AUTOMATED VENTILATION CONTROLLER

Group 15

Sponsored by Chris Neiger

THE TEAM

Wendy Dominguez

Computer Engineering

Gisela Griesheimer

Electrical Engineering

Angelica Longo

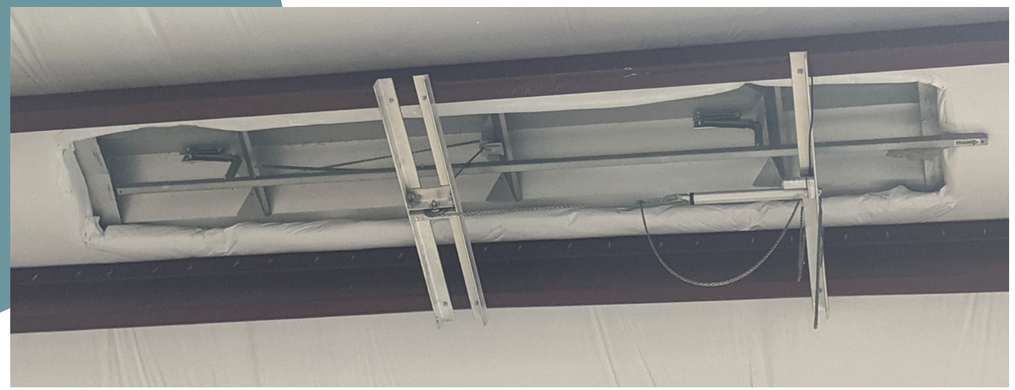
Computer Engineering

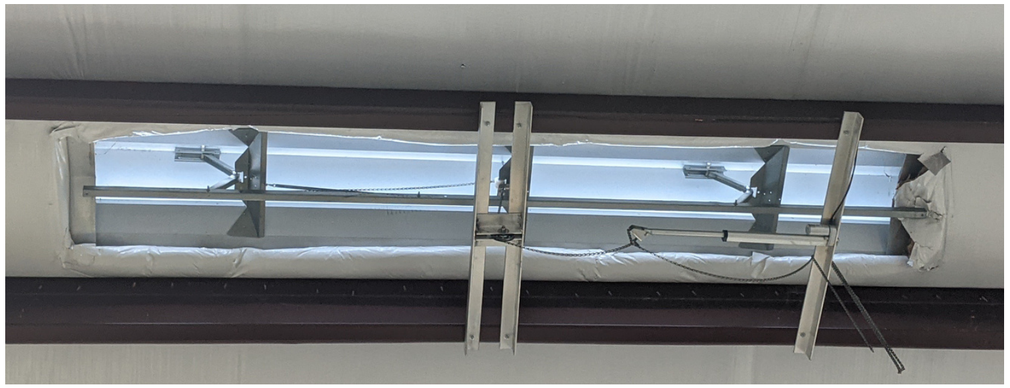
Philip Munyon

Electrical Engineering

The NERF

- Owned by our sponsor Chris Neiger
- 6000 sq ft warehouse in Niceville FL
- 4 Vents
  - Can be open or closed
- Already installed and powered



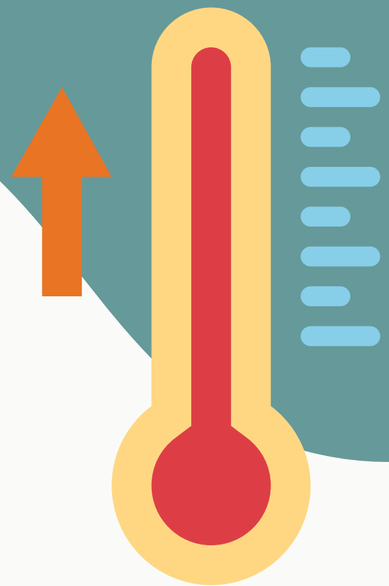


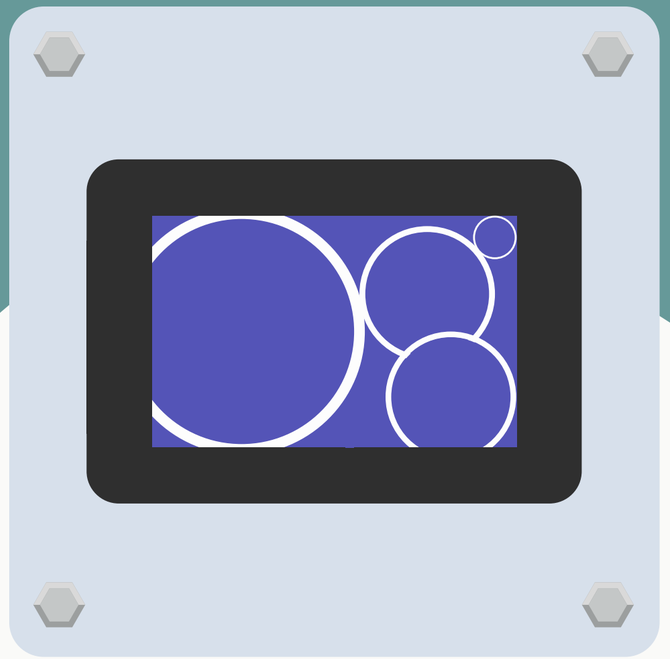
PREVIOUS CONTROL SYSTEM

- Each vent controlled by one switch
- Switch up - open
- Switch down - closed

MOTIVATIONS

- Automate vents to cool warehouse
- Warehouse is large and expensive to air condition
- Smart Home/ IoT tech becoming increasingly more desired
- Natural cooling is better environmentally



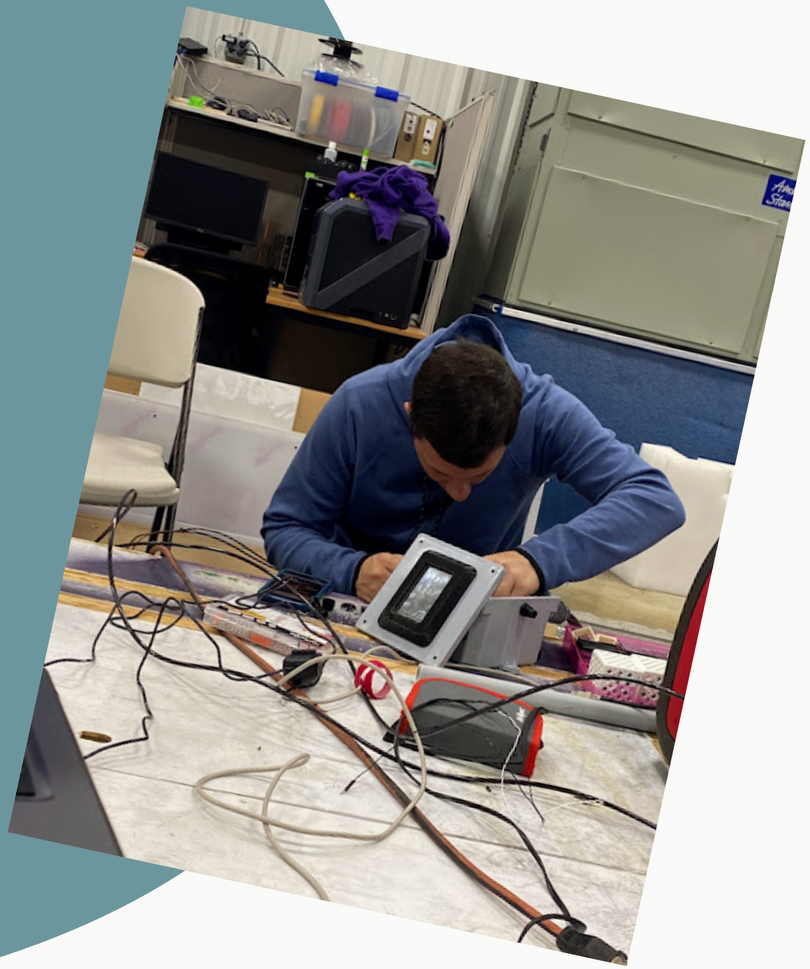


SPONSOR BENEFITS

- Indoor and outdoor temperature sensing for smart ventilation
- Mobile-friendly website for easy remote access
- Touch screen with a simple display of vents' status
- Easy to maintain

GOALS & OBJECTIVES

- 5 indoor Sensor Units to aggregate warehouse temperature and humidity
- Compare indoor climate with outdoor climate
- Control Unit interprets data to tell vents when to open/close
- Touch screen for manual control and visualizing status of each vent
- Website alternative to check and adjust vents remotely



REQUIREMENT SPESIFICATIONS

Component	Parameter	Design Specification
Sensor Unit	Maximum Range	100 feet
Main Unit (Display)	Update Time	40 seconds
Main Unit (Automation)	Override Expiration	3 hours
Main Unit (Controls)	Response Time	1 second
Temperature Sensing	Accuracy	± .5 C
Humidity Sensing	Accuracy	2%
Web Controller	Response Time	60 seconds
Web Scraping	Update Time	1x /second

WORK DISTRIBUTION

	High Level Hardware	Sensors	High Level Software	User Interface
Primary	David	Gisela	Wendy	Angelica
Secondary	Gisela	David	Angelica	Wendy

Power Source

Control Unit

Sensor Unit (5)

Arduino Code

Configures

Microcontroller *(Arduino Nano Every)*

Temperature & Humidity Sensor *(DHT22)*

Reads climate data

Slave Bluetooth Module *(HM-10)*

Slave sends data to Master

Wi-Fi Module *(Adafruit Huzzah)*

Master Bluetooth Module *(HM-10)*

Display *(LCD TFT)*

Sends & receives data to our domain

Hosting Service (Heroku)

Website

User Interface

Login & Logout

Account Page

Website updates database

Arduino Code

Configures

Microcontroller *(Mega Custom)*

Relays *(4)*

Power Source

Database (SQL)

