Deliverable H

Alexandre, Boyu, Leo, Tobaogo and Samuel

March 26, 2023

Link to Wrike:
https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=E6Mzpnlt8sdrCVAxLINJEhO4yeHKnxJM%7CIE2DSNZVHA2DELSTGIYA

Table of Contents:

Prototype 3 (Concept):

Prototype 3 is not to create another sensor or model of an object, the 3rd prototype is to simply create a line of code that incorporates both the level and dust sensor. The code will have both sensors meeting the range of conditions for the alert to notify the clients or workers.

The code will meet conditions like:

1. If: Dust level > 10 ppm and Silo 1 level < 1500kg,

But: Silo 2 level > 1000 kg and Silo 3 level > 1000 kg

Response: Stop output from silo 1.

2. If: Dust level > 10 ppm

But: Silo 1 level > 1500kg, Silo 2 level > 1000kg, and Silo 3 level > 1000 kg,

Response: Slow down the output of silos until Dust level <10 ppm

Dust from silo 1 will eventually clear out. Slowing down all silos will reduce stress on the filter.

3. If: Dust level > 10 ppm and Silo 3 level > 2000kg,

But: Silo 1 level > 2000kg and Silo 2 level > 2000kg

Response: Stop output from silo 3.

Prototype (Overall)

The assembly of our entire prototype, including, level sensor (physical & analytical) dust sensor (physical & analytical)

Testing Outline:

Table 1: Testing Dates, Descriptions of Why, How, When:

Test ID	Test Objective	Description of Prototype used and of Basic Test Method	Description of Results to be Recorded and how these results will be used	Estimated Test duration and planned start date
1	Level sensor: To detect low silo	The level sensor gives the level at which the silos are at.	The sensor provides real-time data to the control system to be evaluated.	1 day 3/18/2023
2	Dust sensor: To detect high dust levels	The dust sensor measures the amount of dust the filter is cleaning.	The sensor provides real-time data to the control system to be evaluated.	1 day 3/18/2023
3	Program (code): To gather data from level and dust sensors and provide feedback.	The program gets data from both sensors and evaluates it to give the appropriate response.	The program compares data from both sensors and responds according to the conditions that are met.	1 day 3/19/2023
4.	Physical test of all components	Experimenting silo levels with sand in a bucket, Dust levels using dust(flour), and making sure the program responds to those conditions.	The physical test is used to simulate conditions or cases that can occur during normal operations.	1 day 3/25/2023
5.	3D print a box that fits the dust sensor	Make sure the level sensor is organized properly and contained	Have the dimensions of the box and presented to the clients	1day 3/26/2023

Figure 1:

Testing the Dust Sensor Measured in Ppm through Second

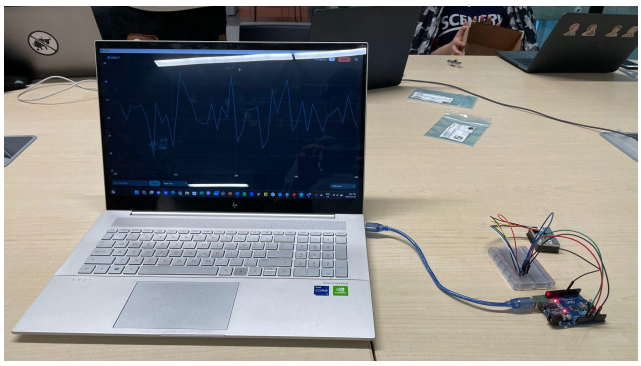


Figure 2: Pictures and Videos Testing of Level Sensor

VIDEO IN SEPARATE SUBMISSION

Figure 3: How the Two Sensors Work Together

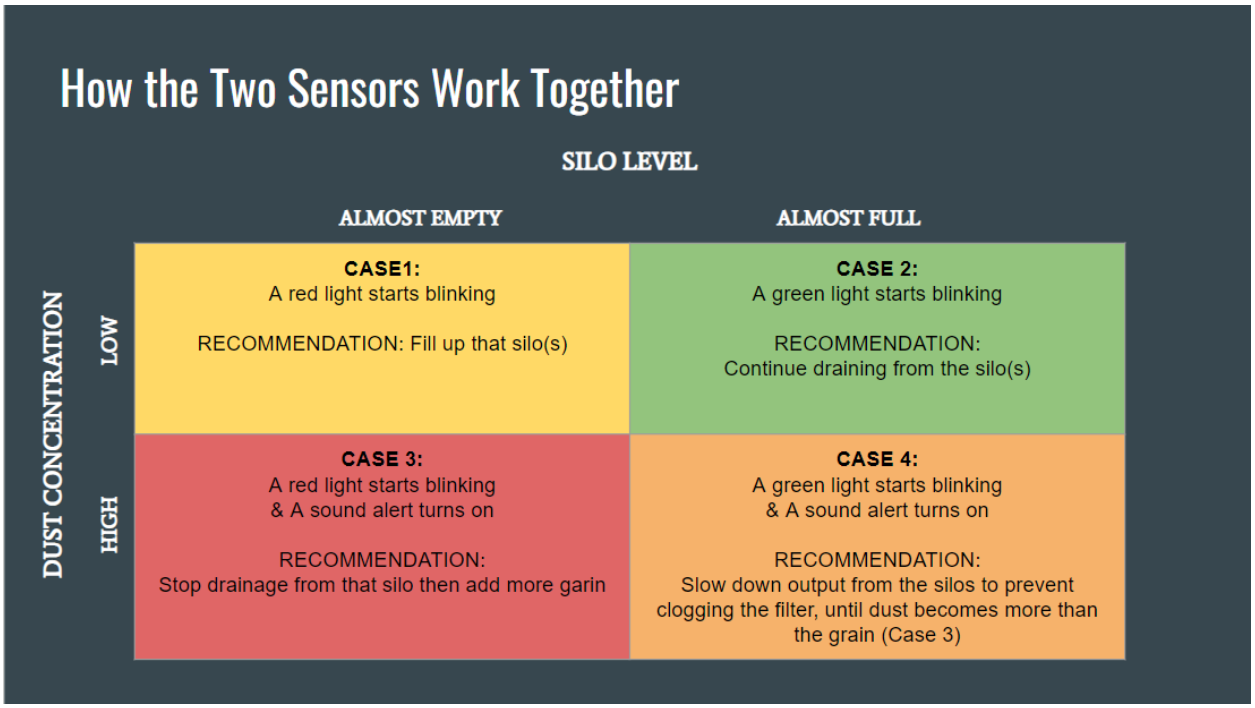
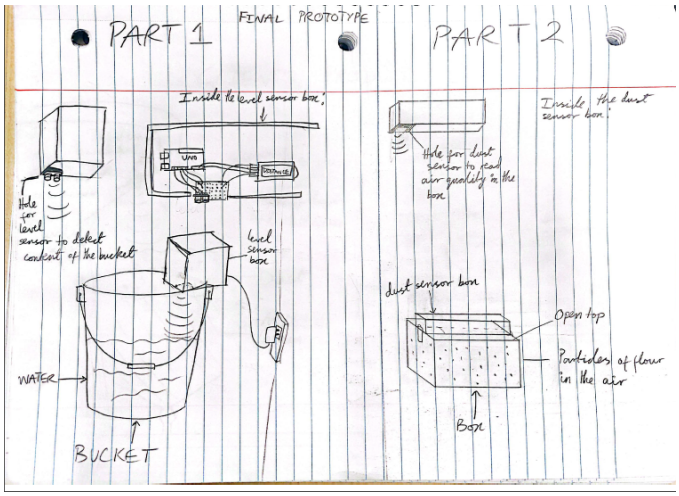


Figure 4: Sketch of Entire Set up:



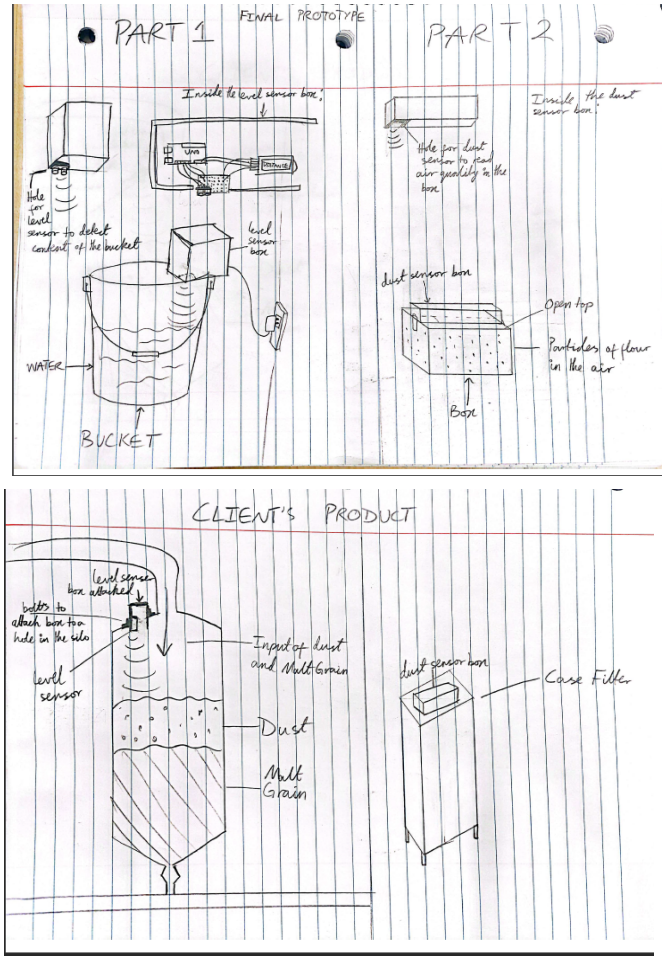


Figure 5: Level Sensor Code:

```
#include <LiquidCrystal_I2C.h>


LiquidCrystal_I2C lcd(0x27, 16, 2); // I2C address 0x3F, 16 column and 2
rows


int trigPin = 9;    // TRIG pin

int echoPin = 8;    // ECHO pin


float duration_us, distance_cm;
```

```
void setup() {
  lcd.init();                // initialize the lcd
  lcd.backlight();           // open the backlight
  pinMode(trigPin, OUTPUT); // config trigger pin to output mode
  pinMode(echoPin, INPUT);  // config echo pin to input mode
}

void loop() {
  // generate 10-microsecond pulse to TRIG pin
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  // measure duration of pulse from ECHO pin
  duration_us = pulseIn(echoPin, HIGH);

  // calculate the distance
  distance_cm = 0.017 * duration_us;

  lcd.clear();
  lcd.setCursor(0, 0); // start to print at the first row
  lcd.print("Distance: ");
  lcd.print(distance_cm);

  delay(500);
}
```

Figure 6: Dust Sensor Code:

```
/*

Interfacing Sharp Optical Dust Sensor GP2Y1014AU0F with Arduino

*/

#define measurePin 0 //Connect dust sensor to Arduino A0 pin

#define ledPower 7 //Connect 3 led driver pins of dust sensor to Arduino D2

int samplingTime = 280; // time required to sample signal coming out of the sensor

int deltaTime = 40;

int sleepTime = 9680;

float voMeasured = 0;

float calcVoltage = 0;

float dustDensity = 0;

void setup(){

Serial.begin(9600);

pinMode(ledPower, OUTPUT);
```

```
}

void loop(){

digitalWrite(ledPower, LOW); // power on the LED

delayMicroseconds(samplingTime);

voMeasured = analogRead(measurePin); // read the dust value

delayMicroseconds(deltaTime);

digitalWrite(ledPower, HIGH); // turn the LED off

delayMicroseconds(sleepTime);

// 0 - 5V mapped to 0 - 1023 integer values

// recover voltage

calcVoltage = voMeasured * (5.0 / 1024.0);

// linear equation taken from http://www.howmuchsnow.com/arduino/airquality/

// Chris Nafis (c) 2012

dustDensity = 170 * calcVoltage - 0.1;
```

```
Serial.println(dustDensity); // unit: ug/m3


delay(1000);


}
```

