RainShroom

Physicalizing precipitation for mushroom foraging

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Introduction

To physicalize data we created the RainShroom system. A design for helping beginner local Victoria mushroom hunters learn how weather patterns impact their ability to go hunt for mushrooms. RainShroom is a data physicalization of a dataset containing the attributes of daily precipitation, daily average temperature, and whether those conditions make for an eligible day to harvest mushrooms.

Data Visualization Purpose

The motivation behind this data visualization is to help local novice mushroom foragers learn the rain patterns of when pacific golden chanterelles are optimal for harvesting. This system was inspired by some of our friends in the UVic Mycology club.

Pacific golden chanterelles, as seen in Figure 1 are local to Southern Vancouver Island, and grow only in the autumn here [1]. Due to this short window ideal for harvesting, those interested in exploring the land to forage them must train themselves in precipitation accumulation patterns and temperature patterns to know what days are eligible for going out and hunting to actually find healthy mushrooms[2].

There are two key components for successful autumn mushroom foraging, as this isn't a widespread hobby, one must acquire knowledge on fertile friendly areas ideal for mushroom growth, and weather patterns for when mushrooms will be ready for harvesting [3]. Therefore, once someone has figured out a good location for finding mushrooms, they must then learn what precipitation and temperature patterns make for ideal autumn harvesting. How rain and temperature influences mushroom growth is complex, they can pop up overnight when it has been raining, they can also pop up a few days after rain has stopped if the soil stays damp, they can disappear as quickly as they grew. Within a day a mushroom can appear and rot back into the ground [4]. Additionally, ideal mushroom growing weather is in damp, moist, warm climates between 19 and 24 degrees celsius [5].

Fig 1. Image of Pacific Golden Chanterelles [2]

Our data physicalization will help with stage 2 of Sawyer's eight phases of creativity, acquiring the knowledge, it will help users prepare, know the domain, and lay groundwork for advancing knowledge within the hobby of mushroom foraging [6]. The purpose of this data physicalization is to communicate what precipitation conditions are ideal for mushroom foraging so that the user can build domain knowledge of how to identify good mushroom harvesting days. This project would be considered mini-C, this system's purpose is pattern recognition learning, so it is for individual improvement in learning more about the mushroom foraging hobby.

The UVic Mycology club provided us with this dataset from their own field work to gather how rain patterns make for good or bad days out in the field foraging, as seen in Table 1. [7]. Their data set covers a range of local mushroom species, locations, and times of the year [7]. For the sake of this project we just selected pacific golden chanterelles out of the larger dataset, as they had the longest streak of consecutive days of growth recorded.

Location	Date	Rainfall Accumulation(inches)	Daily Average Temperature(C)	Optimal Pacific GoldenChantrelle Foraging
Sooke Hills Wilderness Park	9/20	3.1"	21	TRUE
Sooke Hills Wilderness Park	9/21	0.1"	18	TRUE
Sooke Hills Wilderness Park	9/22	0.0"	24	FALSE
Sooke Hills Wilderness Park	9/23	0.5"	20	FALSE
Sooke Hills Wilderness Park	9/24	0.0"	19	TRUE
Sooke Hills Wilderness Park	9/25	7"	23	FALSE
Sooke Hills Wilderness Park	9/26	0.0"	29	FALSE
Sooke Hills Wilderness Park	9/27	0.4"	28	FALSE
Sooke Hills Wilderness Park	9/28	0.0"	21	TRUE
Sooke Hills Wilderness Park	9/29	0.0"	19	TRUE
Sooke Hills Wilderness Park	9/30	0.9"	20	TRUE
Sooke Hills Wilderness Park	10/1	0.0"	28	TRUE
Sooke Hills Wilderness Park	10/2	0.0"	28	FALSE

Table 1. Rain Accumulation Patterns Influence on Mushroom Foraging [7]

Data Mapping

The material properties of this system encode the mushroom foraging dataset so users are able to understand data-related patterns and trends. The first physicalization that's mapped is whether a day is an optimal pacific golden chanterelle foraging. This is mapped to the mushroom on the base illuminating. A glowing mushroom means it is a good day to go out and forage, and an unlit mushroom means it is not an optimal day.

Next, daily average temperature is mapped to the overhead light. This light is up where the rain falls to depict that what comes from the head of the lamp is the daily weather. The temperature mapping can be seen in Table 2.

Temperature	Colour	Meaning
Greater than 30C	Magenta	Too hot for mushrooms to grow
25C to 29C	Red	Leaning hot, chance for mushroom growth
19C to 24C	Green	Perfect mushroom foraging weather
13C to 18C	Cyan	Leaning cold, chance for mushroom growth
Less than 12C	Blue	Too cold for mushroom growth

Table 2. Temperature Colour Mapping

Then, daily precipitation is mapped to the water falling. The greater the rate of rainfall the greater the total daily rainfall accumulation.

Finally, each day is mapped to 10 second intervals. This can be counted, or our electronics are kept in a 3D printed box with a blue LED on it, this LED dims and lights back up every 10 seconds in accordance to the day mappings.

All these mapping could be interpreted or perhaps guessed and conclusions drawn from observation by the user. However, to ensure that all these mappings are clear and no guessing is required by the user we made an infographic to go with our system as seen in Figure 2.