Users

Vent Configurations

Indoor/Outdoor Climate Data

User Interface

Home Screen

Information Button

Ventilation Buttons

Average Temperature & Humidity

Information Screen

Ideal Temperature

Override Toggle

Each Sensor Unit's Temp & Humidity

Reset Button

Back Button

Gisela Griesheimer

Angelica Longo

Wendy Dominguez

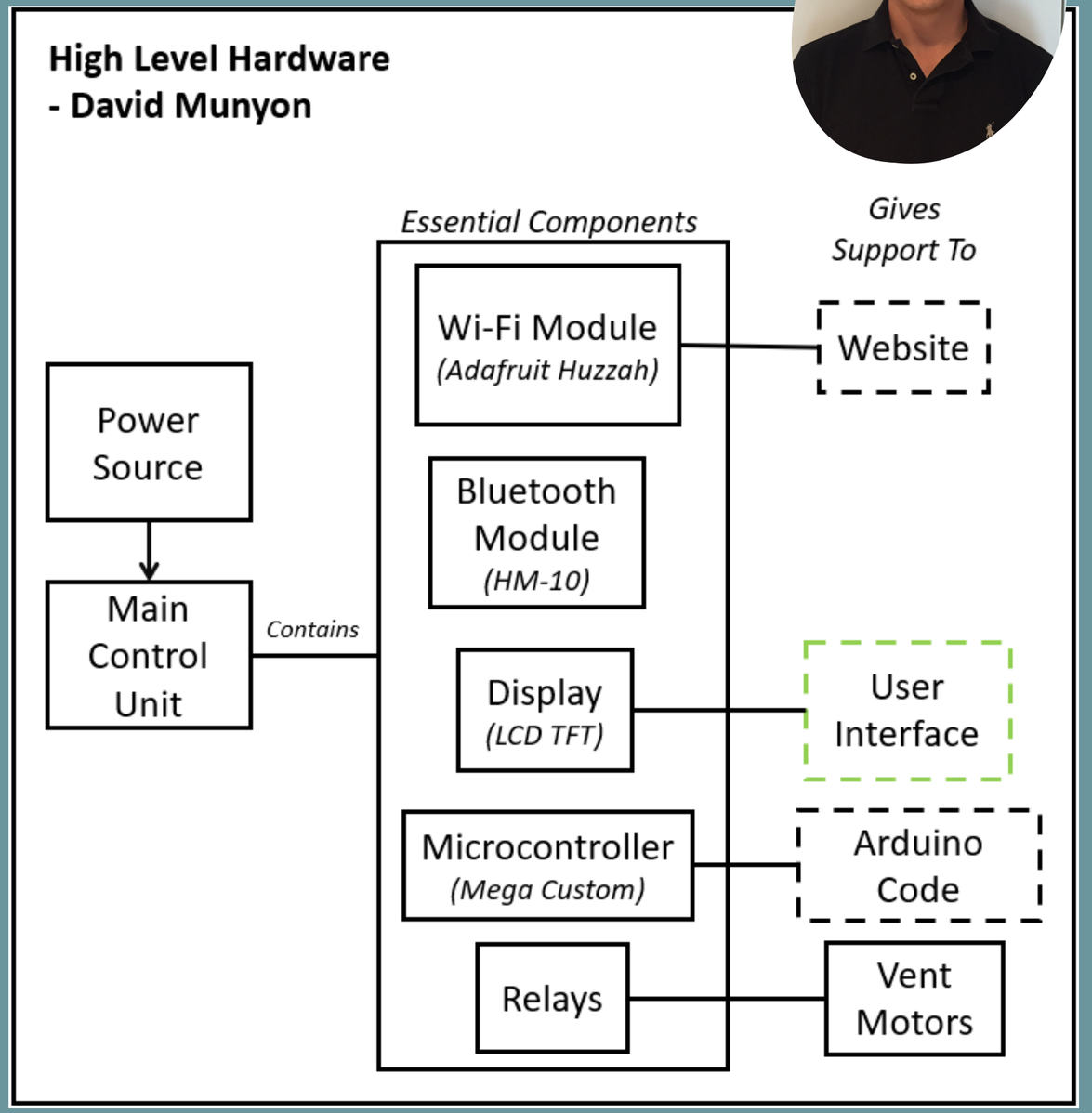
David Munyon

Hardware

Software

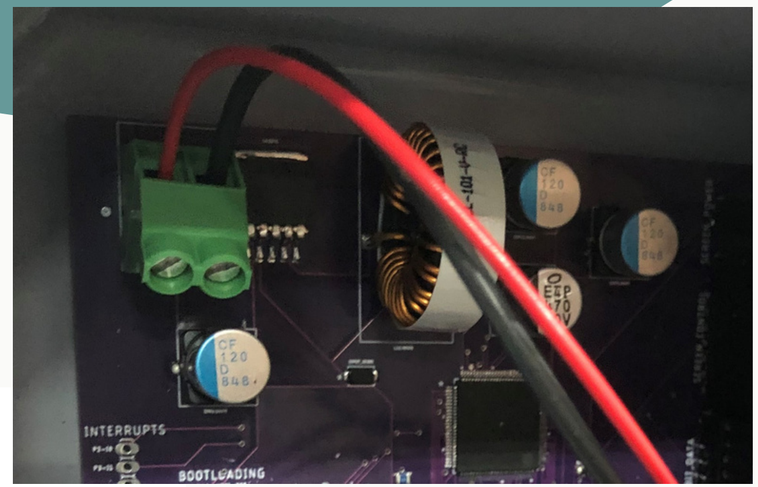
HARDWARE COMPONENTS FOR CONTROL UNIT

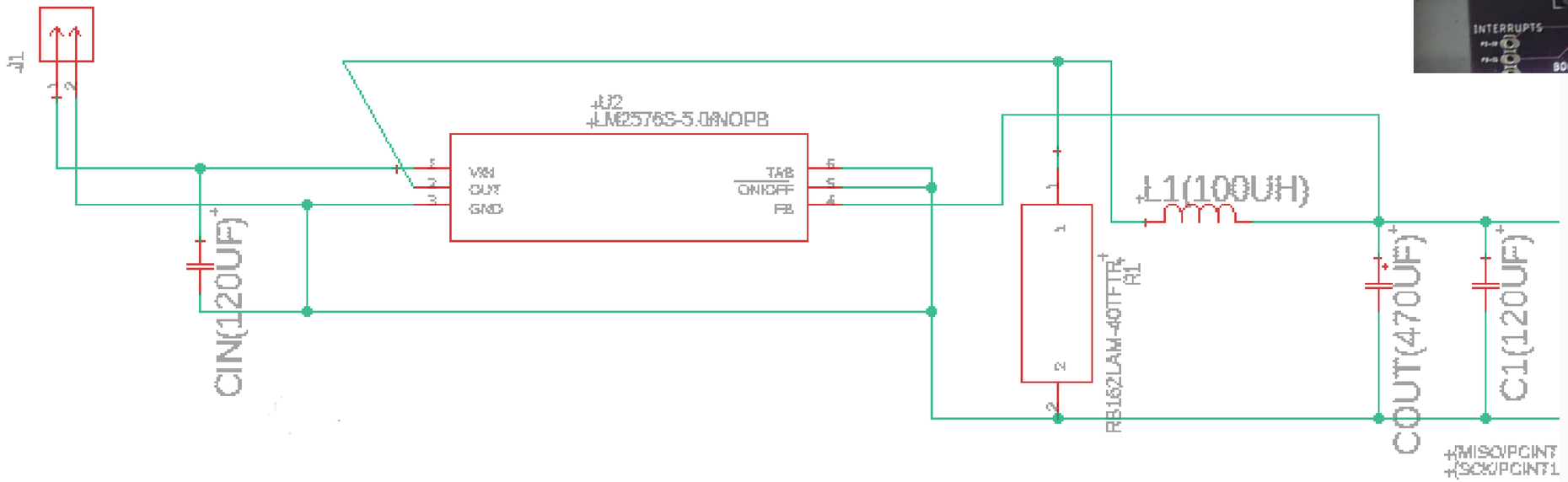
- Power Supply- LM2576
- Bluetooth Module- HM-10
- Wifi Module- Adafruit HUZZAH
- Relay Module - ELEGOO 4-Channel
- Microcontroller- Atmel ATMEGA2560
- Touch Display- Adafruit 3.5” TFT Display w/ resistive touch sensing



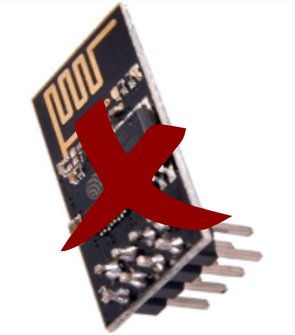
POWER SUPPLY - LM 2576

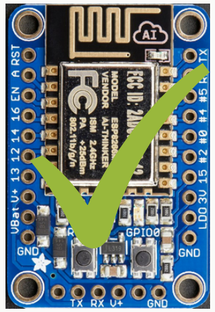
- Step Down Buck Converter, Fixed output of 5V
- Only Buck Converter in stock at time of PCB design
- Max output- 3A





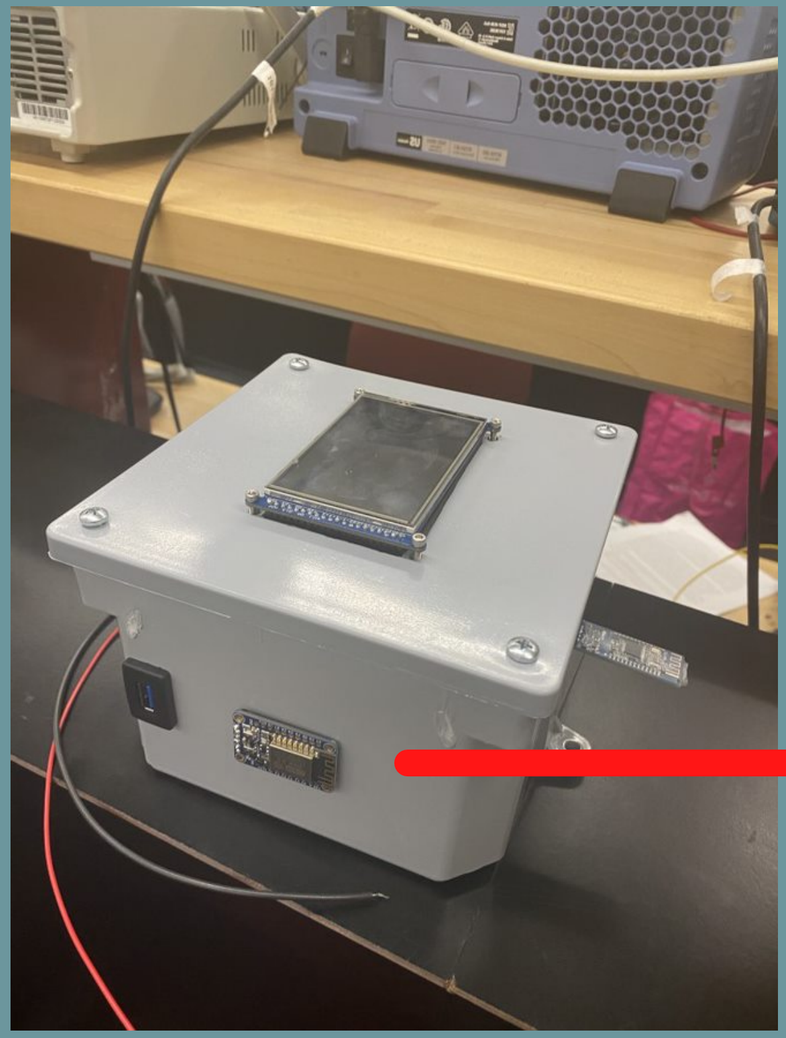
WIFI MODULE COMPARISION





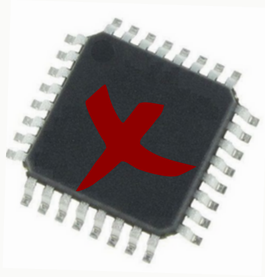
	ESP 8266	**Adafruit Huzzah**
Input Voltage	3.3V input	3-6V input
Logic Level	3.3V logic level	3.3V logic level
Core	ESP 8266	ESP 8266
Programming	Arduino IDE	Arduino IDE (Requires FTDI Cable)

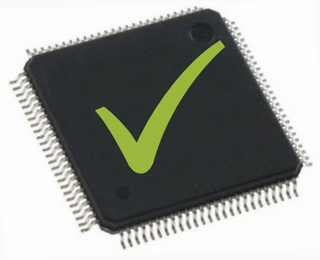
WIFI MODULE: ADAFRUIT HUZZA



- **3-6V input and 3.3V logic level**
- **Sends outside climate data to main control unit**
- **Receives indoor climate data for storage on the database**

