Name: JAMIE GONZALES ESGUERRA (9) **Class: PA12**

Problem statement

Temperature is an important factor to the growth of plants. Temperature can affect the photosynthesis of plants whereby the plants use sunlight, water and carbon dioxide to create oxygen and energy in the form of sugar. Different plants require different temperature. For example, lettuce cannot exceed a temperature above 28°C. Hence, it is important to regulate and maintain the temperature in a greenhouse to maximise crop yield. I aim to regulate the temperature based on the requirements of a specific plant to produce consistent and predictable higher crop yield using sensors and actuators. The farmers would be given a choice whether they want it to work automatically or manually by using a switch. As an example, I would follow the temperature requirement of a lettuce (28°C). When the program is set manually, the farmers are obliged to operate the DC Motor Fan when needed. When it is automatic, the Dc Motor fan would turn on itself when needed. For farmers to know whether the temperature has exceeded the limit, the buzzer would turn on and the Tri_LED colour red would be lighted up. Furthermore, to reduce mistakes, the farmers would not be able to turn on the DC Motor Fan when the temperature is lower than the threshold instead, the orange led would light up to indicate that the DC Motor Fan should not be turned on. Lastly, Ubidots is used to show the temperature of the temperature sensor over time.

System Requirement

This system design is built to constantly monitor the temperature in the greenhouse by using a temperature sensor which has an ability to measure the surrounding temperature. By converting the binary to voltage and voltage to degree Celsius, we would have the data of the surrounding temperature in degree Celsius. I programmed the Arduino to have a temperature threshold of 28°C which is the maximum temperature that a lettuce can take.

I used MQTT to send the temperature data to Ubidots for the farmers to have a visualization of how the temperature changes over time. This is useful as it can show the specific temperature at a specific date and time.

When the temperature sensor detects that the temperature above the threshold, a **buzzer** turns on.

The **LED_TRI** has three colours that represents the following:

Green light – Temperature is below the threshold

Red light – Temperature is too high

Blue light – Fan is being activated by the farmer (will only show when temp. is higher than the threshold and the program is set to manual.)

The farmers can either choose to operate the DC Motor Fan **manually or automatically** by using a **switch**.

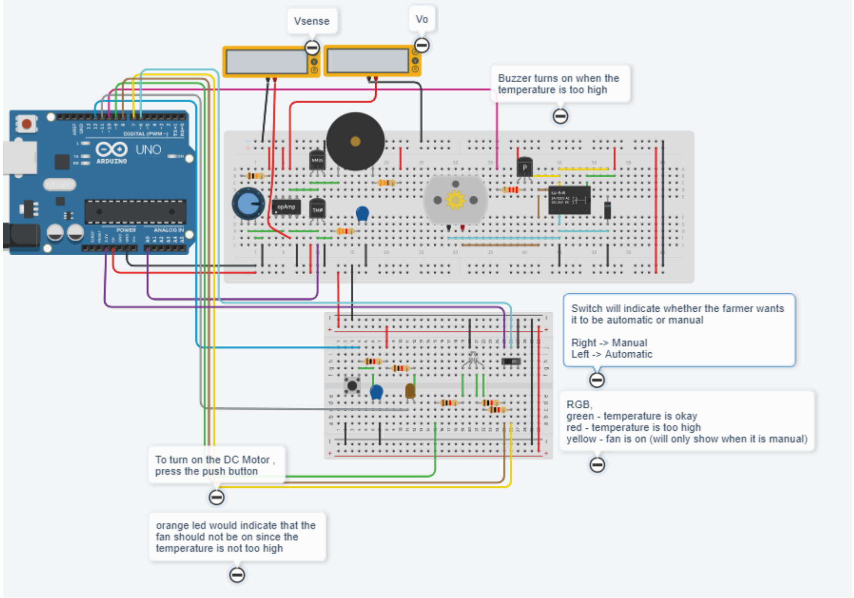
Automatic

When the farmer set the **switch** to the automatic operation, the farmers do not need to manually turn on the DC Motor fan when the temperature is too hot by using the **push button**. The Arduino will turn on the DC Motor fan by itself to lower the temperature. Hence, this allows the farmers to have flexibility on their time as they may not be always around to maintain the temperature of the greenhouse.

Manual

When the temperature is too high and it is operating **manually,** the farmer must switch on the fan by himself/herself. However, the farmer would not be able to switch on the DC motor fan when the temperature is below the limit. Instead, it will show a warning in which the **orange led** will turn on, indicating that the fan does not need to be turned on.