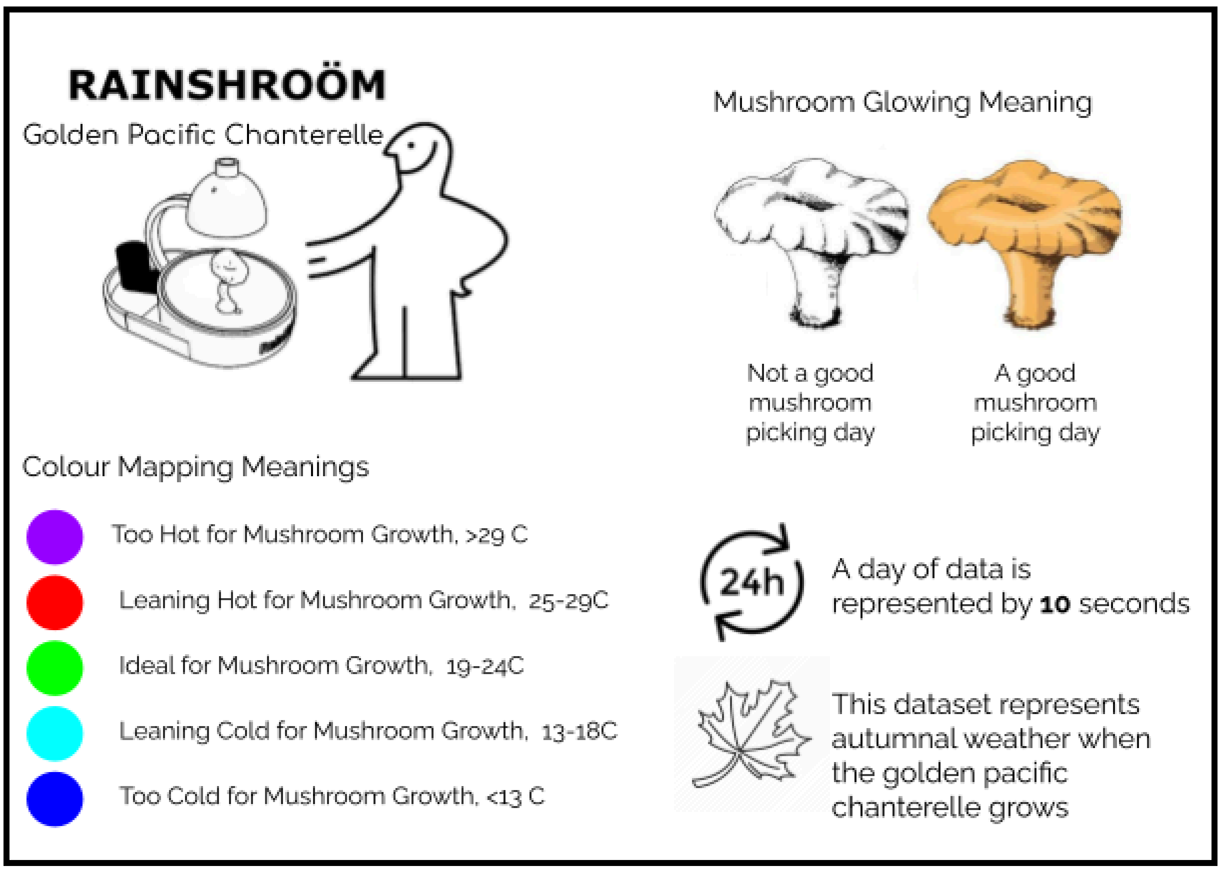

Figure 2. RainShroom Infographic

Design Rationale

Due to the pacific golden chanterelle's limited growth season to just autumnal months, throughout the year, during the part of the year spent waiting for the next season the user can learn growth patterns from the previous season. Ideally the user would have one for each mushroom they are interested in learning about and be able to learn the distinct patterns of each mushroom.

For this system we made it a skeuomorph of a lamp, design attributes from a familiar home design object in the user's home, to make this new system feel familiar [8]. While the shape of a lamp is essential to a lamp, it does not serve any pragmatic purpose in our new system beyond making it a desirable comfortable design.

We designed this system to be aesthetic to live in the home since it resembles a lamp; it can look nice and not out of place in a home on a table or desk. For spatial representations the location of this system matters, ideally this system should be near a window or door so that the user can extend their acquired knowledge to the real world weather patterns happening at present time. Especially during the season of autumnal pacific golden chanterelle harvesting, they can apply their knowledge to the daily weather patterns to determine if it is a good day to go harvest.

Additionally, we designed the mushroom on the base to look like a pacific golden chanterelle mushroom rather than a generic mushroom, and glow the golden color of a pacific golden chanterelle to help familiarize new mushroom foragers with what this mushroom species looks like for when they are out hunting in the forest to easily identify them.

This system represents the mushroom foraging digital data set using a relational approach, where the sequence of water falling and lights illuminating logically paints a picture of the mushroom foraging data. Adjacent ten second instances of data combine in sequences to help form the user's mental model of how rainfall and temperature impact mushroom harvesting.

Data-Related Queries

Once the user is informed that every ten seconds is a new day and observe the system changing accordingly, they will be able to come to conclusions of how weather impacts mushroom growth.

By observing when the mushroom lights up in relation to how days of various rates rainfall and temperature, the user should be able to come to conclusions about their hobby. They can compare and contrast how daily patterns in rainfall make for good mushroom picking days, additionally how daily temperature patterns make for good mushroom picking days. By learning the patterns of for example, how a warm 3 day period with light rainfall impacts optimal mushroom picking versus how a hot 3 day period with heavy rainfall impacts optimal mushroom growth, they can apply their acquired knowledge to future years of mushroom growth.

User interaction is supported through visualization of this dataset, but also through auditory noise. Every ten seconds represents the day changing, there are auditory associations with the noise rain actually makes, this sound can enforce learning about how precipitation influences mushroom growth. Additionally, the user can interact with the system by feeling the water flow, touching the wet or dry mushroom. In future iteration, it would be ideal to either have multiple devices to learn about other mushroom growth patterns, or to have the mushroom be replaceable and have the precipitation and temperature patterns updated, to physicalize how weather impacts different species of mushroom.

System Explanation - 3D Model

Steps we took to 3D CAD model the RainShroom as seen in Figure 3.

Figure 3. 3D CAD model of the RainShroom

1. Defined the problem and requirements for the Rainshroom project, including the optimal mushroom foraging time and how to map that physically using an RGB LED, water pump, and chanterelle model.
2. Opened Tinkercad to create a new project.
3. Sketched out the design for the Rainshroom project. We broke it down into four main components: shower head as seen in Figure 4, spine as seen in Figure 5, mushroom as seen in Figure 6, and base as seen in Figure 7.
4. Designed each component using Tinkercad's tools, ensuring that the separate parts fit together correctly and could be printed without support structures.
5. Starting with a typical 3mm led, the dimensions and the overall size of the device was created to ensure proportionality.
6. Estimated the appropriate tolerance gap for each component.
7. Printed each component of the Rainshroom project separately using Tom’s personal 3D printer with white 1.75mm PLA filament.
8. Assembled the pieces of the Rainshroom project, ensuring that they fit together to the degree of the digital model. We reinforced the fit using preliminary super glue and then reinforced it with UV glue.
9. Connected the Dupont wires to the Arduino Uno
10. Imported the code to the Arduino while loosely connected to ensure functionality

11. Placed the board into the electronic housing as seen in Figure 7A
12. Assembled the lid by attaching the toggle button, blue LED, and the LED dome as seen in Figure 7B to Figure 7C
13. Connected the wires to the main housing from the RainShroom device to the board
14. Tested the physical prototype of the Rainshroom project to ensure that it satisfies the required functionality and features, including the RGB LED, water pump, and pacific golden chanterelle model.