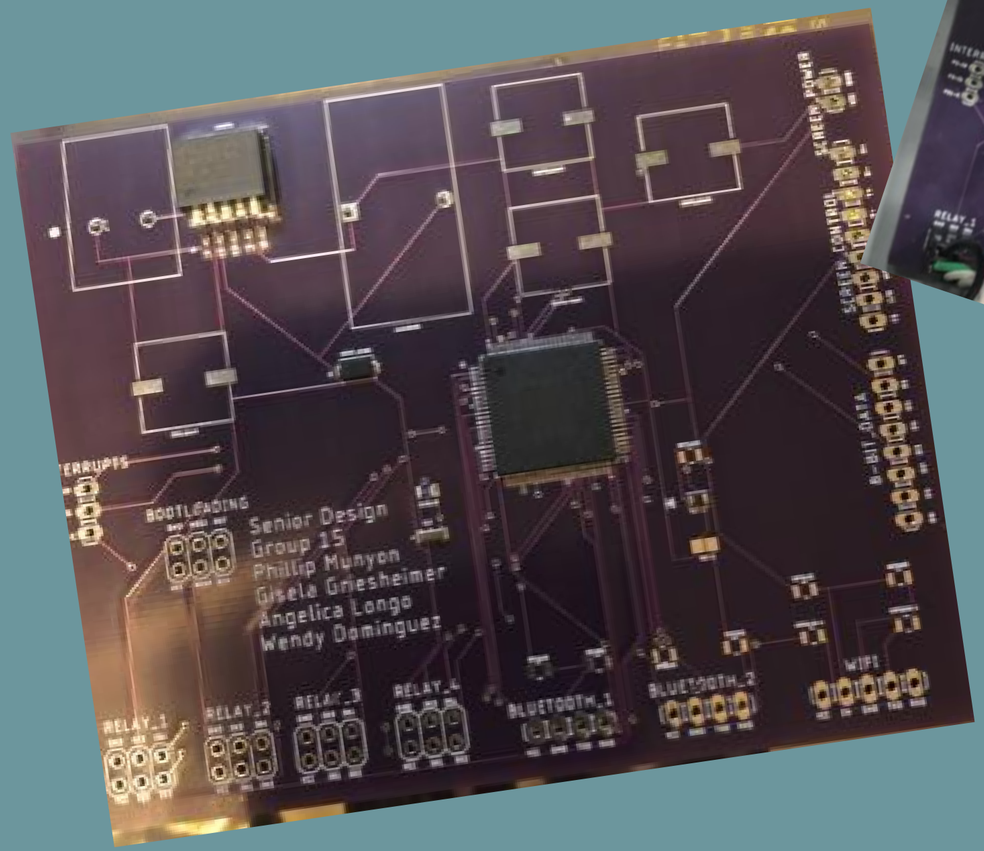
MICROCONTROLLER COMPARISION

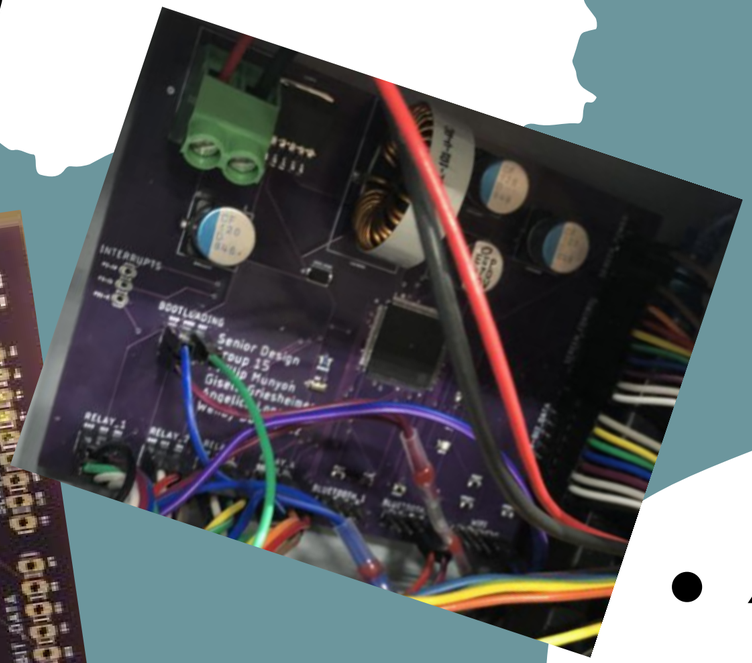


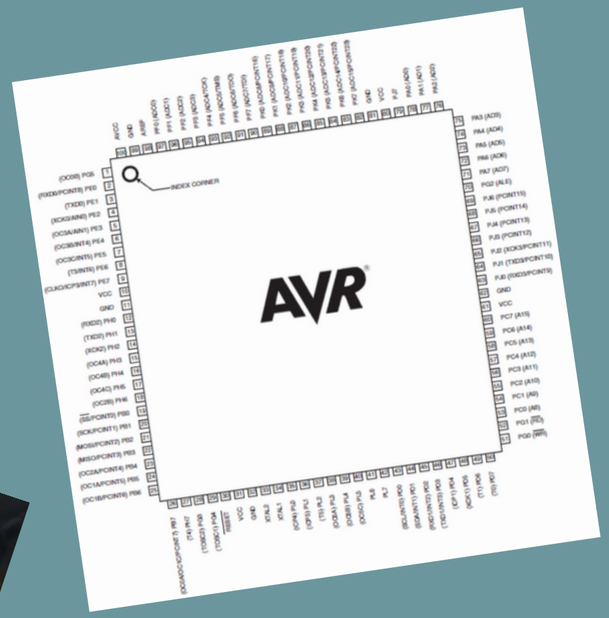


	ATmega328	ATmega2560
Number of Pins	32 Pins	100 Pins
Operating Voltage	5 V	5 V
Arduino IDE Compatible	Yes	Yes
Number of RX/TX pins	1	4
Satisfy Design Requirements?	No, not enough pins	Yes

CONTROL UNIT MICROCONTROLLER: ATMEGA2560

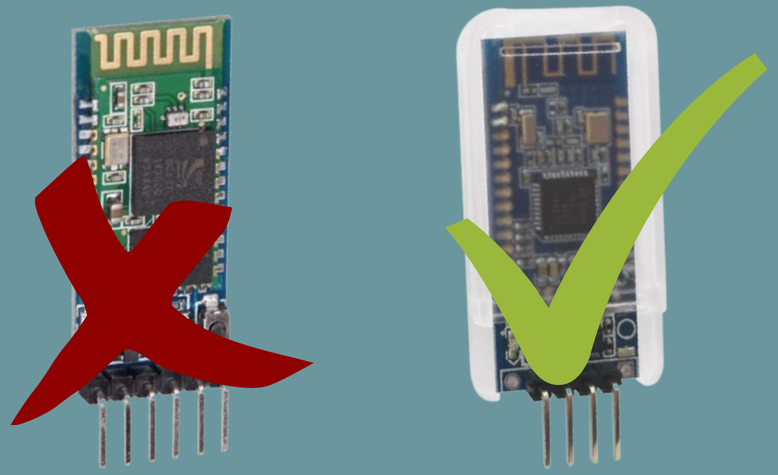






- 4 dedicated hardware serial ports
- 16 analog inputs
- 54 digital pins

BLUETOOTH MODULE COMPARISION



	HC-05	HM-10
Bluetooth Technology	Bluetooth 2.0	Bluetooth 4.0
Bluetooth Low Energy	No	Yes
Range	100 ft	100 ft
Documentation	Yes	Yes
Price	$7.99	$10.99

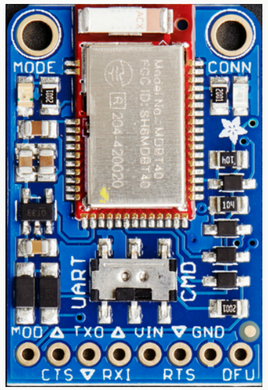
4.0 BLUETOOTH MODULE TESTING

Amazon

Connection Issues

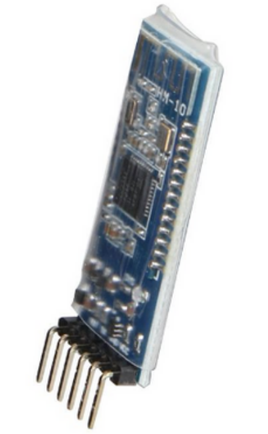
ebay

No Data Sheet



Adafruit

Minion-Mode Only

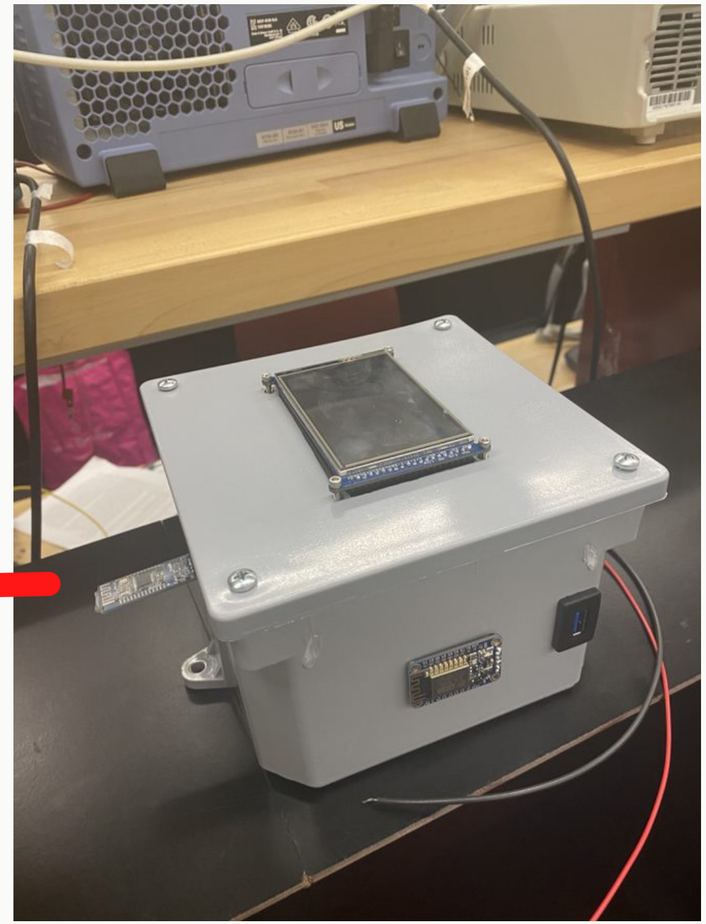


Microcenter

Just Right!