System Architecture



Buzzer turns on when the temperature is too high

Switch will indicate whether the farmer wants it to be automatic or manual

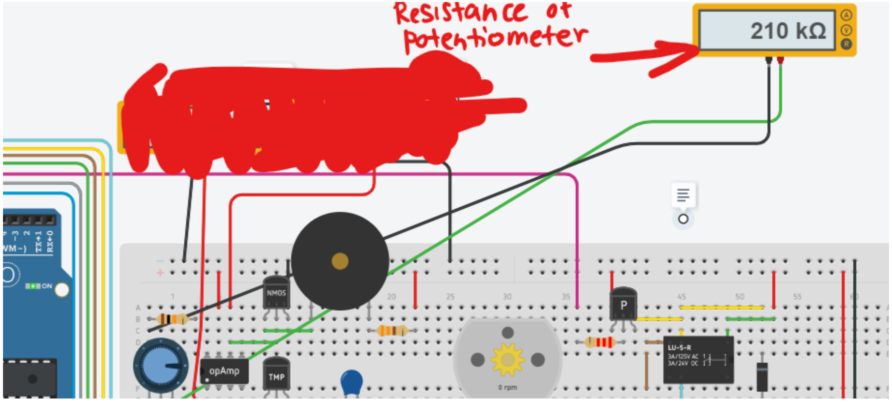
Right -> Manual
Left -> Automatic

RGB,
green - temperature is okay
red - temperature is too high
yellow - fan is on (will only show when it is manual)

To turn on the DC Motor , press the push button

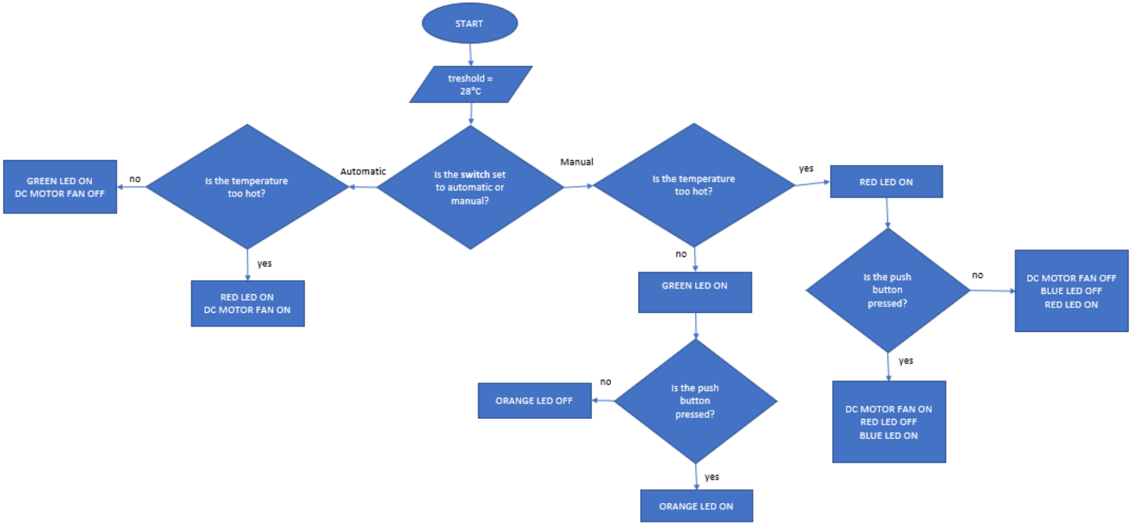
orange led would indicate that the fan should not be on since the temperature is not too high

- Temperature threshold of 28°C
- An electromagnetic relay to turn on the DC Motor Fan when needed
- Switch used to either change the program to automatic or manual.
- After adjusting the potentiometer, the should be **210k ohm** for the buzzer to turn on when the temperature exceeds the **threshold of 28°C**.



[redacted]

- TRI_LED to indicate whether the temperature is too hot (red light), below the treshold (green) or when the fan is being manually activated.