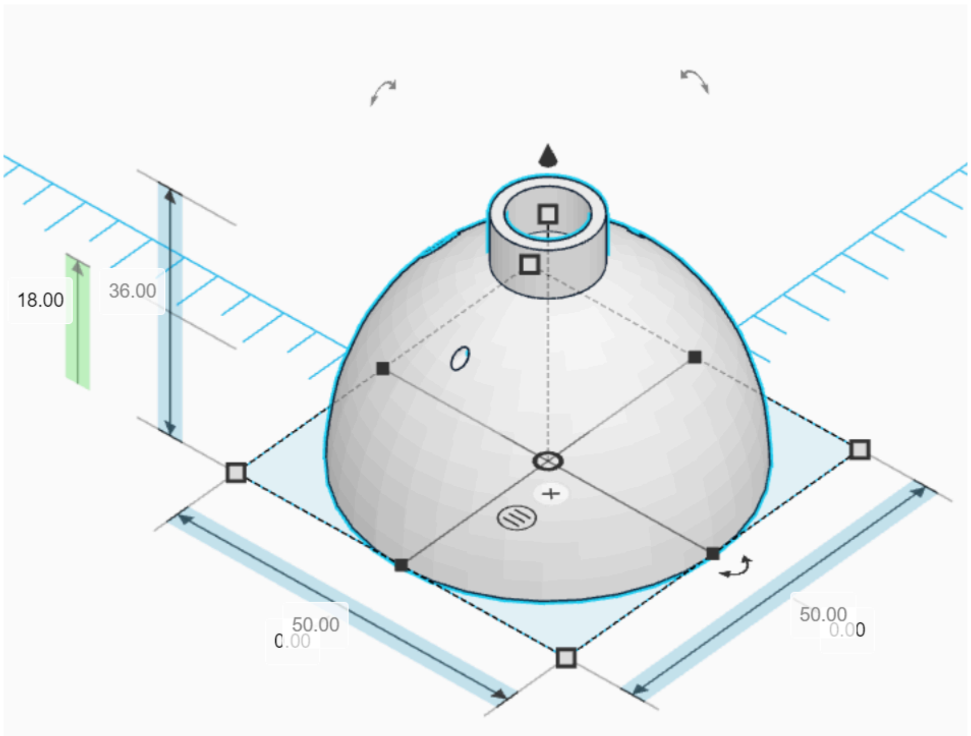

Figure 4. 3D CAD Model of the Showerhead Component

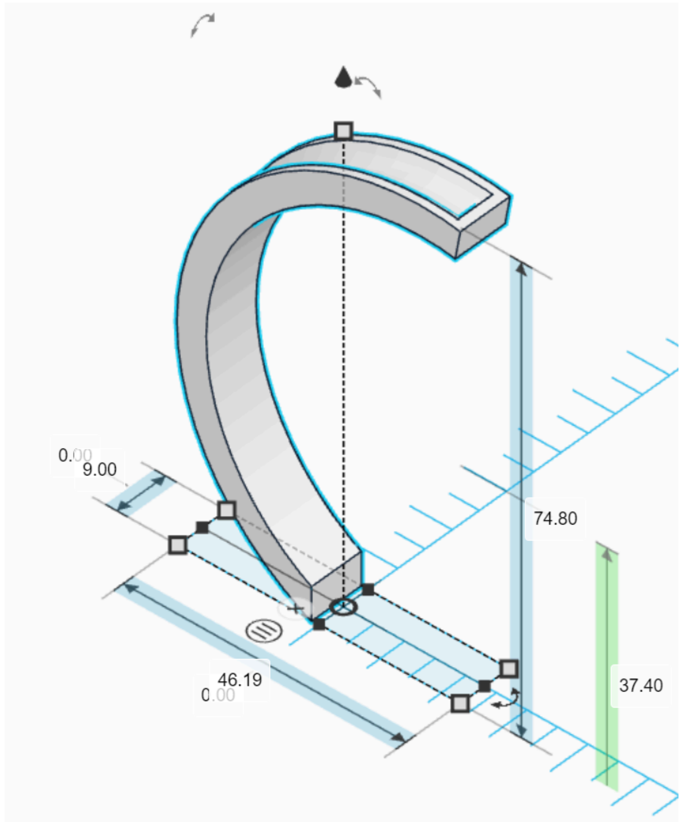

Figure 5. 3D CAD Model of the Spine Component

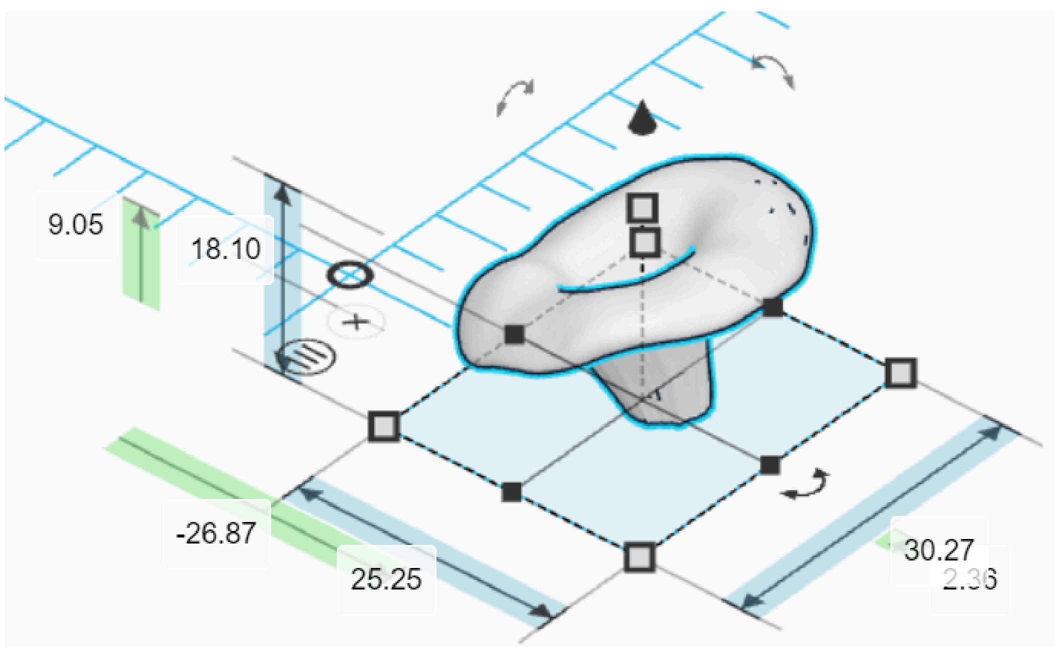

Figure 6. 3D CAD Model of the Mushroom Component