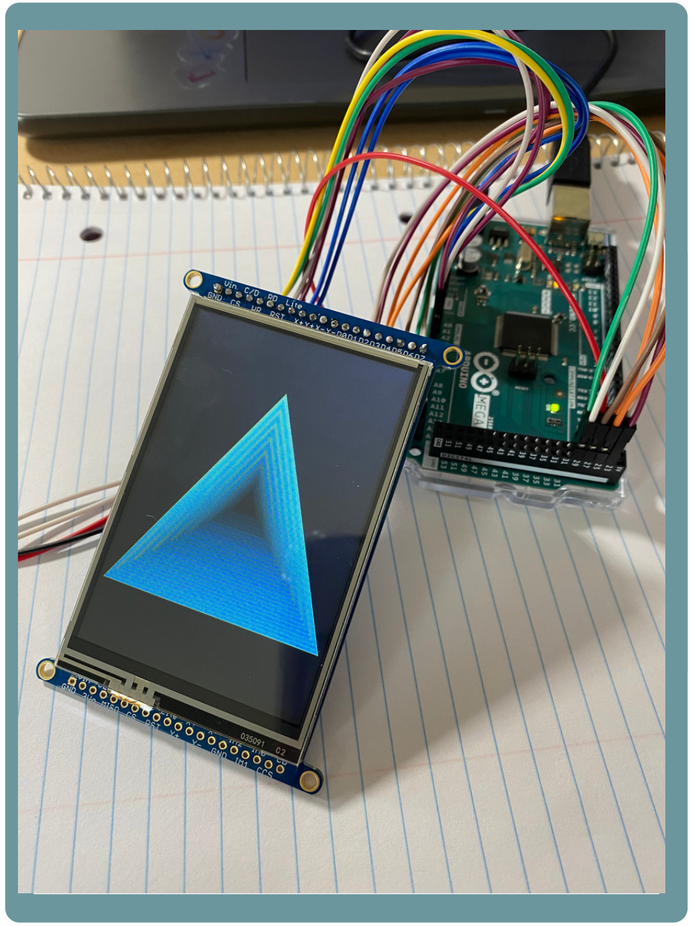
BLUETOOTH MODULE : HM-10

- 5V input and 3.3V logic level
- Receives climate data from sensors



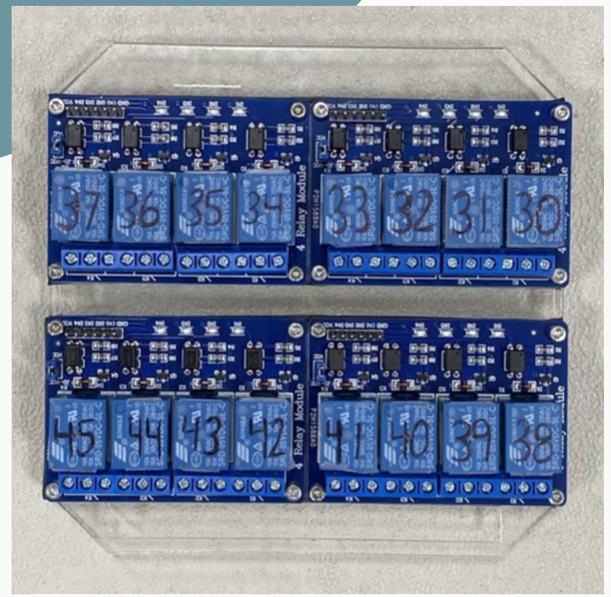
TOUCH DISPLAY: ADAFRUIT

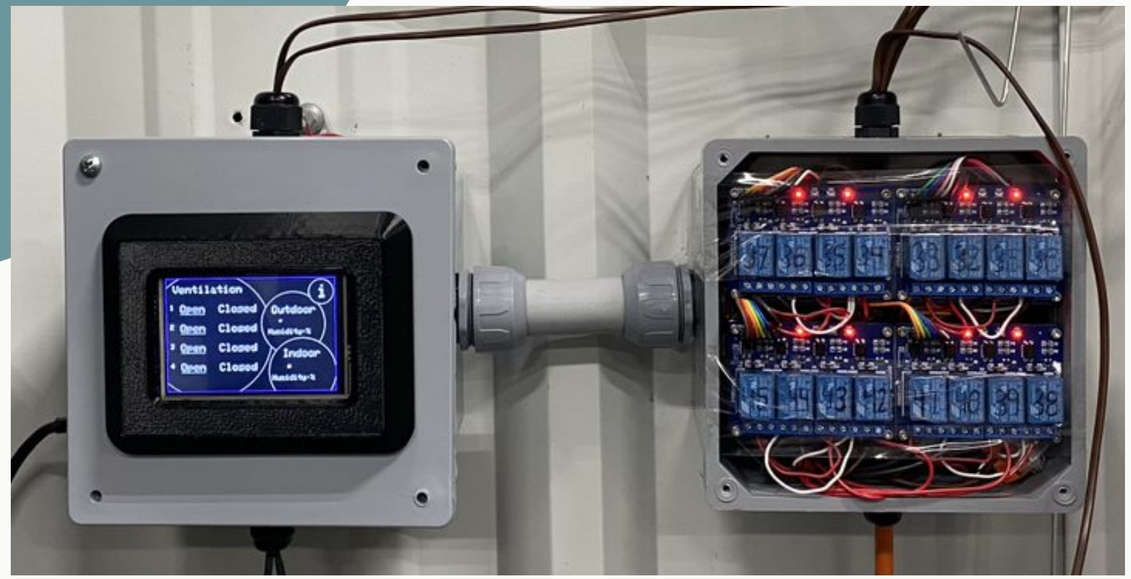
	3.5” TFT Touch Screen Display
Size	3.5”
Screen Type	TFT
Touch Compatible	Yes
Touch Type	Resistive
Operating Voltage	5 V
Data Transfer Method	8-bit
Backlight Control Method	Pulse Width Modulation



RELAYS

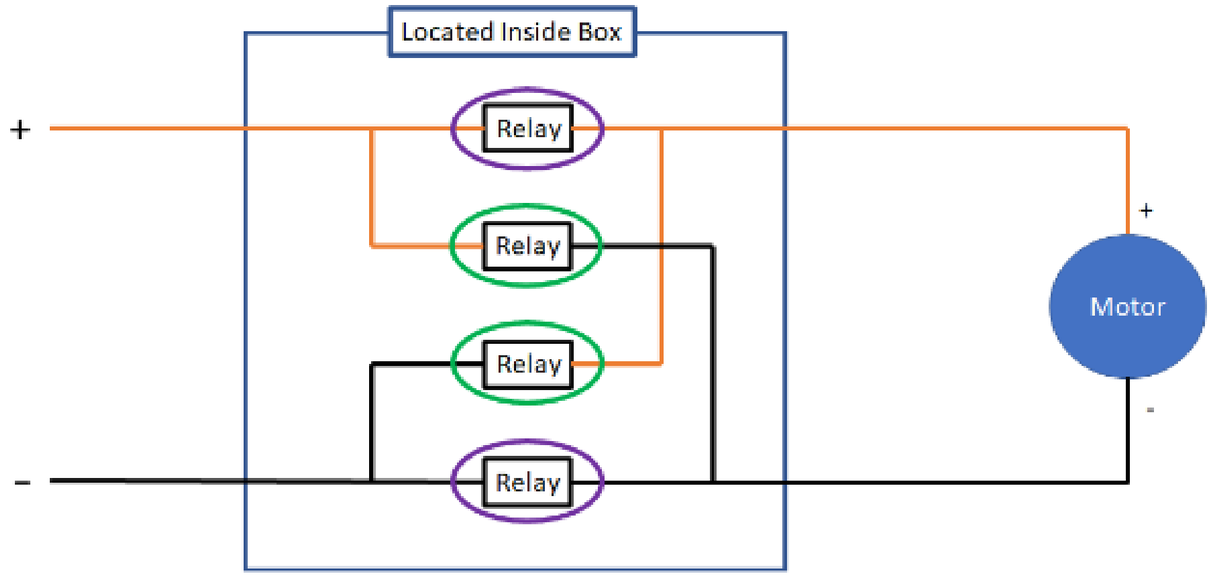
- ELEGOO 4 Channel Relay Module
- 5V Input Voltage
- Low-Active Relays
- Max 30V DC @ 10A



