Project Deliverable G: Prototype 2 and Customer Feedback

Danielle Courtney
Riana Leveque
Amanda Lawrence
Hiba Abdelali
Amelie Simon

March 12th, 2023

Table of Contents

1. Introduction

Based on our last deliverable, we are going to work on this one relating it to the client feedback. The last prototypes goals were to have the ability to ensure that the key parts of our complete device are successful, beginning from the ground up and to ensure the motor (DC) and pulley system is fully functioning. Through prototyping, we could confirm it glides smoothly over the bearings and is strong enough to carry the weight of the sensors, while working out any unexpected problems that may arise. Moreover, in this deliverable we are going to include an analytical, numerical, or experimental model for our prototype. We will outline a prototyping test plan while updating your target specifications, detailed design and BOM after tests are completed and analyzed. And finally, we are defining a stopping criterion which will allow us to end the test once you are satisfied that you have achieved your testing objectives.

2. Prototyping

2.1. Objectives

The goal of this prototype is to create a successful motor and pulley system. The DC motor will rotate the belt allowing the sensors to move up and down in a controlled motion. This device needs to be able to lift the weight of the sensors up and down so that the photoresistor can detect the amount of light that is being reflected at different levels within the silo. The height where the amount of light drastically changes is where the malt changes to dust within the silo. Therefore, this motor system will allow the users to detect this level and know how much malt can be pumped out before reaching the layer of dust. Using the measurements from the ultrasonic sensor, it will also know when to rotate clockwise to move the sensor downward, and when to rotate counterclockwise to rotate the sensor upwards. This is because when the ultrasonic sensor reaches a small number, meaning it is getting close to the top of the protective case, to motor will start moving in a clockwise direction to bring the sensor back down. When the sensor reads a large number, it will indicate that it is almost at the bottom of the protective case and turn the motor counterclockwise.

2.2. Prototype 2

2.2.1. Tinkercad

https://www.tinkercad.com/things/9lKtKYE2Ky6

2.2.2. Code

```
void setup()
{
 pinMode(3,OUTPUT);
 pinMode(4,OUTPUT);

}
void loop ()
{
 digitalWrite (3,HIGH);
digitalWrite(4,LOW);
 delay(5000);


 digitalWrite(3,LOW);
 digitalWrite(4,HIGH);
 delay(5000);
}
```

3. Analysis and Feedback

3.1. DC Motor Test

To test the performance of the motor, multiple tests will be performed. First, the code will be tested. To make the motor change directions when getting too close to the top or bottom of the silo if statements will be added to the void loop. The code will read: if (distance<5) {digitalWrite (3,HIGH); digitalWrite(4,LOW); delay(5000);} this will make the motor spin clockwise moving the motor down. To move the motor up the code will read; if (distance>20) {digitalWrite(3,LOW); digitalWrite(4,HIGH); delay(5000); }. This will spin the motor counter clockwise. To test this code, the direction of rotation will tested at a series of points that spans the range of the system. Another test that will be performed is to test the amount of weight that the motor will be able to move. Different strengths of motors can move different loads and it is important that the motor can move the weight of the sensors with too much strain on the system. To do this, items with gradually increasing loads can be placed on the motor until its performance becomes compromised and the mass of the final load will become the max load for the system. These are two tests that will be performed on the motor.

3.1.1. Chart

Distance (cm)	Rotation Per Minute	Direction
4	16511	clockwise
5	16511	clockwise
10	16511	clockwise
20	16511	clockwise
21	-16511	Counter clockwise
20	-16511	Counter clockwise
10	-16511	Counter clockwise
5	-16511	Counter clockwise
4	16511	Clockwise

3.2. Client Feedback

Based on feedback from the third client meeting improvements will continue to be made to improve the design of our product. The client was satisfied with the improvements we discussed in the last deliverable including accessibility, food safety, and easy maintenance. One detail that will be changed in the final design is that instead of the L brackets being bolted to the inside of the silo, the client suggested that they should be welded into the silo. This is a piece of feedback that will be implemented into our final design.

4. Prototype 3 Test Plan

In this phase of prototyping, we are designing a casing for the device in order to avoid hazards within the silo. This is necessary to make sure the entirety of the device can be completely enclosed and there is no risk of exposure to harsh environments, as well as avoiding exposing the product (malt) to the device. During the first client meeting, the product being food safe was a large concern and the aluminum casing will secure all parts; this avoids broken pieces entering the product and ensures materials follow Heath Canada regulations. Another issue that was brought up was the life cycle of the device, which will be lengthened when the sensors, Arduino board, etc. are not exposed to the malt. It will also stop any damages due to potential environmental changes (i.e., water, dirt, dust, etc.). This prototype will be tested by ensuring the casing is properly secure and should take a maximum of ten minutes.

5. Wrike

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=910OC478nPfG5yt5jY71Ni854BASqitw%7CIE2DSNZVHA2DELSTGIYA

6. Transfer of Knowledge

The last prototype tested the critical part of the system which was the sensors. Those sensors successfully detected the change in density through reflection of light, the volume associated with the change in light intensity. This prototype was tested both in Tinkercad and physically. Since both worked, Tinkercad is a good tool for prototyping and testing and was used for this prototype. The prototype in this deliverable is the motor part which moves the sensor system up and down. Those two systems will be connected to see if they work together.

7. Conclusion

Since this was our team’s second prototype, our justifications and reasoning for this prototype did include a short explanation of our results from our previous prototype and how this second prototype continues the development of our solution. This second prototype was mostly of a critical subsystem. The whole purpose for creating the prototype is to test and get measurable results to evaluate a metrics. The results should be as objective as possible and collected with a clear procedure that is repeatable.