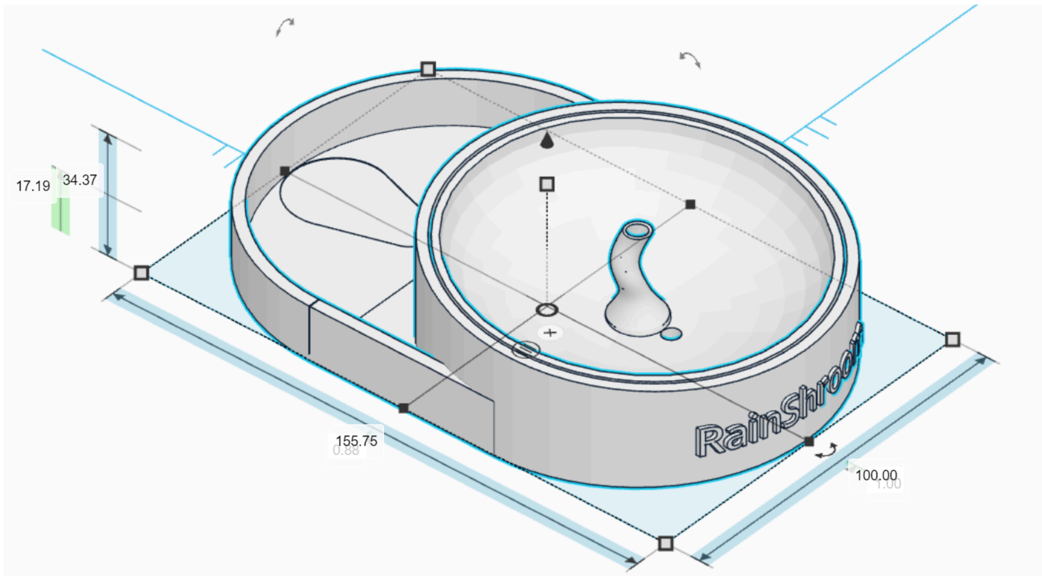

Figure 7. 3D CAD Model of the Base Component

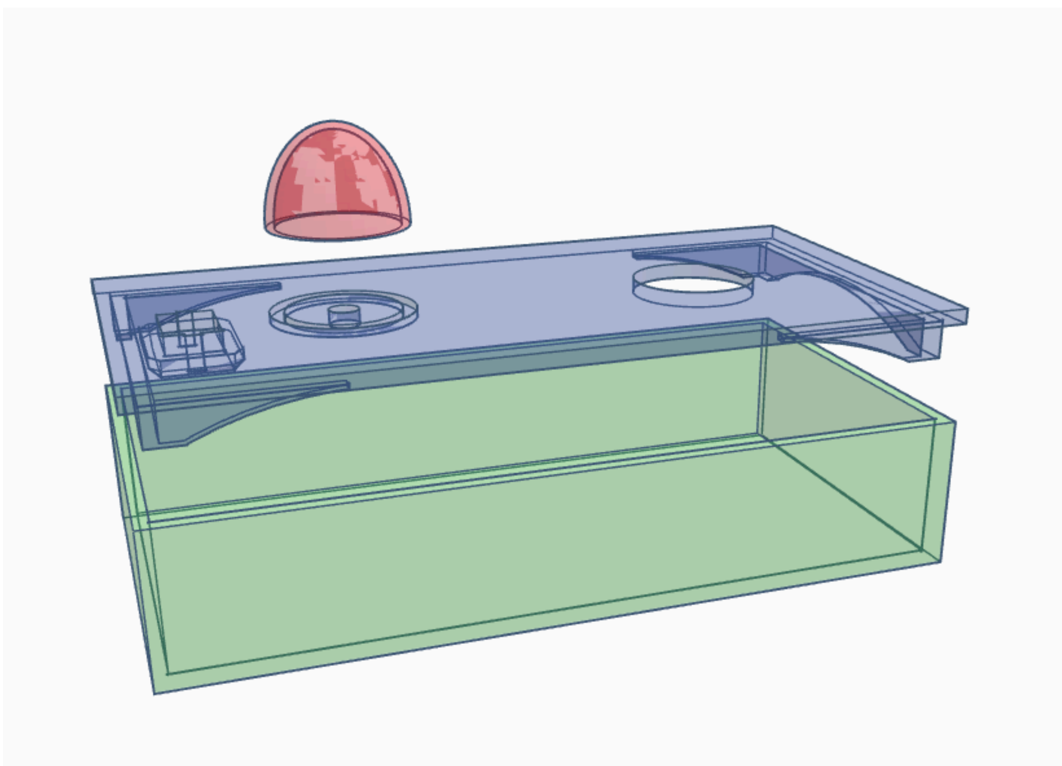
Figure 7A. Completed housing

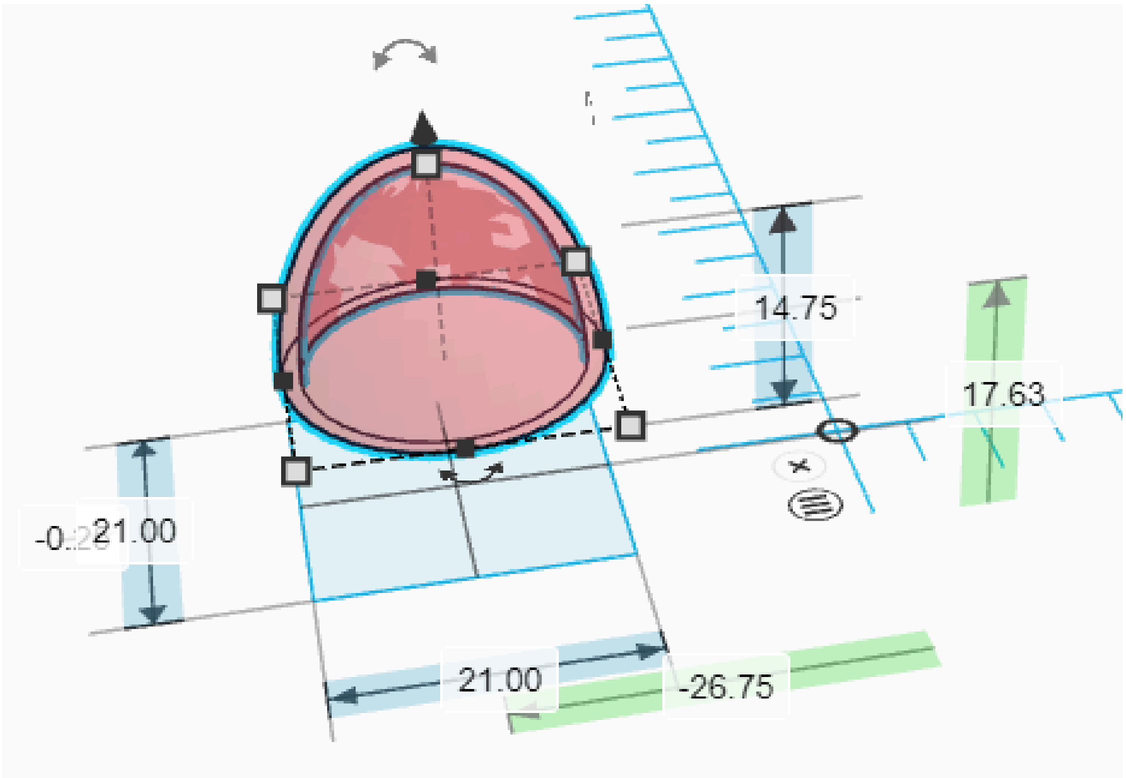

Figure 7B. LED on/off status dome