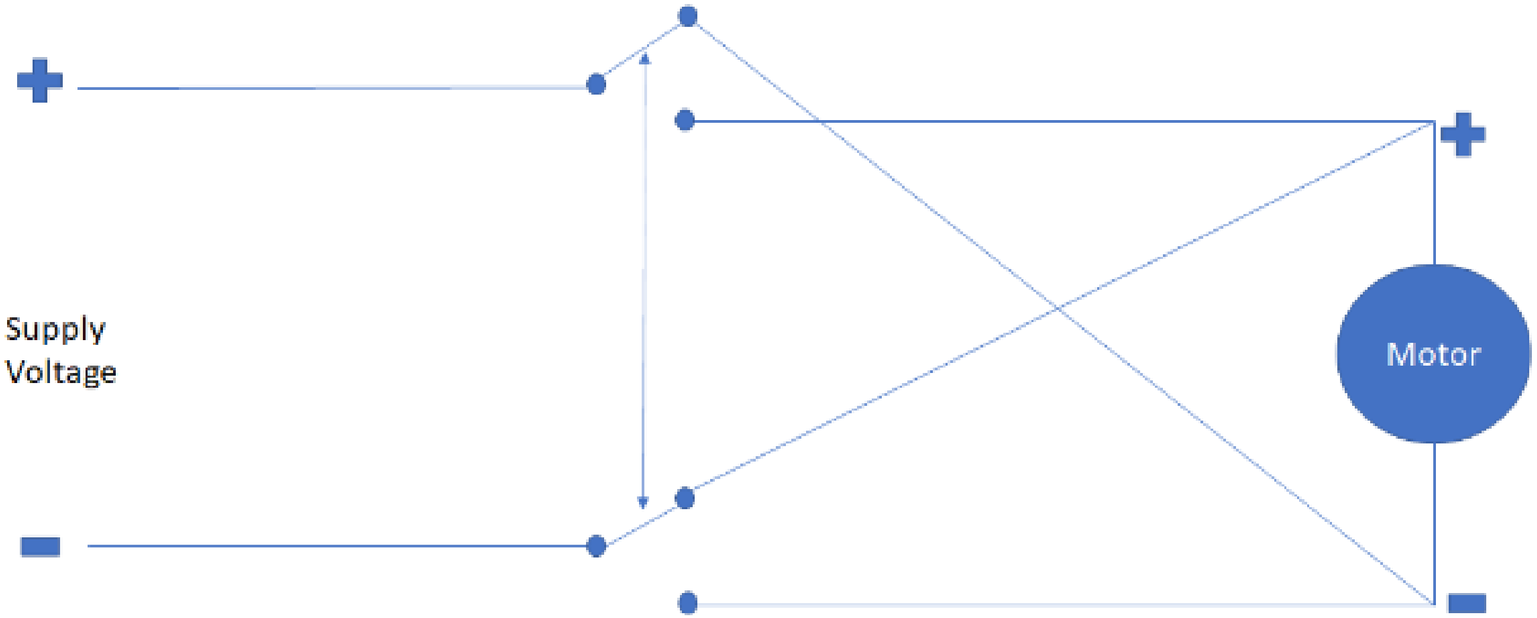


RELAY OPERATION

Relay Module Wiring Diagram



Double Pole - Double Throw Switch Diagram



Opening Relays

Closing Relays

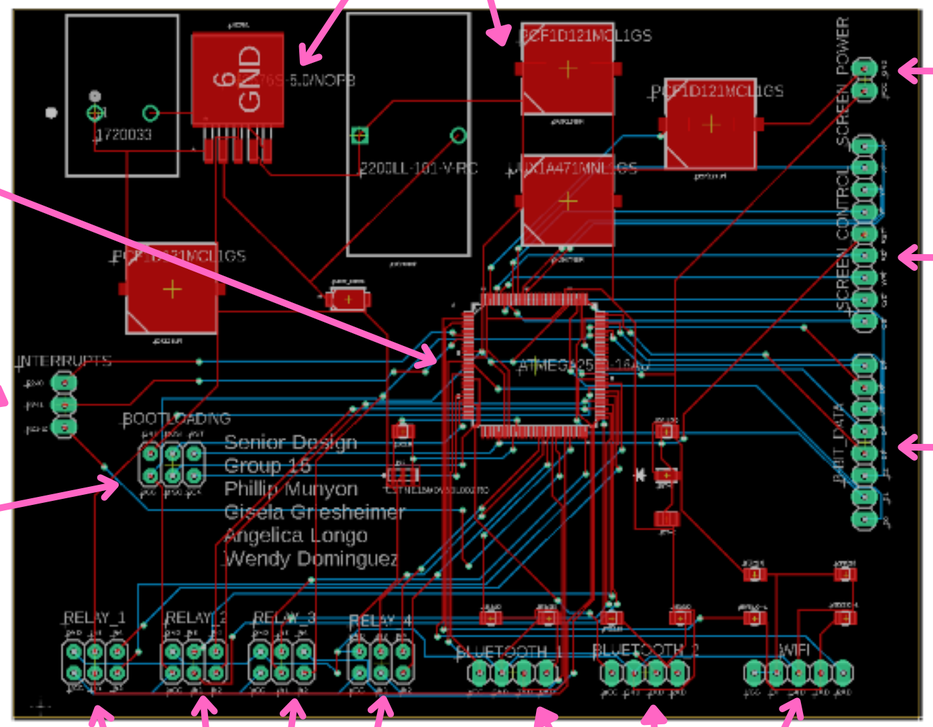
CONTROL UNIT PCB: TWO LAYER DESIGN

Power Supply and Auxiliary Components

ATmega2560

Interrupt Pin Connections

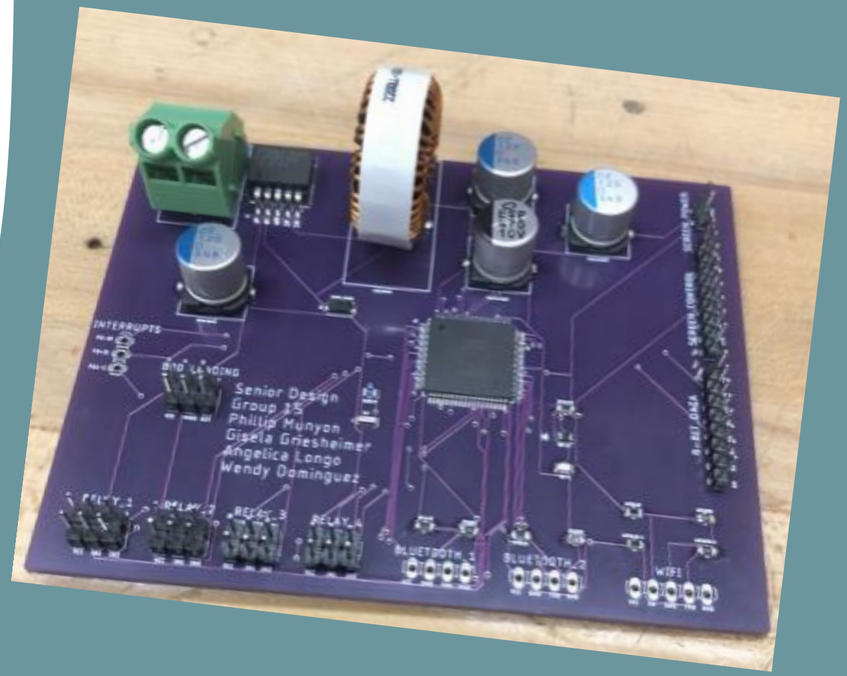
Bootloading Communication



Screen Power

Screen Control

Screen Data

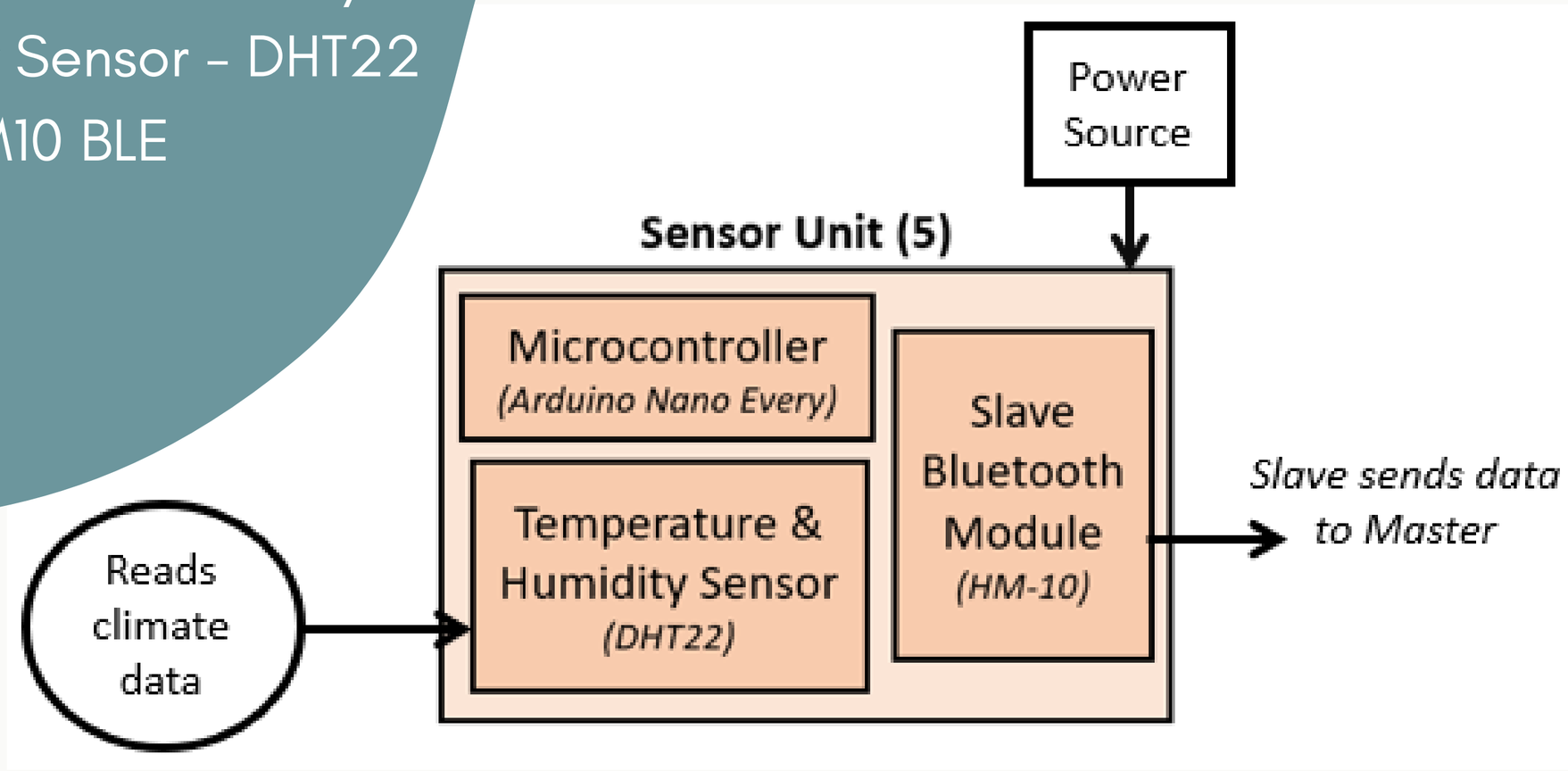


Relay Connections

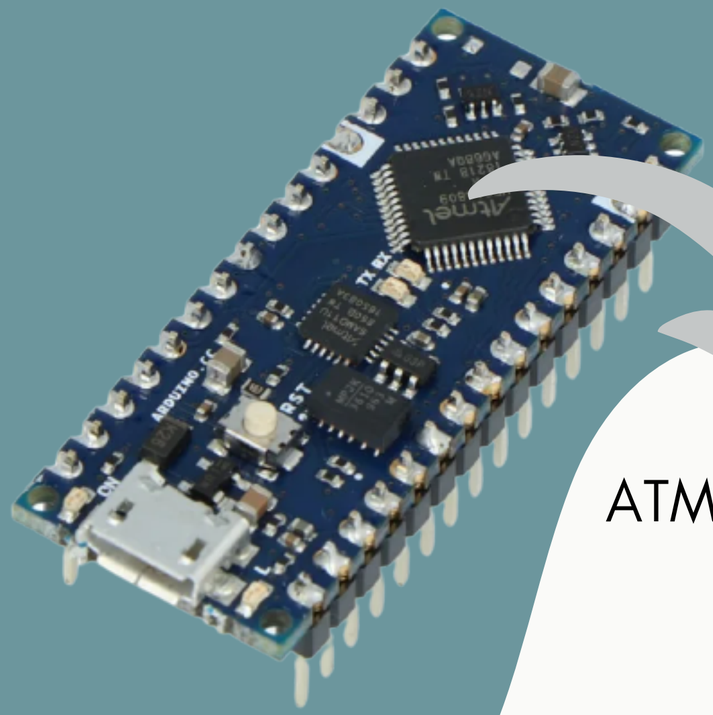
UART Communications Connections

HARDWARE COMPONENTS FOR SENSOR UNIT

- Microcontroller - Arduino Nano Every
- Temperature/Humidity Sensor - DHT22
- Bluetooth Moudle - HM10 BLE
- Power source



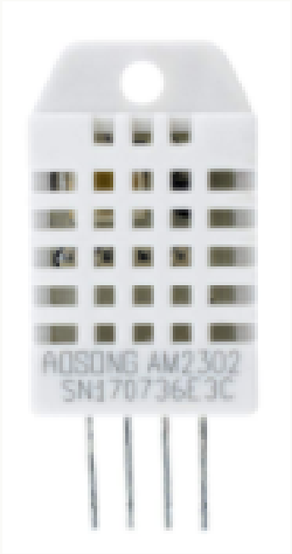
SENSOR UNIT MICROCONTROLLER: ARDUINO NANO EVERY



ATMEGA 4809 AFR

- Prioritized Aurdino in testing
- Chose Nano Every as cheapest module
- Kept Nano Every in final design as ATMEGA 4809 AFR is unobtainable