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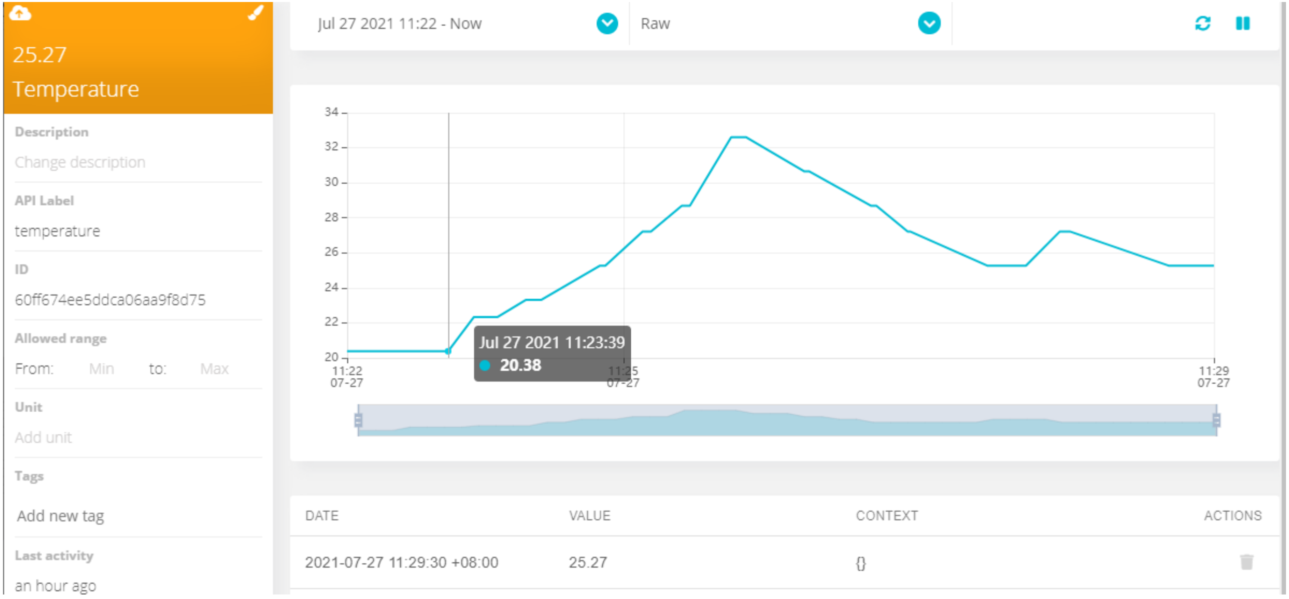
Temperature of greenhouse over time (above 28°C, buzzer on)



