Deliverable G: Prototype II and Customer Feedback

By Group 3.1

March 12, 2022

Table of contents

Introduction

In the previous deliverable, prototype 1 was created, developed, and tested. The prototype was subjected to customer feedback in order to design the next prototype. In this deliverable, our team will be doing prototype 2, which is similar to the last deliverable. prototype 2 will encompass the feedback obtained by customers and improvements to functions of the GCHE system in the previous prototype. This deliverable will have some parts including: prototype and prototype analysis, feedback from client and potential users and so on.

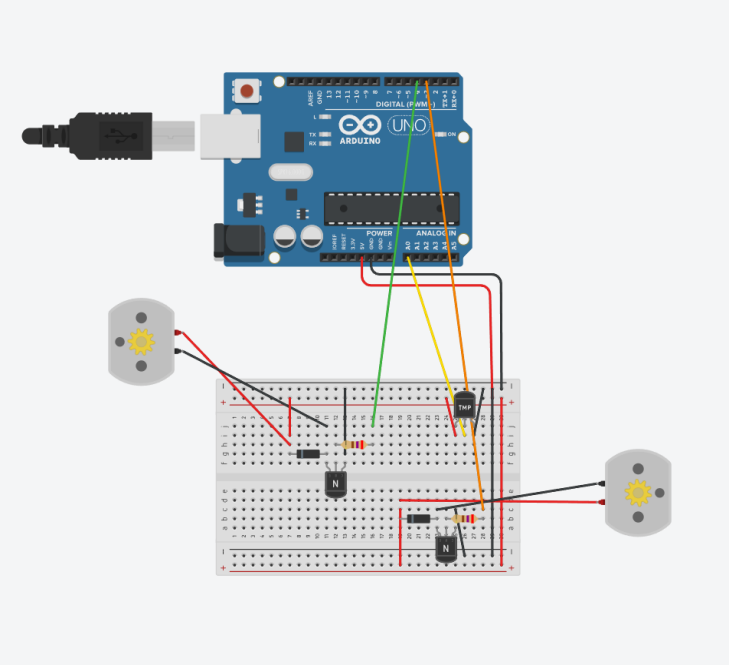
Client's feedback:

Overall, the client was satisfied with our first prototype, but there are still major problems of our prototype:

1. In order to achieve the amount of heat needed to have comfort in the house using the vertical pipes, it requires heavier and more expensive equipment like some drilling system which may not easily be accessible by an average of the lower price family
2. Only vertical loop is used in our prototype so it need to go a lot deeper, it may not affect the functionality but also be careful not to reach the maximum depth underground according to the client's need

Prototype II:

Circuit Diagram:



Arduino Code:

Arduino Code

//Group 3.1 Temperature Control System.
// C++ code
//
 	
int vtemp = 0;
int ctemp = 0;
int desiredTemp = 15;
float temp = 0;
float condensation = 0;
 	
int fanPin = 4;
int pumpPin = 3;
 	
void setup()
{
Serial.begin(9600);
}
 	
void loop()
{
delay(1000);
 	
// reads desired temperature:
if (Serial.available() > 0) {
desiredTemp = Serial.parseInt();

```
        }

        //turn on fan
        if (desiredTemp != ctemp) {
                digitalWrite(fanPin, HIGH);
        } else {
                digitalWrite(fanPin, LOW);
        }

        //trun on sump pump
        if (condensation > 0) {
                digitalWrite(pumpPin, HIGH);
        } else {
                digitalWrite(pumpPin, LOW);
        }

        //reads pin (voltage)
        vtemp = analogRead(0);
        //turns voltage into degrees
        temp = (vtemp*5.0);
        temp /=1024.0;
        ctemp = (temp - 0.5)*100;

        //prints water level
        Serial.print("Condensation level ");
        Serial.print(condensation);
        Serial.println(" mm");

        //prints desired temperature
        Serial.print("Desired Temp ");
        Serial.print(desiredTemp);
        Serial.println(" Degrees C");

        //prints temperature
        Serial.print("Actual Temp ");
        Serial.print(ctemp);
        Serial.println(" Degrees C");
}
```

Testing Goals:

The original goal of this prototype is to test the functionality of all the electronic components of the prototype such as the arduino, temperature sensor, water sensor, and the code needed to run siad components to ensure that they are all functioning as intended.

However due to the fact our BOM has yet to be approved leading to us being unable to purchase any materials we have changed the goal of this prototype to simply testing of the programming component of our design.

Our system consists of an arduino that will control the systems of our box, a water level sensor(Simulated by the variable *int condensation*) that will determine when the sump pump activates, a sump pump (Simulated by the motor on the left), a temperature sensor that will determine when the fan(Simulated by the motor on the right) activates, and a fan. The arduino will be housed in a waterproof container on the inside of our HEC.