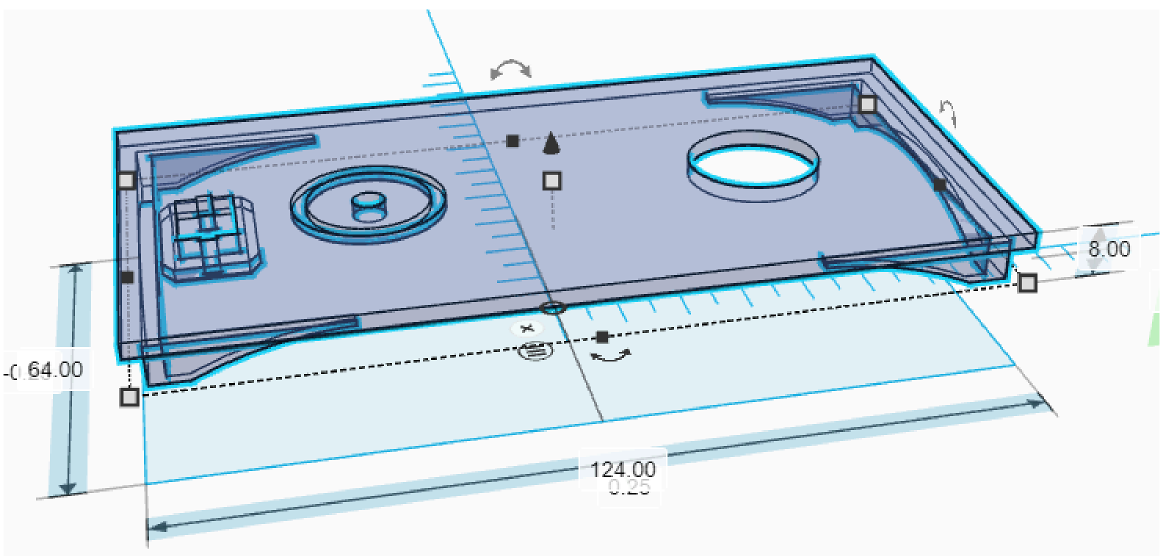

Figure 7C. Top plate

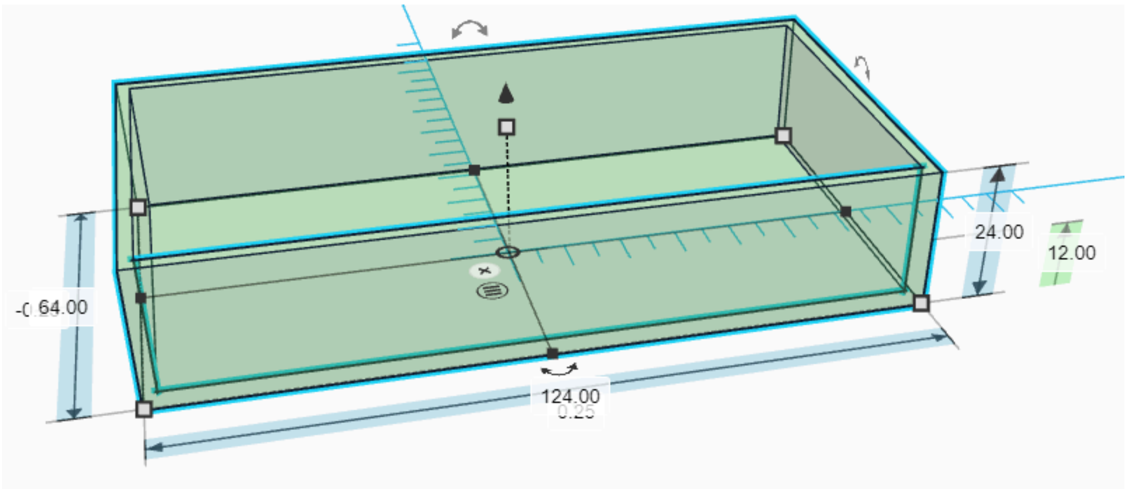

Figure 7D. Electronic housing

System Explanation - Materials and Tools

The following materials and tools were used to construct the project.