25.27
Temperature

Description
Change description

API Label
temperature

ID
60ff674ee5ddca06aa9f8d75

Allowed range
From: Min to: Max

Unit
Add unit

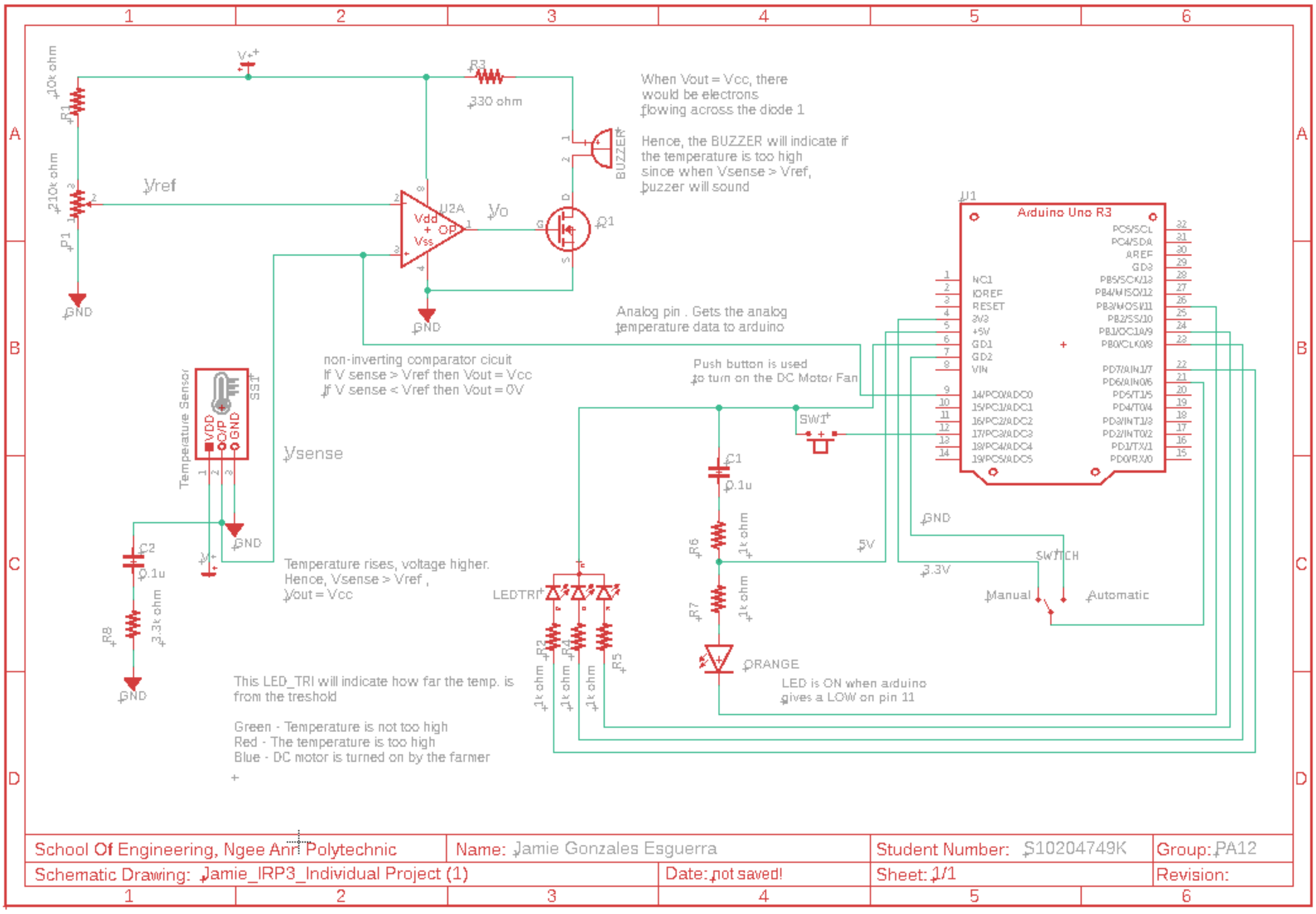
Tags
Add new tag

Last activity
an hour ago

Jul 27 2021 11:22 - Now
Raw

DATE	VALUE	CONTEXT	ACTIONS
2021-07-27 11:29:30 +08:00	25.27	{}	

Temperature Sensing Sub-System Schematic & Prototypes



When Vout = Vcc, there would be electrons flowing across the diode 1

Hence, the BUZZER will indicate if the temperature is too high since when Vsense > Vref, buzzer will sound

Analog pin . Gets the analog temperature data to arduino

non-inverting comparator cicuit
If V sense > Vref then Vout = Vcc
If V sense < Vref then Vout = 0V

Push button is used to turn on the DC Motor Fan

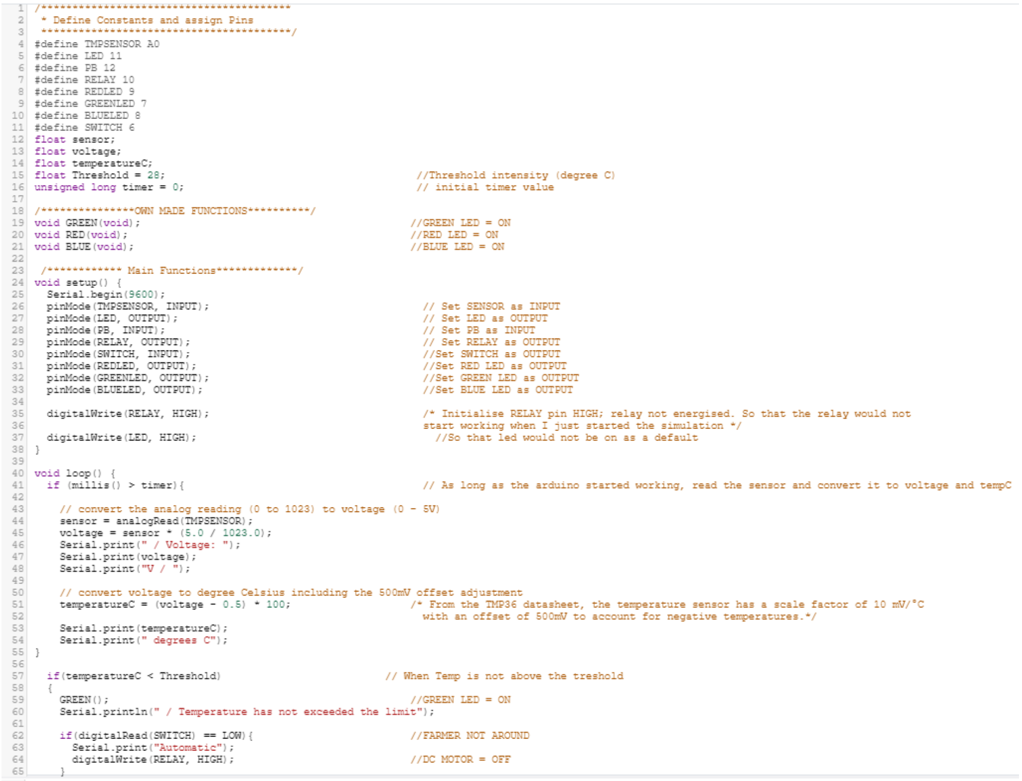
Temperature rises, voltage higher.
Hence, Vsense > Vref ,
Vout = Vcc

