather than using tape would be beneficial, since on a product sold to the market, we would of course be using fasteners and glue to hold the box rather than tape. Moreover, improved wrist support would be very appreciated, and another wrist strap would be great in order to ensure the user is strapped in securely. Lastly, the box would likely be not only reduced in size but done with a different material. This would reduce the weight of our product. Something that the group was looking to add but ran out of time were magnetized tips on

the ends of the claws of the grabber. These tips would be a great help for super small objects like rings, coins, or nails that the claws of the grabber would be too large for. Small hooks on the ends of the claws would also be invested in as this could help pick up small strings or circular shaped objects.

APPENDICES

8 APPENDIX I: Design Files

MakerRepo link to the Third Hand team project.

https://makerepo.com/ddhdz/1213