Stopping criteria:

Testing will be stopped once we have determined that all arduino code written for the test is functioning as intended.

Analysis:

During our simulation, all of our code returned the correct values. While this was only a simulation it let us change things that needed to change. The tests of this prototype helped us understand what needs to be done on the real components.

Prototyping test plan:

Green = Completed, **Yellow** = In progress, **Red** = Not started.

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	• Determine optimal layout of the system	• Small scale paper/cardboard model. • Visual analysis	• The shape and layout of the model will be recorded.	• From March 5th to March 6th. • **Completed**
1.5	• Test computer code used for the prototype.	• Tinkercade simulated arduino circuit. • Computer simulation.	• Whether or not the code functions properly.	• From March 12th to March 13th. • **Completed**
2	• Test the electronic components used within our design.	• Assembled electronic components in the design. • Physical testing of electronics & code.	• Battery life in hours • Temperature control software. • Compatibility of components • Calibration of sensors	~~• From March 6th to March 13th.~~ • **Delayed**
3	• Testing the fully assembled small scale prototype.	• A functional heat exchange chamber for our prototype.	• How well the HEC retains heat.	• From March 6th to March 27th.

		● Testing how well HEC can retain heat.		

Target Specifications:

Functional requirements:

	Design specification	Relation	Value	Units	Verification method
1	Temperture control	=	22-23	ºC	Test
2	Emission	=	0	N/A	Test
3	Control system	=	Yes	N/A	Test
4	Vent operation	=	Yes	N/A	Test

Non-functional requirements:

	Design specification	Relation	Value	Units	Verification method
1	Looks	=	Yes	N/A	Test
2	Life span	>	40	Years	Test
3	Reliability	=	Yes	N/A	Test
4	Material	=	Yes	N/A	Test
5	Location	=	N/A	N/A	Test

Constraints:

	Design specification	Relation	Value	Units	Verification method

1	**Cost**	**<**	**20,000 - 30,000**	**CAD**	**Estimate/ Final check**
2	**Available different seasons**	**=**	**yes**	**N/A**	**Test**
3	**Maxmum Area**	**<**	**140**	**M^2**	**Estimate/Final Check**
4	**Operation conditions:**	**=**	**-60.8 to 49.6**	**ºC**	**Test**
5	**Weight**	**<**	**N/A**	**KG**	**Test**

Feedback

Feedback was collected periodically during development over a controlled group of young and old people. Compared with elder, young people have more trust in the GCHE system that uses clean energy.The overall consensus is that the GCHE system is cheap enough and highly functional. The following are the different feedback between young people and old people.

- Young people:
    - The design is more beautiful and makes the yard look better. Solar panels, for example, can be designed to make them look better.

    - The system has a sense of science and technology, better use experience, with remote control. For example, the user can use the phone to adjust the temperature.

    - Provide timely customer return visits, understand the advantages and disadvantages of the system, and provide requirements or modifications appropriately.

- Old people:
    - The system should have a small footprint and not cause damage to their own yard. For example, give them enough space for planting in their yard.
    - In winter, when it is very cold, the heating mode should be good enough to ensure the temperature of the room.
    - More simple operation, so that customers more easily understand how to use, no complicated design, simple and easy to understand.

Stopping Criteria:

1. Any damage, harm or mistreatment to materials and/or parts while working during the production process

2. Any harm, injury and/or mistreatment to team members while working during the production process

3. Simulations should not be performed if these costs outweigh the potential savings of changing the current system

4. Any damage, harm or mistreatment to equipments and/or tools while working during the production process

5. The production process causing the increased potential for hazardous dangers and/or risks affecting team members

6. Prevention and/or protection resources not working properly to prevent members from hazards and/or risks during the production process

Conclusion

In this deliverable we set out to determine whether an arduino would be capable of all the control needs that our system would have. Our group used tinker cad circuits to simulate the electronics system of our system. While most of the components were easily simulated, some were not as easy. Our solar and battery systems were not able to be simulated. This was due to the fact that in the tinker cad software, there is no way to connect the arduino to a power source other than the USB cable. Our simulation also contains two motors which, in our case, will represent the blower fan and the sump pump. In the end we were able to accurately simulate our electronic system in the Tinker CAD software.

Tinker CAD:
https://www.tinkercad.com/things/4VNNv7UHJB7-start-simulating/editel?lessonid=EHD2303J3YPUS5Z&projectid=OIYJ88OJ3OPN3EA&collectionid=OIYJ88OJ3OPN3EA&sharecode=ZwuNT4IVmoVB5nNA9C2165EwzNKDXyLUU2IEUypxx1Y

Wrike:
https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=9ixyo0ajXsoxIHwoHmNz7GSPOEMetgS6%7CIE2DSNZVHA2DELSTGIYA