This LED_TRI will indicate how far the temp. is from the treshold

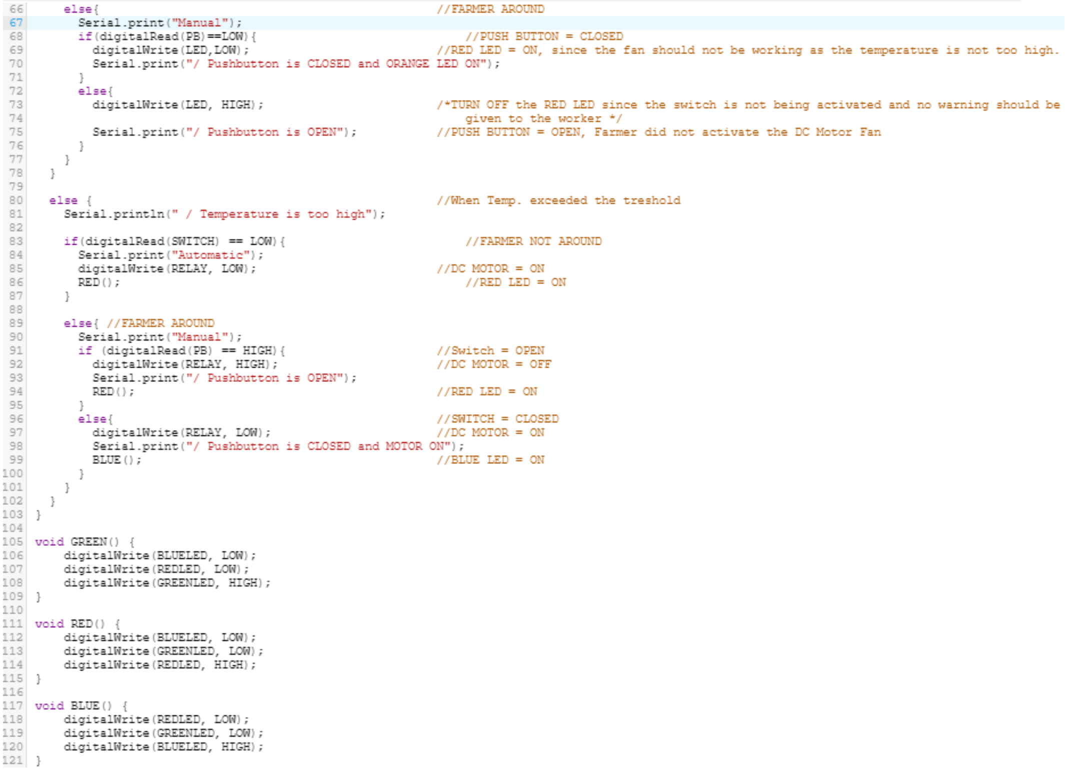
Green - Temperature is not too high
Red - The temperature is too high
Blue - DC motor is turned on by the farmer