Figure 7: Entire code connecting two sensors

```
#include <SoftwareSerial.h>
#include <BlynkSimpleStream.h>

// Define the pins used for the sensors
const int dustSensorPin = A0;
const int trigPin = 2;
const int echoPin = 3;

// Define variables to store the sensor data
int dustConcentration;
float distance;

// Define the Blynk authentication token
char auth[] = "YourAuthToken";

// Define the software serial pins for the ESP8266 module
SoftwareSerial espSerial(10, 11); // RX, TX

void setup()
{
  // Start serial communication with the Arduino IDE serial monitor
  Serial.begin(9600);

  // Start serial communication with the ESP8266 module
  espSerial.begin(9600);

  // Connect to the Blynk server
  Blynk.begin(espSerial, auth);

  // Configure the sensor pins
  pinMode(dustSensorPin, INPUT);
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
}

void loop()
{
  // Read the dust concentration data
  dustConcentration = analogRead(dustSensorPin);

  // Read the ultrasonic sensor data
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  distance = pulseIn(echoPin, HIGH) * 0.034 / 2;

  // Print the sensor data to the Arduino IDE serial monitor
  Serial.print("Dust concentration: ");
  Serial.println(dustConcentration);
  Serial.print("Distance: ");
```

```
  Serial.println(distance);

  // Send the sensor data to the Blynk app
  Blynk.virtualWrite(V0, dustConcentration);
  Blynk.virtualWrite(V1, distance);

  // Call the Blynk.run() function to process Blynk app commands
  Blynk.run();

  // Wait for a short period of time before repeating the loop
  delay(100);
}
```

Target Specifications Changes

Instead of measuring from 10 ppm to 20 ppm. We decided to have the minum air quality be around 800 ppm and maximum be around 1500 ppm

Feedback and Comment

The feedback from clients was questioning whether the ppm levels we told them were accurate, turns out their suspicions were correct. We changed the average levels for the dust sensor to be around 800-1500 ppm

Target Specifications

	Level Sensor	Dust Sensor
Weight	13g	21g
Dimension	45*20*15mm	71*70*23mm
Testing Range	20-4000 mm	0.0-999.9 ug/m3
Air Quality	N/A	800-1500 ppm
Energy Consumption	120wH	120wH
Safety Incidents	0 incidents reported during testing	0 incidents reported during testing
Maintenance	Nearly zero maintenance	Nearly zero maintenance
Durability	Long-term stable work	Long-term stable work
Cost-effectiveness	0.006 CAD/H	0.006 CAD/H

Bill of Materials

Prototype One				
Description	Unit of Quantity	Price (CAD)	Price total per item	Link
Ultrasonic level sensor - HC-SR04	1	$5.00	$5.00	https://...
Arduino UNO R3	1	$17.00	$17.00	https://...
Elegoo 16x2 LCD display module (Order latest by Friday or Ask TA)	1	$16.99	$16.99	https://...
Male to male (5 cm)	5	$10.99	$10.99	https://...
Male to male (20 cm)	25			https://...
Female to male (20cm)	10			https://...
Plastic (can hold 8L volume, 9.83 inch height by 9.25 inch width)	1	$4.94	$4.94	https://... B_ihH0
Red	1	$1.20	$1.20	https://...
Green	1			https://...
330 ohms (Order latest by Friday or Ask TA)	3	MakerLab	$0.00	https://...
500k ohm (ASK TA)	1	$16.99	$16.99	
Repersents Grain and dust	10kg	$3.99	$3.99	https://...
Half Board	1	$5.00	$5.00	https://...
MDF, 5 faces. (L: 20cm; W: 15cm)	1	$2.50	$2.50	https://...
DC Power Supply 9V 1A	1	$14.99	$14.99	https://...
PVA wood glue	1	$6.07	$6.07	https://...
Computer Monitor with the interface	1	(Use our own)	$0.00	
			$105.66	

Prototype Two				
Description	Unit of Quantity	Price (CAD)	Price total per item	Link
GP2Y1014AU0F Dust Sensor Module	1	$11.74	$11.74	https://...
DC Power Supply 9V 1A	1	$14.99	$14.99	https://...
Represent dust	1kg	$4.99	$4.99	https://...
Arduino Type 2	1	$17.00	$17.00	
			$48.72	

Prototype Three				
Description	Unit of Quantity	Price (CAD)	Price total per item	Link
30 ROW SOLDERFUL BREADBOARD	1	$6.61	$6.61	https://...
CONN SIL HDR MALE PIN 20POS TIN	1	$7	$7	https://...
			$13.81	

			$168.19	