Materials:

1. Acrylic paint set
2. Black PLA plastic strand
3. Honey coloured LED
4. Blue LED
5. RGB LED
6. Dental floss
7. Plastic sheeting
8. Toggle push button
9. Plastic tubing
10. UV glue
11. White matte PLA plastic roll

Tools:

1. 3D printer: Prusa MK3
2. Blowtorch
3. Dupont connectors
4. Electrical wires
5. Flathead screwdriver

6. Foam tape
7. Piezoelectric buzzer
8. Pliers
9. Push-toggle button
10. Snippers
11. Super glue
12. USB-B to USB-A connector
13. UV flashlight
14. 5V DC water pump

System Explanation - Assembly Steps

First, after 3D printing the pieces to build the RainShroom 3D model, we assembled the four main components and reinforced those joints with UV glue. We then began working on circuit construction. The first step of circuit building was setting up the LEDs. Based on the 3D CAD model, we wired up the LEDs, one for the showerhead component and one for the mushroom. Then we wired up the 5V DC water pump. The electronic circuit is quite simple, as seen in Figure 8.

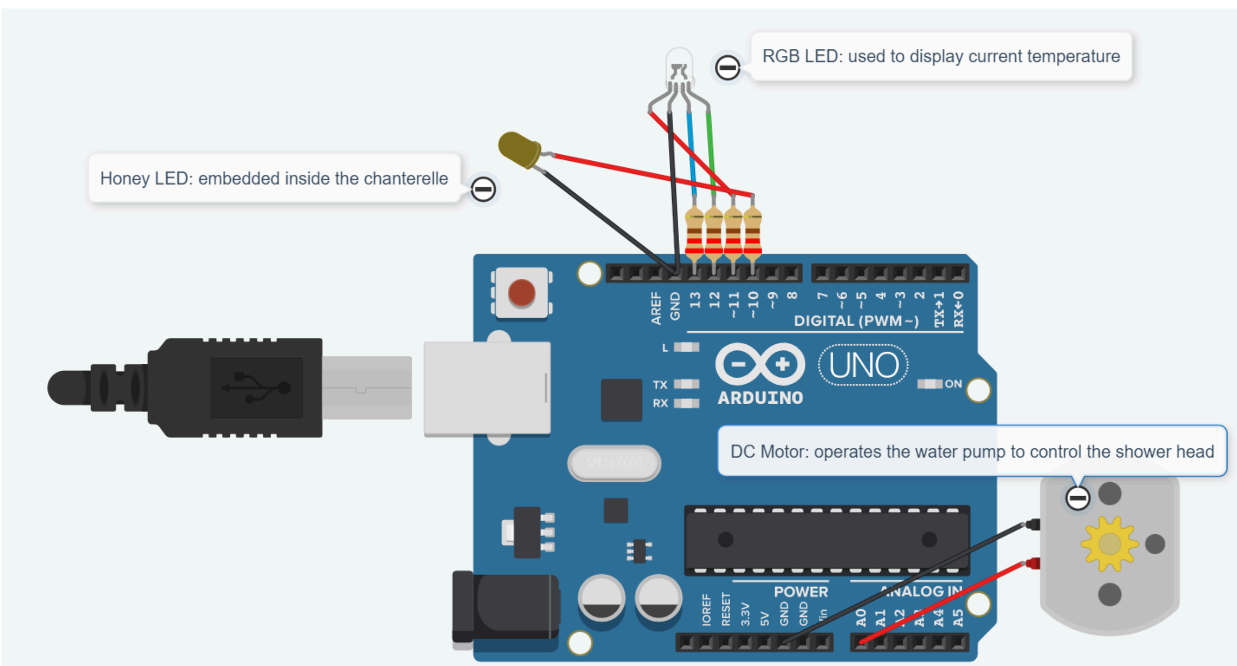

Figure 8. Rainshroom Arduino Circuit Diagram

Due to the design of the 3D model and the angles of plastic in the drainage bowl, it was very difficult to snake wires for the LED into the mushroom, as seen in Figure 9. Some improvising had to be done to drill a hole in to get an LED into the head of the mushroom from the bottom, which then had to be patched because we drilled through the drainage bowl and water would have gotten into the electronics. To get the wire through this hole to connect to the leds, we had to use dental floss and a little hook to snake the wires through. It worked although future design iterations could be done to improve the angles for easier assembly.