LED is ON when arduino gives a LOW on pin 11

School Of Engineering, Ngee Ann Polytechnic	Name: Jamie Gonzales Esguerra	Student Number: S10204749K	Group: PA12
Schematic Drawing: Jamie_IRP3_Individual Project (1)	Date: not saved!	Sheet: 1/1	Revision:



```
/******************************************
 * Define Constants and assign Pins
 ******************************************/
#define TMPSENSOR A0
#define LED 11
#define PB 12
#define RELAY 10
#define REDLED 9
#define GREENLED 7
#define BLUELED 8
#define SWITCH 6
float sensor;
float voltage;
float temperatureC;
float Threshold = 28;                                         //Threshold intensity (degree C)
unsigned long timer = 0;                                      // initial timer value

/***************OWN MADE FUNCTIONS**********/
void GREEN(void);                                            //GREEN LED = ON
void RED(void);                                              //RED LED = ON
void BLUE(void);                                             //BLUE LED = ON

 /************ Main Functions*************/
void setup() {
  Serial.begin(9600);
  pinMode(TMPSENSOR, INPUT);                                   // Set SENSOR as INPUT
  pinMode(LED, OUTPUT);                                        // Set LED as OUTPUT
  pinMode(PB, INPUT);                                          // Set PB as INPUT
  pinMode(RELAY, OUTPUT);                                      // Set RELAY as OUTPUT
  pinMode(SWITCH, INPUT);                                      //Set SWITCH as OUTPUT
  pinMode(REDLED, OUTPUT);                                     //Set RED LED as OUTPUT
  pinMode(GREENLED, OUTPUT);                                   //Set GREEN LED as OUTPUT
  pinMode(BLUELED, OUTPUT);                                    //Set BLUE LED as OUTPUT

  digitalWrite(RELAY, HIGH);                                   /* Initialise RELAY pin HIGH; relay not energised. So that the relay would not
                                                               start working when I just started the simulation */
  digitalWrite(LED, HIGH);                                       //So that led would not be on as a default
}

void loop() {
  if (millis() > timer){                                       // As long as the arduino started working, read the sensor and convert it to voltage and tempC

    // convert the analog reading (0 to 1023) to voltage (0 - 5V)
    sensor = analogRead(TMPSENSOR);
    voltage = sensor * (5.0 / 1023.0);
    Serial.print(" / Voltage: ");
    Serial.print(voltage);
    Serial.print("V / ");

    // convert voltage to degree Celsius including the 500mV offset adjustment
    temperatureC = (voltage - 0.5) * 100;                    /* From the TMP36 datasheet, the temperature sensor has a scale factor of 10 mV/°C
                                                               with an offset of 500mV to account for negative temperatures.*/
    Serial.print(temperatureC);
    Serial.print(" degrees C");
}

  if(temperatureC < Threshold)                         // When Temp is not above the treshold
  {
    GREEN();                                                 //GREEN LED = ON
    Serial.println(" / Temperature has not exceeded the limit");

    if(digitalRead(SWITCH) == LOW){                          //FARMER NOT AROUND
      Serial.print("Automatic");
      digitalWrite(RELAY, HIGH);                             //DC MOTOR = OFF
    }
```



```
    else{                                                    //FARMER AROUND
      Serial.print("Manual");
      if(digitalRead(PB)==LOW){                                  //PUSH BUTTON = CLOSED
        digitalWrite(LED,LOW);                               //RED LED = ON, since the fan should not be working as the temperature is not too high.
        Serial.print("/ Pushbutton is CLOSED and ORANGE LED ON");
      }
      else{
        digitalWrite(LED, HIGH);                             /*TURN OFF the RED LED since the switch is not being activated and no warning should be
                                                                 given to the worker */
        Serial.print("/ Pushbutton is OPEN");                //PUSH BUTTON = OPEN, Farmer did not activate the DC Motor Fan
      }
    }
  }

  else {                                                     //When Temp. exceeded the treshold
    Serial.println(" / Temperature is too high");

    if(digitalRead(SWITCH) == LOW){                              //FARMER NOT AROUND
      Serial.print("Automatic");
      digitalWrite(RELAY, LOW);                              //DC MOTOR = ON
      RED();                                                     //RED LED = ON
    }

    else{ //FARMER AROUND
      Serial.print("Manual");
      if (digitalRead(PB) == HIGH){                          //Switch = OPEN
        digitalWrite(RELAY, HIGH);                           //DC MOTOR = OFF
        Serial.print("/ Pushbutton is OPEN");
        RED();                                               //RED LED = ON
      }
      else{                                                  //SWITCH = CLOSED
        digitalWrite(RELAY, LOW);                            //DC MOTOR = ON
        Serial.print("/ Pushbutton is CLOSED and MOTOR ON");
        BLUE();                                              //BLUE LED = ON
      }
    }
  }
}

void GREEN() {
    digitalWrite(BLUELED, LOW);
    digitalWrite(REDLED, LOW);
    digitalWrite(GREENLED, HIGH);
}

void RED() {
    digitalWrite(BLUELED, LOW);
    digitalWrite(GREENLED, LOW);
    digitalWrite(REDLED, HIGH);
}

void BLUE() {
    digitalWrite(REDLED, LOW);
    digitalWrite(GREENLED, LOW);
    digitalWrite(BLUELED, HIGH);
}
```