TEMPERATURE & HUMIDITY SENSOR COMPARISON



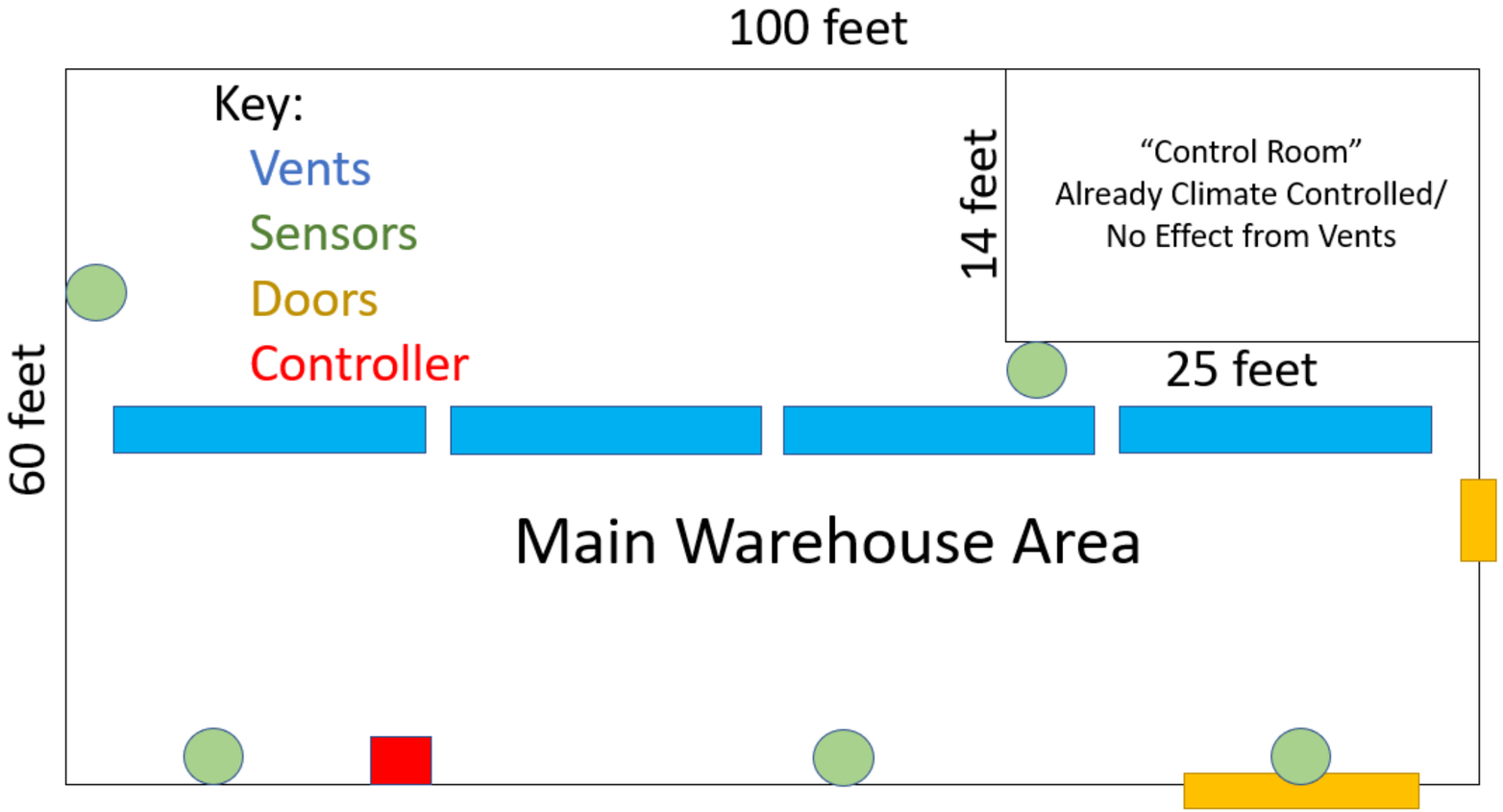
Comparison of DHT11 and DHT22 Sensors

Parameter	DHT11	DHT22
Temp Range	0-50(C)	-40-80(C)
Temp Accuracy	+/-2(C)	+/-0.5(C)
Humidity Range	20%-90%	0%-100%
Humidity Accuracy	+/-5%	+/-2%
Sampling Time	1s	2s
Price	~$5/each	~$10/each

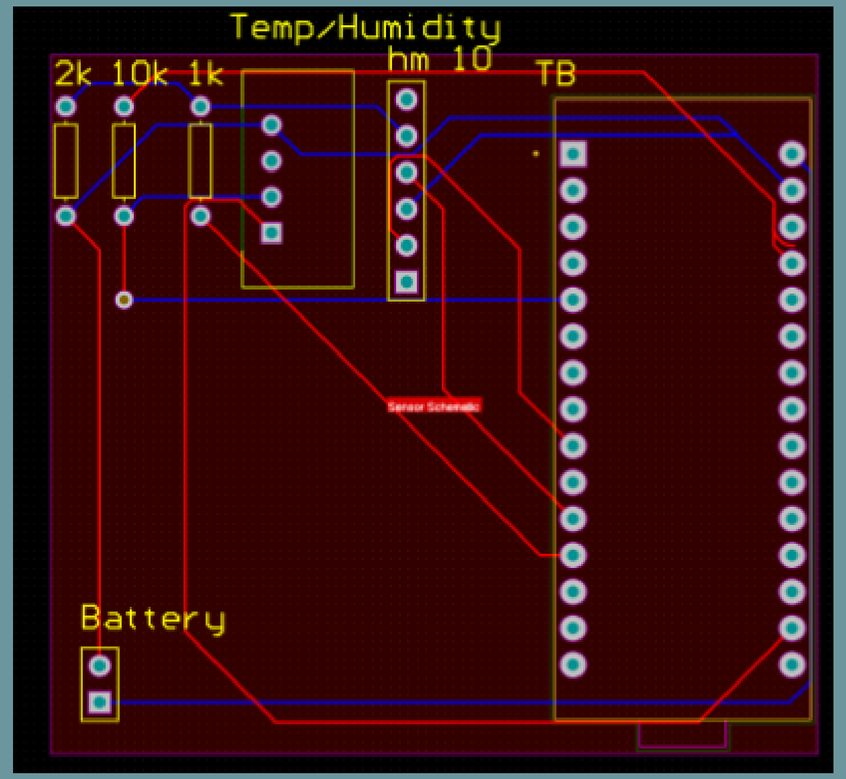
SENSOR UNIT: POWER SUPPLY

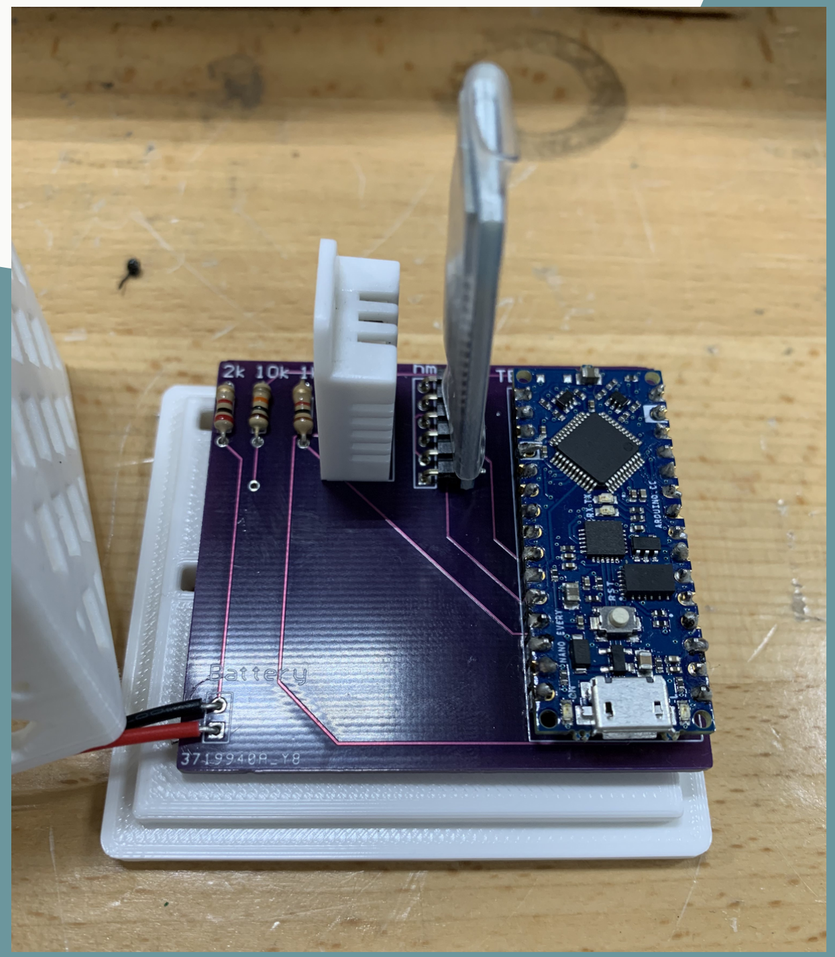
- Required DC voltage of 7-21V
- Initially - Lithium Ion 9V vs Multiple CR2s
- Final Design - Battery power vs Wall power

SENSOR UNIT PLACEMENTS



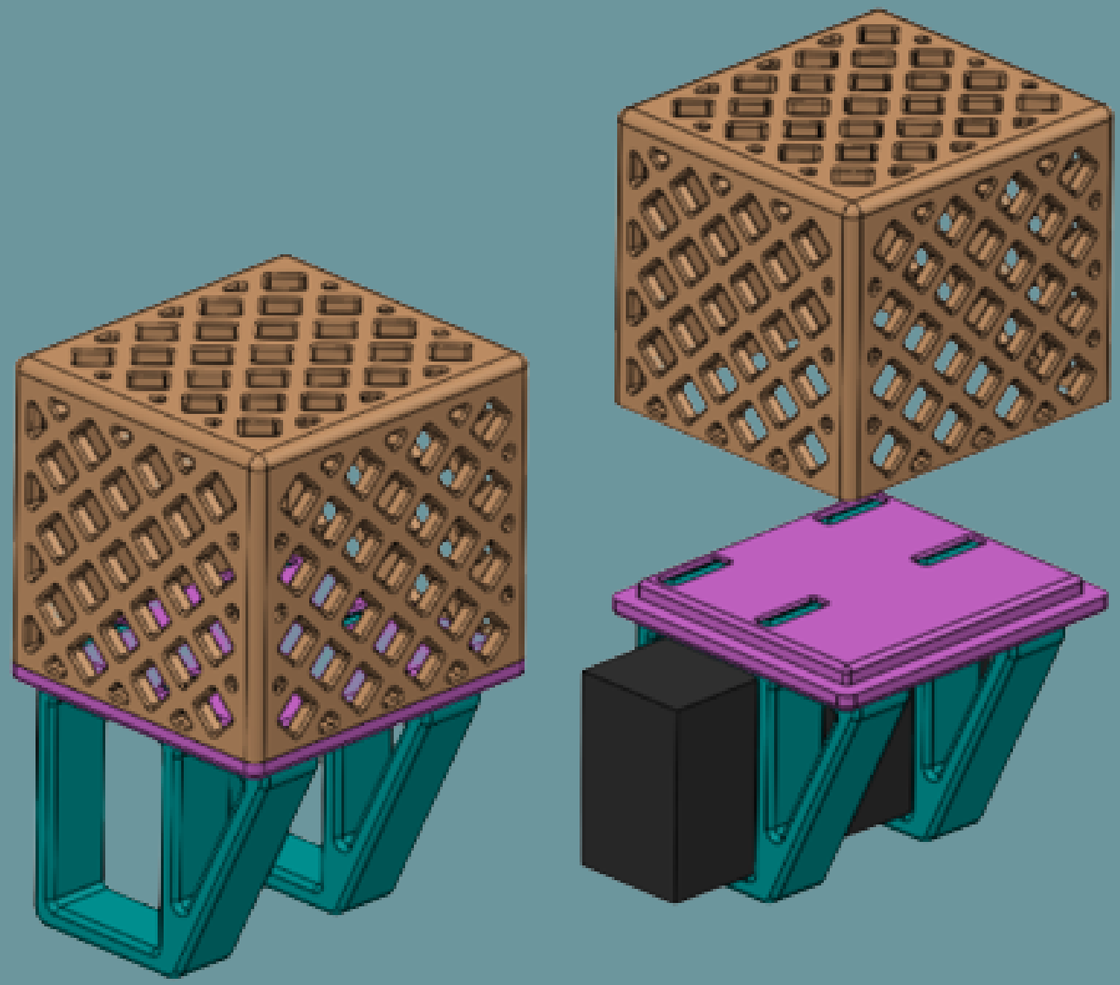
SENSOR UNIT PCB DESIGN

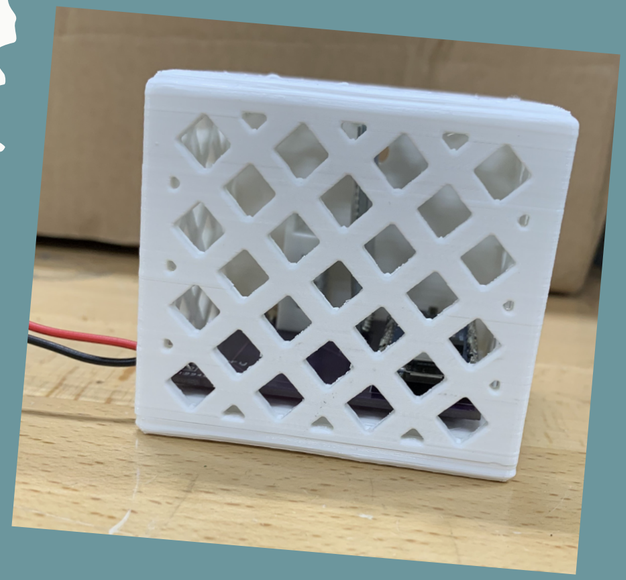




- Also used 2 layer PCB design
- Connects Bluetooth module, temp/humidity sensor, Arduino, and power