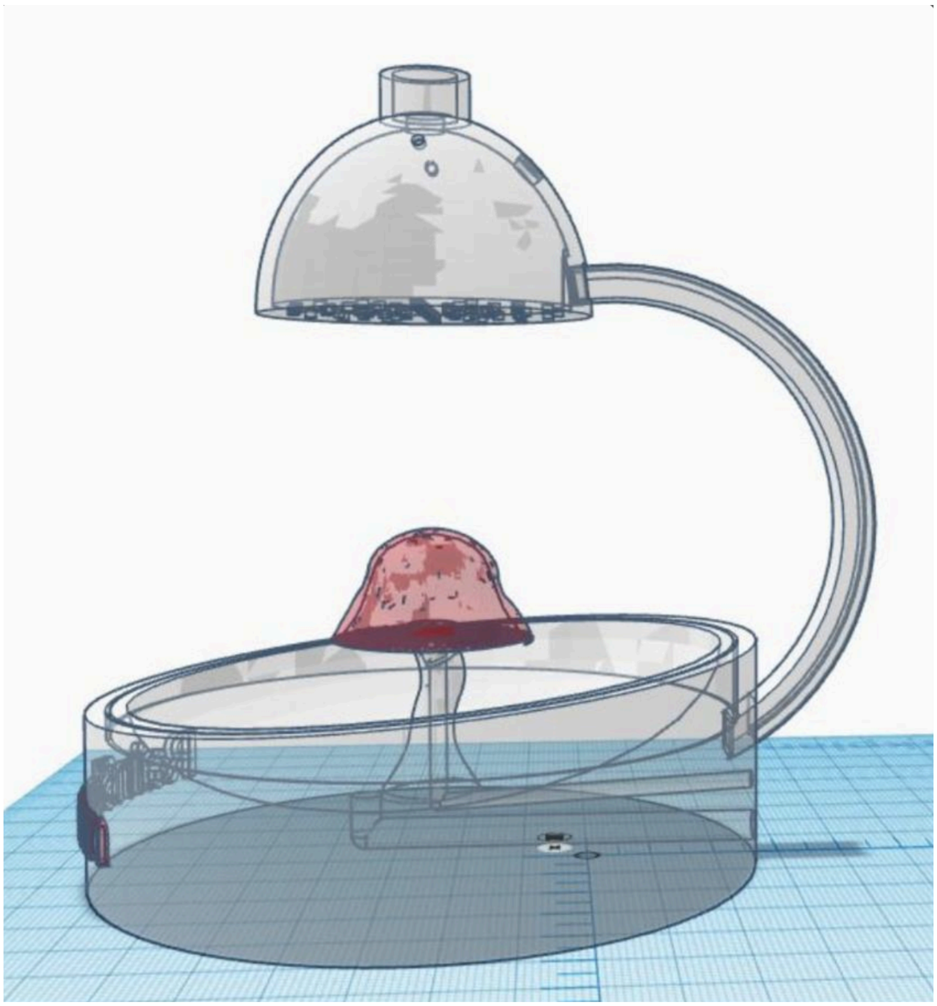

Figure 9. RainShroom Transparent 3D Model

Next, a RGB LED was installed in the "lamp" part of the 3D model so that the showerhead can illuminate based on the previously described data mappings. This was much more straightforward as the showerhead was designed to accommodate a hole for the led to rest in. Once that LED was easily wired into the showerhead, the plastic tube that came with the waterpump was led up the spine component and into the showerhead. The water pump lives in the back of the base component as seen in Figure 7. A rain shield was made from a plastic litre bottle to protect the space around the device and the electronics from water. The board was assembled with a set with a set of Dupont wires into the board to be connected with the Rainshroom device. The parts are then assembled with the blue LED, push toggle button then dome attached to the top plate, the connections leaving the board box are pushed through the circular hole and the board box is sealed. The excisting Dupond connectors are then connected with the connectors exiting from the Rainshroom device, allowing a quick separation of devices or extension if needed. All cabled are zip tied up, soft connections sealed with tape, and parts sealed with UV glue. The electronics including the pump itself live outside the 3D model, as seen in the Figure 10 of the final product.

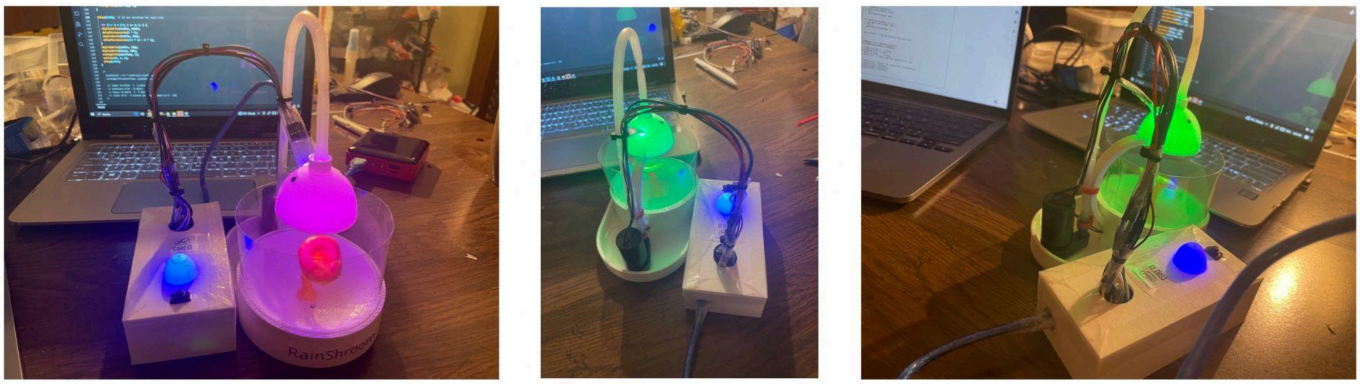

Figure 10. 360 Perspective of Final RainShroom Product

System Explanation - Code

This code is simulating a system that reads data from different mushroom growth locations and determines if the conditions for growing mushrooms are optimal or not. It sets the color of an RGB LED based on the temperature of the mushroom's environment and turns on or off a honey LED depending on whether the conditions are optimal or not. It also adjusts the speed of a water pump based on the amount of rainfall in the environment. The system reads data for 13 different mushroom growth locations, each with their own location, date, amount of rainfall, temperature, and optimal conditions. The readMushroomData function takes a MushroomData struct as input and displays the location and date of the mushroom growth. It then uses an if-else statement to determine the appropriate color to set the RGB LED and turns the honey LED on or off based on whether the conditions are optimal or not. Finally, it adjusts the speed of the water pump based on the amount of rainfall.

The following ports are used:

- honey is connected to pin 10
- red is connected to pin 11

- grn is connected to pin 12
- blu is connected to pin 13
- waterPump is connected to analog pin A0.

The setup() function sets the pin modes for the different ports as OUTPUT, initializes the serial communication, and sets up the initial values for the MushroomData structs. The loop() function reads the data for each mushroom location using the readMushroomData function and then waits for 1 minute before reading the next location. The delay() function is used to introduce a 1 minute delay between cycles.

The readMushroomData function takes in a MushroomData struct as input and displays the location and date of the mushroom growth using the Serial library. It then determines the appropriate color to set the RGB LED based on the temperature of the mushroom environment using a series of if-else statements. It turns the honey LED on or off based on whether the conditions are optimal or not using a simple if-else statement. Finally, it adjusts the speed of the water pump based on the amount of rainfall by calculating the pumpSpeed variable as 32 * mushroom.rainfall and using the analogWrite() function to set the speed of the water pump. It introduces a 10 second delay between each read.