SL Reflections

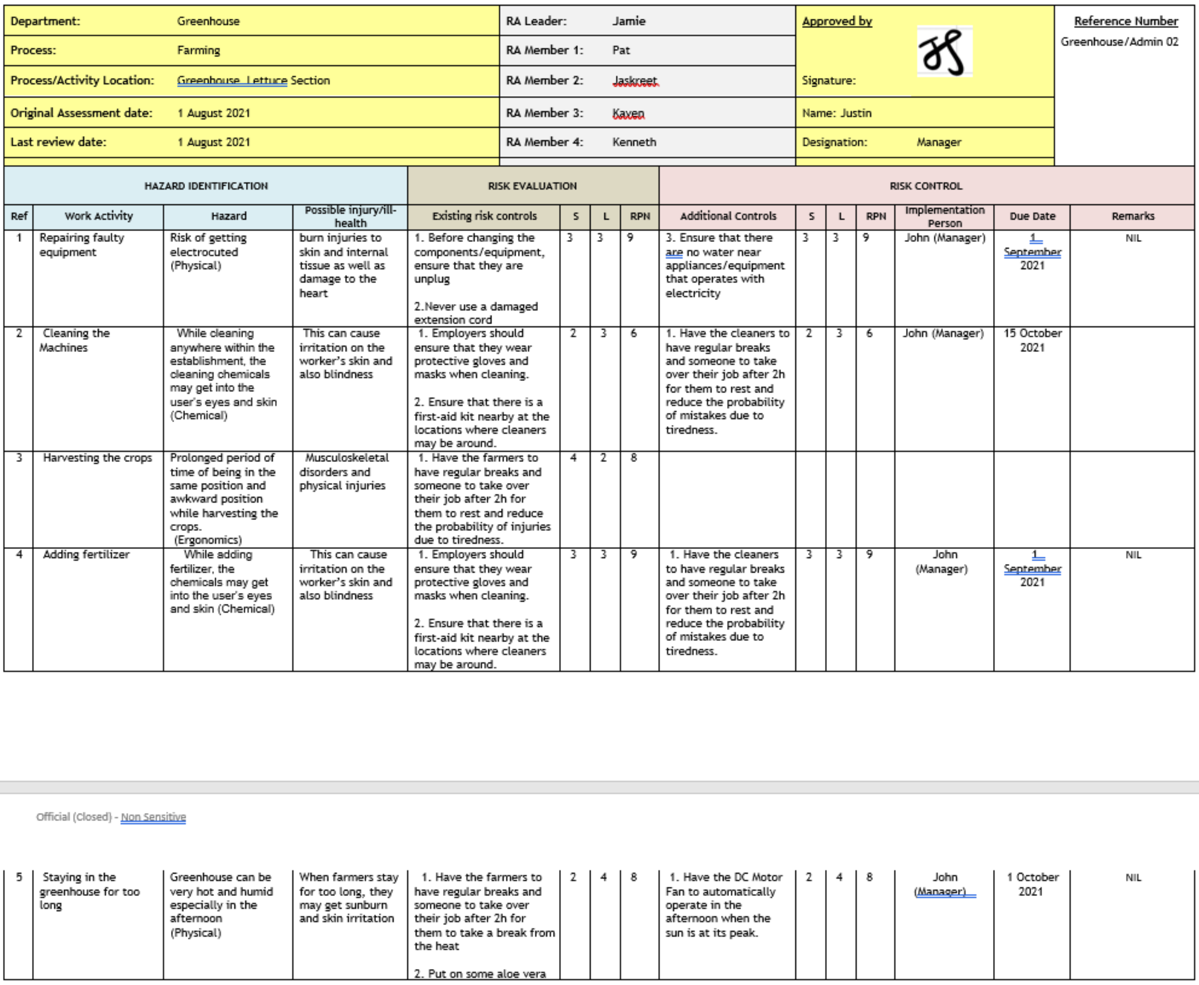
After visiting the Citysprout, I gained a better understanding of how a greenhouse works. Two things that sparked my interest was when they used the fishes' waste as a fertilizer and utilize vertical farming for a better plant growth.