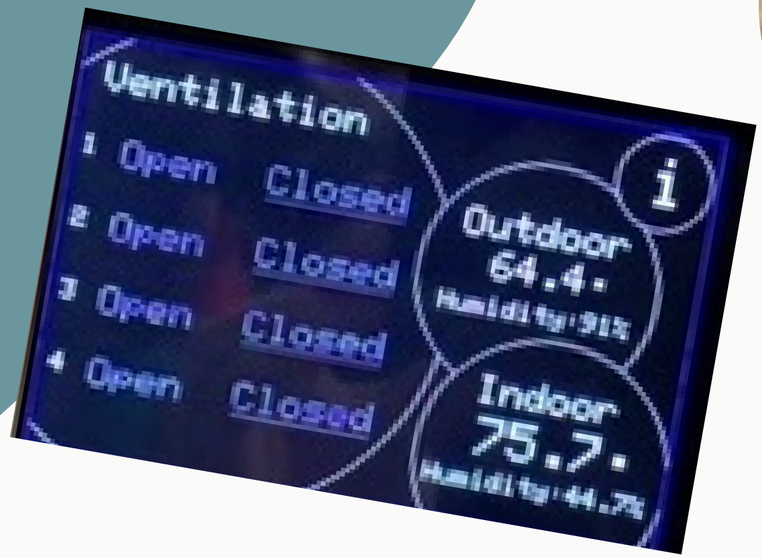
SENSOR UNIT CASING





- Designed to allow airflow for accurate sensor reading
- Snaps together for secure fit
- Stability brackets can also house battery casing

TOUCH DISPLAY INTERFACE



Home Screen

- Indoor and outdoor temperature/humidity
- Control each vent individually

Information Screen

- Display ideal temperature
- Show climate at each Sensor Unit
- Reset button
- Automation override toggle

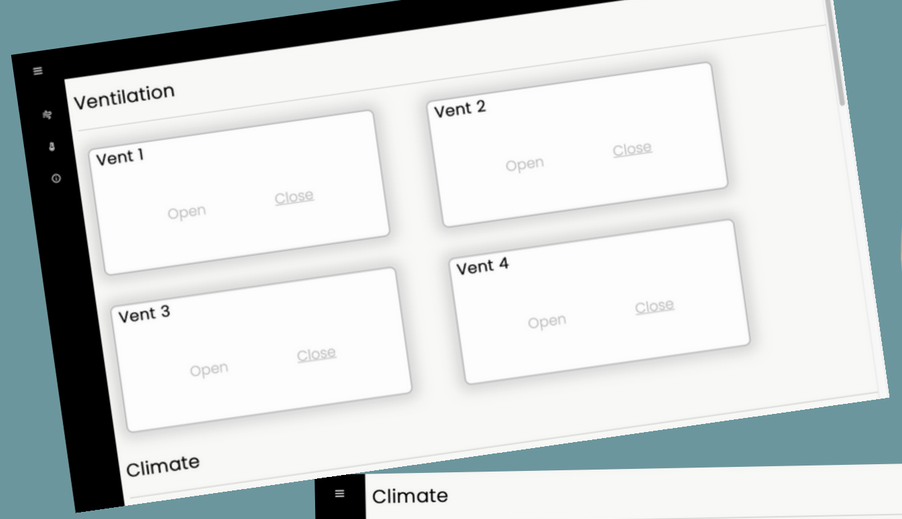
WEBSITE INTERFACE

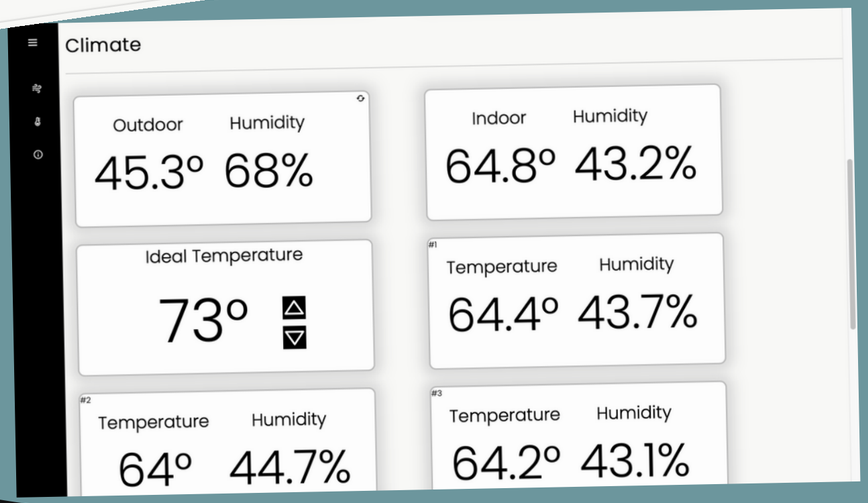
Home Page

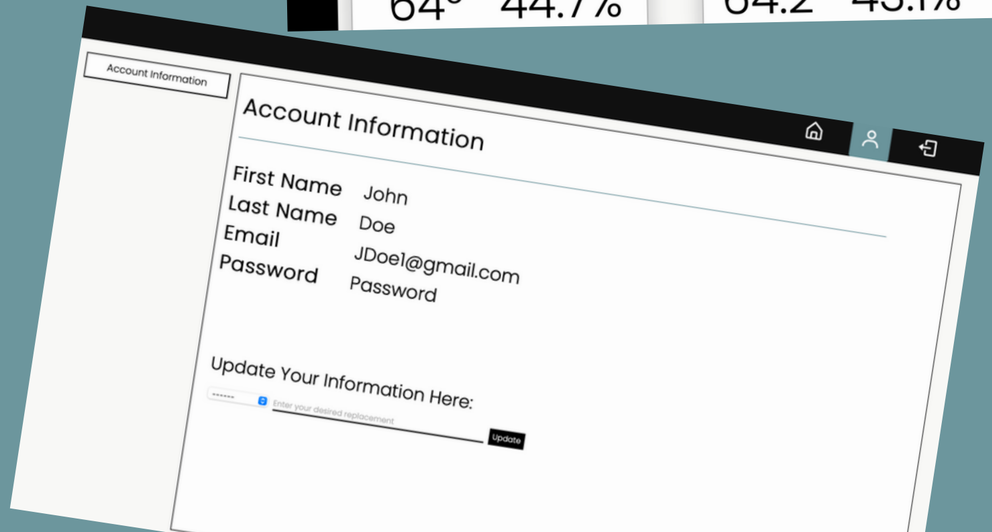
- Control each vent individually
- Indoor and outdoor temperature/humidity
- Show climate at each Sensor Unit
- Set ideal temperature
- Automation override toggle
- Login and logout of account

Account Page

- View/update user information such as
  - email
  - password







ARDUINO CODE

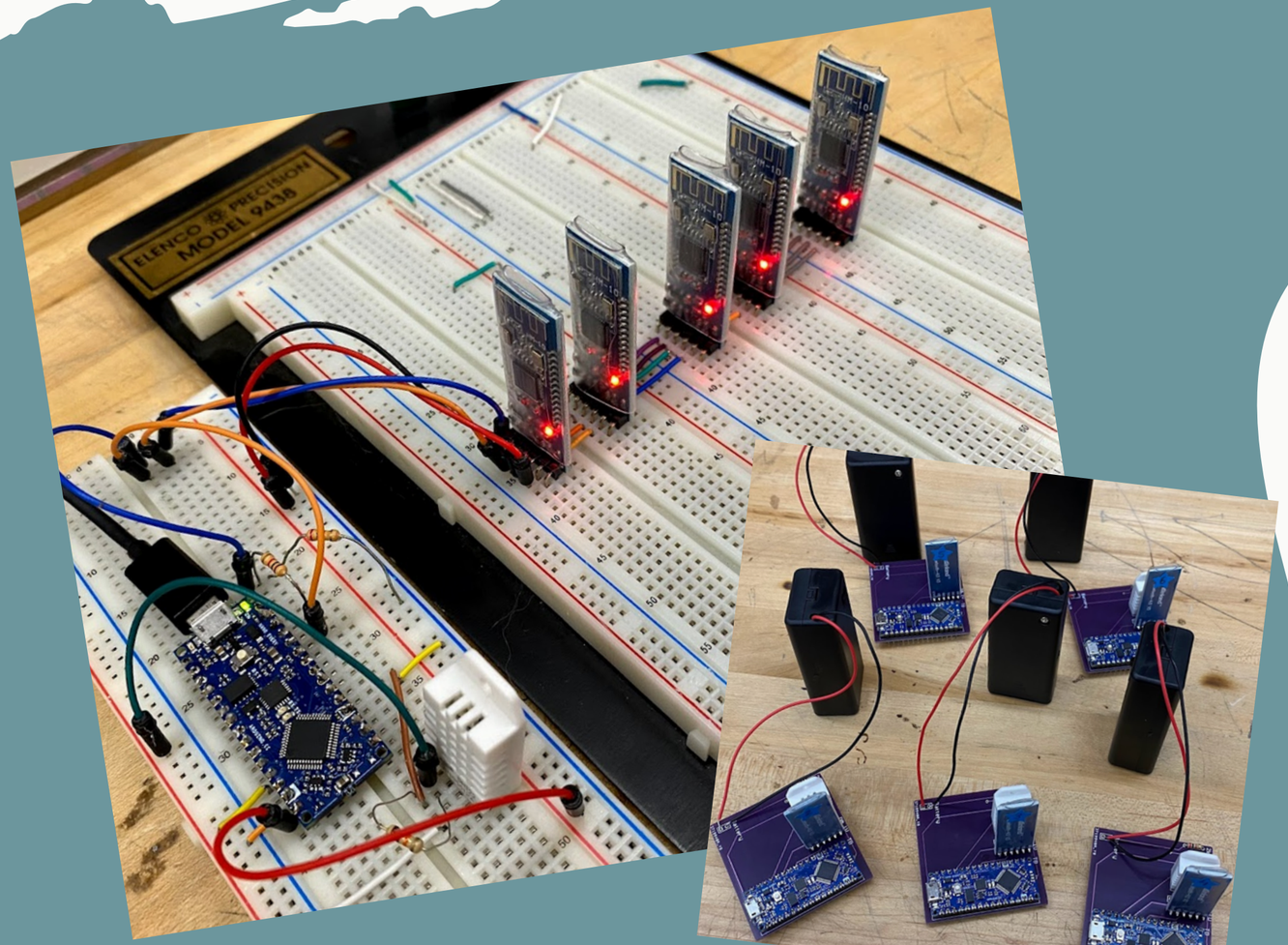
Control Unit Code

- Graphics for LCD
- Touch screen responses
- Logic for automation
- Power on/off relays for vent control
- Bluetooth communications
- Wi-Fi communications

Sensor Unit Code

- Reads climate data from DHT 22
- Sends climate data via HM-10

COMMUNICATION LOOP

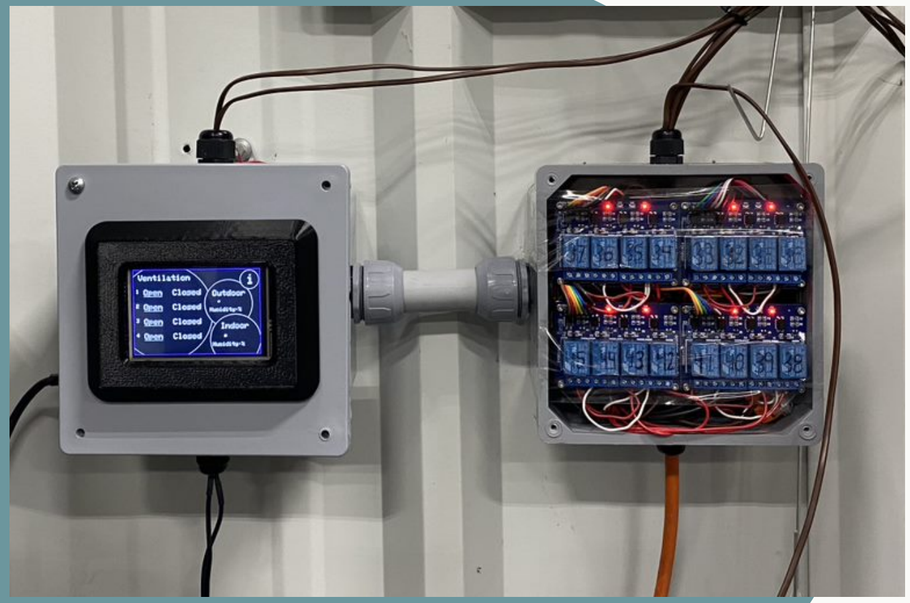


- Master module initiates communication with one Slave at a time
- Slaves send temperature and humidity data to Master after establishing a connection
- Once climate data is received, Master connects to the next Slave module

AUTOMATION LOGIC

CLOSE IF...