The setColor function takes in three integer values representing the red, green, and blue values for the RGB LED and sets the corresponding ports to the input values.

```
// CSC485E: Assignment 2: RainShroom
// Tom Jing, Abby Flint

//map input pins to variables
const int honey = 10;
const int red = 11;
const int grn = 12;
const int blu = 13;
const int waterPump = A0;

//define struct for dataset
struct MushroomData {
  String location;
  String date;
  float rainfall;
  float temperature;
  bool isOptimal;
};

void setup() {
  pinMode(red, OUTPUT);
  pinMode(grn, OUTPUT);
```

```
  pinMode(blu, OUTPUT);
  pinMode(honey, OUTPUT);
  pinMode(waterPump, OUTPUT);
  pinMode(ledPin, OUTPUT);
  pinMode(buzzerPin, OUTPUT);
  tone(buzzerPin, 1000); // sound the buzzer at 1000 Hz
  delay(200); // wait for 200ms
  noTone(buzzerPin); // stop the buzzer

  Serial.begin(9600);
}

void loop() {
//record each row from dataset
  MushroomData mushroom1 = {"Sooke Hills Wilderness Park",
"09/20/2023", 3.1, 40, true};
  MushroomData mushroom2 = {"Sooke Hills Wilderness Park",
"09/21/2023", 0.1, 30, true};
  MushroomData mushroom3 = {"Sooke Hills Wilderness Park",
"09/22/2023", 0, 20, false};
  MushroomData mushroom4 = {"Sooke Hills Wilderness Park",
"09/23/2023", 0.5, 10, false};
  MushroomData mushroom5 = {"Sooke Hills Wilderness Park",
"09/24/2023", 0, 0, false};
  MushroomData mushroom6 = {"Sooke Hills Wilderness Park",
"09/25/2023", 7, 23, true};
  MushroomData mushroom7 = {"Sooke Hills Wilderness Park",
"09/26/2023", 0, 20, false};
  MushroomData mushroom8 = {"Sooke Hills Wilderness Park",
"09/27/2023", 1, 19, false};
  MushroomData mushroom9 = {"Sooke Hills Wilderness Park",
"09/28/2023", 0, 23, false};
  MushroomData mushroom10 = {"Sooke Hills Wilderness Park",
"09/29/2023", 0, 23, true};
  MushroomData mushroom11 = {"Sooke Hills Wilderness Park",
"09/30/2023", 1, 20, true};
  MushroomData mushroom12 = {"Sooke Hills Wilderness Park",
"10/01/2023", 0, 19, true};
  MushroomData mushroom13 = {"Sooke Hills Wilderness Park",
"10/02/2023", 0, 23, false};

//calls readMushroomData function for each row of dataset
  readMushroomData(mushroom1);
  readMushroomData(mushroom2);
  readMushroomData(mushroom3);
  readMushroomData(mushroom4);
  readMushroomData(mushroom5);
  readMushroomData(mushroom6);
  readMushroomData(mushroom7);
  readMushroomData(mushroom8);
  readMushroomData(mushroom9);
  readMushroomData(mushroom10);
  readMushroomData(mushroom11);
```

```
  readMushroomData(mushroom12);
  readMushroomData(mushroom13);
  delay(60000); // additional 1 min delay between cycles

}

//takes values from dataset and maps to inputs
void readMushroomData(MushroomData mushroom) {

  for (int i = 0; i < 256; i++) {
    digitalWrite(ledPin, HIGH);
    delayMicroseconds(i * 5);
    digitalWrite(ledPin, LOW);
    delayMicroseconds(255 * 20 - i * 4);
  }
  digitalWrite(ledPin, HIGH);

//print statements for testing purposes
  Serial.print("Location: ");
  Serial.println(mushroom.location);
  Serial.print("Date: ");
  Serial.println(mushroom.date);

//temperature colour mapping as outlined in document
  int temperature = (int)mushroom.temperature;
  if (temperature >= 30) {
    setColor(255, 0, 255);  // magenta too hot

  } else if (temperature >= 25) {
    setColor(255, 0, 0);  // red lean hot

  } else if (temperature >= 19) {
    setColor(0, 255, 0);  // green ideal

  } else if (temperature >= 13) {
    setColor(0, 255, 255);  // cyan lean cold

  } else {
    setColor(0, 0, 255);  // blue too cold
  }

//turn on mushroom light if dataset is TRUE
  if (mushroom.isOptimal) {
    digitalWrite(honey, HIGH);
  } else {
    digitalWrite(honey, LOW);
  }

  delay(10000);  // 10 sec duration for each read
    for (int i = 255; i >= 0; i--) {
    digitalWrite(ledPin, HIGH);
    delayMicroseconds(i * 5);
    digitalWrite(ledPin, LOW);
```

```
    delayMicroseconds(255 * 20 - i * 4);
  }

}

  pumpSpeed = 32 * mushroom.rainfall;
  analogWrite(waterPump, pumpSpeed);

  // light <0.10/hr  |  2.40/day
  // moderate 0.10 - 0.30/hr
  // heavy >0.30/hr  |  7.20/day
  // scale of 0 - 8 inches per day, mapped to 0 - 255


void setColor(int redValue, int greenValue, int blueValue) {
  digitalWrite(red, redValue);
  digitalWrite(grn, greenValue);
  digitalWrite(blu, blueValue);
}

  if (mushroom.isOptimal) {
    digitalWrite(honey, HIGH);
  } else {
    digitalWrite(honey, LOW);
  }

  pumpSpeed = 32 * mushroom.rainfall;
  analogWrite(waterPump, pumpSpeed);

  // light <0.10/hr  |  2.40/day
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  // scale of 0 - 8 inches per day, mapped to 0 - 255

  delay(10000);  // 10 sec duration for each read
}

void setColor(int redValue, int greenValue, int blueValue) {
  digitalWrite(red, redValue);
  digitalWrite(grn, greenValue);
  digitalWrite(blu, blueValue);
}
```

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