Greenhouse is crucial as it can bring a significant benefit to produce higher crop yield and achieve the Singapore's 3030 goal by constantly monitoring the important environmental factors such as the temperature and moisture. This relates to the aim of my project: To regulate the temperature based on the requirements of a specific plant to produce consistent and predictable higher crop yield using sensors and actuators. The IRP3 lessons have helped me developed relevant skills to design a prototype that helped me achieve my aim. For example, I learnt to use an operational amplifier and relay to control my buzzer and dc motor fan respectively. Not only I have learnt the theory knowledge of these components but I have also picked up the skills to create this in a breadboard. Furthermore, I have learnt how to create a schematic diagram using eagle which is is very meaningful and useful for me as I can potentially use this knowledge for another project in the future.After the webinar with Citysprouts on MsTeams, they have mentioned that they would prefer their equipment to operate automatically for convenience. I included this feedback as an additional feature to my project by using a switch to operate the DC Motor Fan automatically or manually. Another important skill that I have gained is the use of Ubidots. Even though we weren't able to implement the Bluetooth to an actual Arduino due to covid restrictions, I believe that understanding the use of Ubidots can have a significant benefit for engineers as we can constantly monitor our prototype without physically around it.

One of the challenges I faced was programming my tinkercad. My program LED and relay turns on when I send it a "LOW" instead of a "HIGH". This has caused confusion to me as I originally use "HIGH" to turn an LED. To solve this, I comment on my program every time I turn on or off an actuator. Additionally, the serial monitor would also indicate whether the relay or led is on.

With all the knowledge I gained through IRP3, I am not more confident when designing/programming a circuit and how I can implement op amp/relay/schematic diagram/Ubidots to my prototype.

Urban Agricultural Risk Assessment Form



Department:	Greenhouse	RA Leader:	Jamie	Approved by Signature:	Reference Number Greenhouse/Admin 02
Process:	Farming	RA Member 1:	Pat		
Process/Activity Location:	Greenhouse, Lettuce Section	RA Member 2:	Jaskreet		
Original Assessment date:	1 August 2021	RA Member 3:	Kaven	Name: Justin	
Last review date:	1 August 2021	RA Member 4:	Kenneth	Designation: Manager	

HAZARD IDENTIFICATION				RISK EVALUATION				RISK CONTROL						
Ref	Work Activity	Hazard	Possible injury/ill-health	Existing risk controls	S	L	RPN	Additional Controls	S	L	RPN	Implementation Person	Due Date	Remarks
1	Repairing faulty equipment	Risk of getting electrocuted (Physical)	burn injuries to skin and internal tissue as well as damage to the heart	1. Before changing the components/equipment, ensure that they are unplug 2.Never use a damaged extension cord	3	3	9	3. Ensure that there are no water near appliances/equipment that operates with electricity	3	3	9	John (Manager)	1 September 2021	NIL
2	Cleaning the Machines	While cleaning anywhere within the establishment, the cleaning chemicals may get into the user's eyes and skin (Chemical)	This can cause irritation on the worker's skin and also blindness	1. Employers should ensure that they wear protective gloves and masks when cleaning. 2. Ensure that there is a first-aid kit nearby at the locations where cleaners may be around.	2	3	6	1. Have the cleaners to have regular breaks and someone to take over their job after 2h for them to rest and reduce the probability of mistakes due to tiredness.	2	3	6	John (Manager)	15 October 2021	
3	Harvesting the crops	Prolonged period of time of being in the same position and awkward position while harvesting the crops. (Ergonomics)	Musculoskeletal disorders and physical injuries	1. Have the farmers to have regular breaks and someone to take over their job after 2h for them to rest and reduce the probability of injuries due to tiredness.	4	2	8							
4	Adding fertilizer	While adding fertilizer, the chemicals may get into the user's eyes and skin (Chemical)	This can cause irritation on the worker's skin and also blindness	1. Employers should ensure that they wear protective gloves and masks when cleaning. 2. Ensure that there is a first-aid kit nearby at the locations where cleaners may be around.	3	3	9	1. Have the cleaners to have regular breaks and someone to take over their job after 2h for them to rest and reduce the probability of mistakes due to tiredness.	3	3	9	John (Manager)	1 September 2021	NIL
5	Staying in the greenhouse for too long	Greenhouse can be very hot and humid especially in the afternoon (Physical)	When farmers stay for too long, they may get sunburn and skin irritation	1. Have the farmers to have regular breaks and someone to take over their job after 2h for them to take a break from the heat 2. Put on some aloe vera	2	4	8	1. Have the DC Motor Fan to automatically operate in the afternoon when the sun is at its peak.	2	4	8	John (Manager)	1 October 2021	NIL

Official (Closed) - Non Sensitive