- Humidity is above 90% (assume its going to rain)
- Average indoor temperature is within ideal temperature buffer (± 3°)



OPEN IF...

- Average indoor temperature is hotter than ideal temperature buffer AND outdoor temperature
- Any Sensor Unit reads a temperature that is 4° hotter than ideal temperature AND average temperature is *not* within the ideal temperature buffer

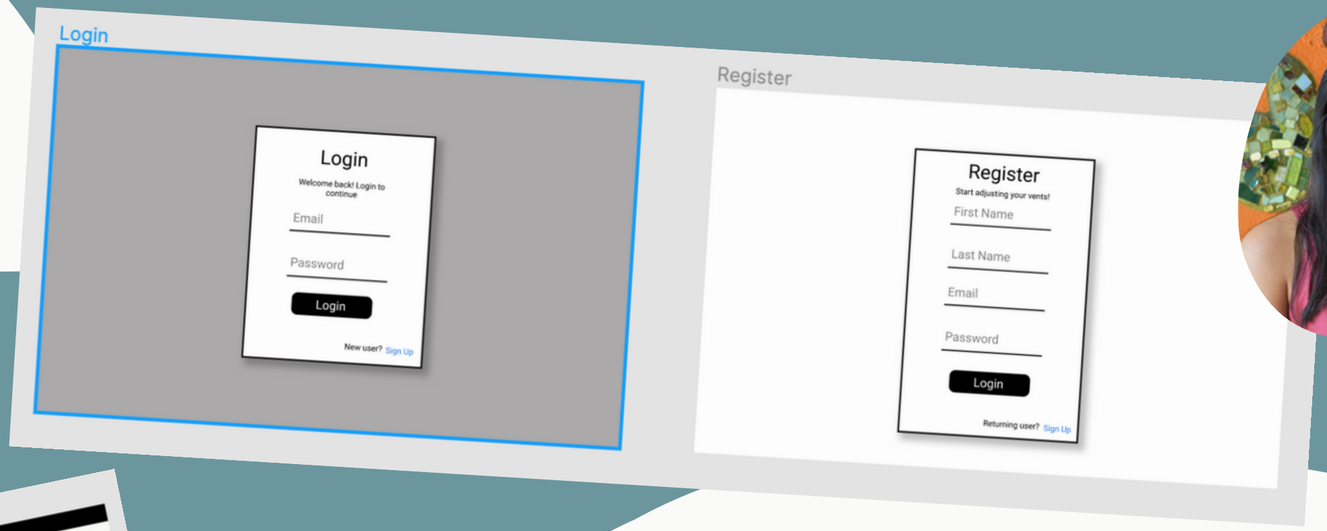
USER INTERFACE

- Why a web application?
- It is cross-platform.
- There are free resources to deploy.
- Has access from a laptop or desktop too.
- Gaining full-stack development experience.
- Opened source.

HEROKU

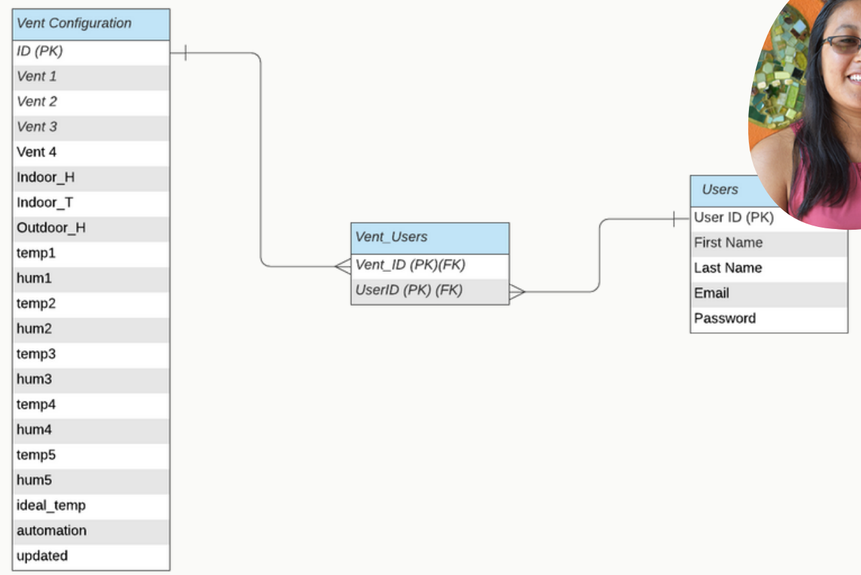
Android

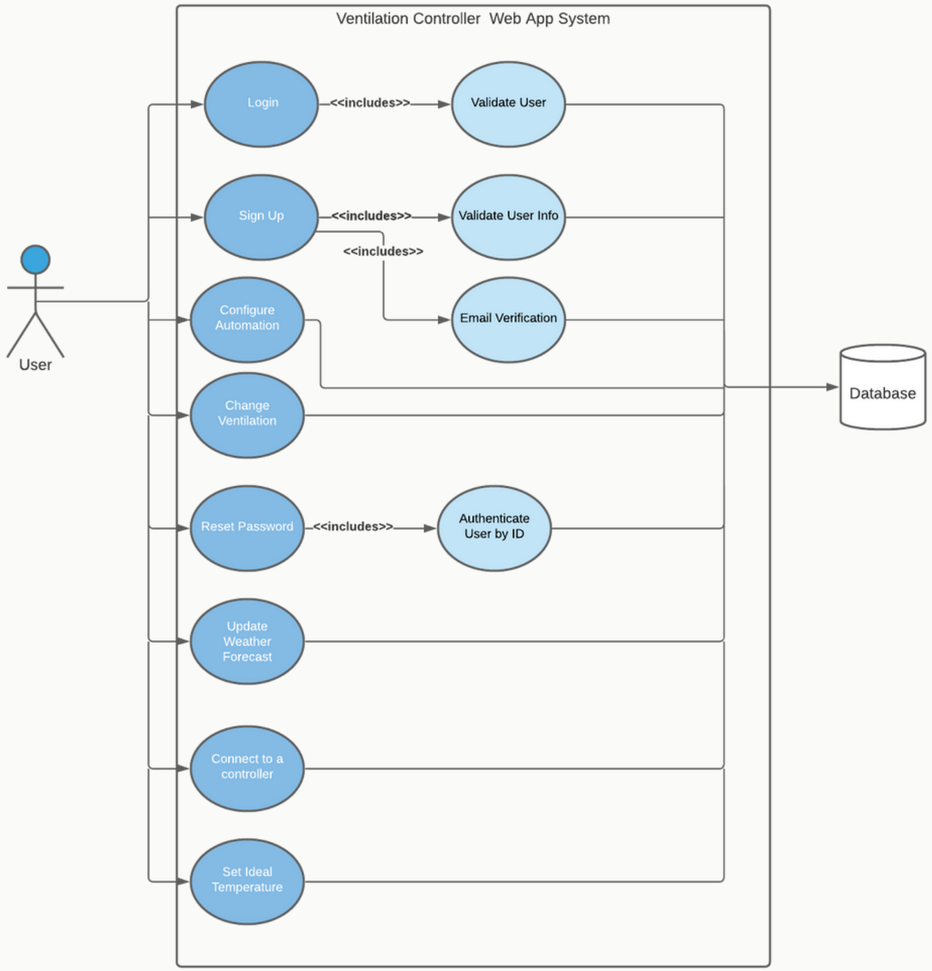
WEBSITE DESIGN



- We used Figma to create wireframes that would give the best online user experience.
- A wire frame was built for the 4 web pages that we would be using: login, register, home and account.
- Creating the wireframes was beneficial in styling each page as well as for the overall layout of each element.

SOFTWARE OUTLINE

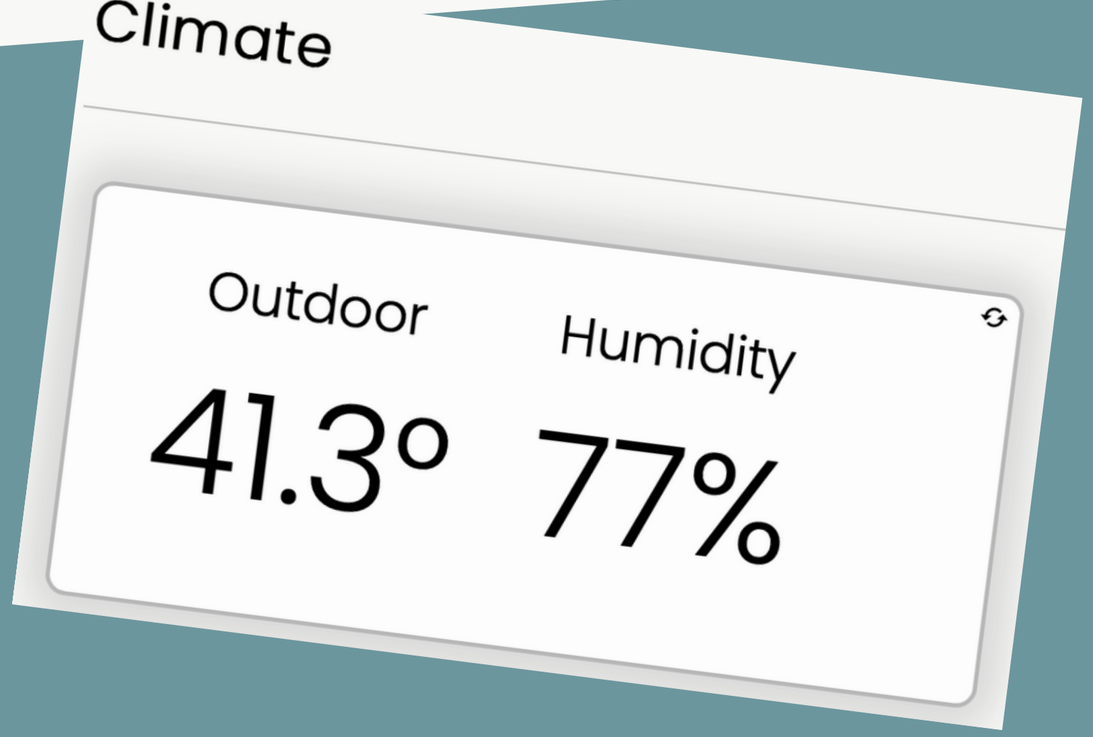




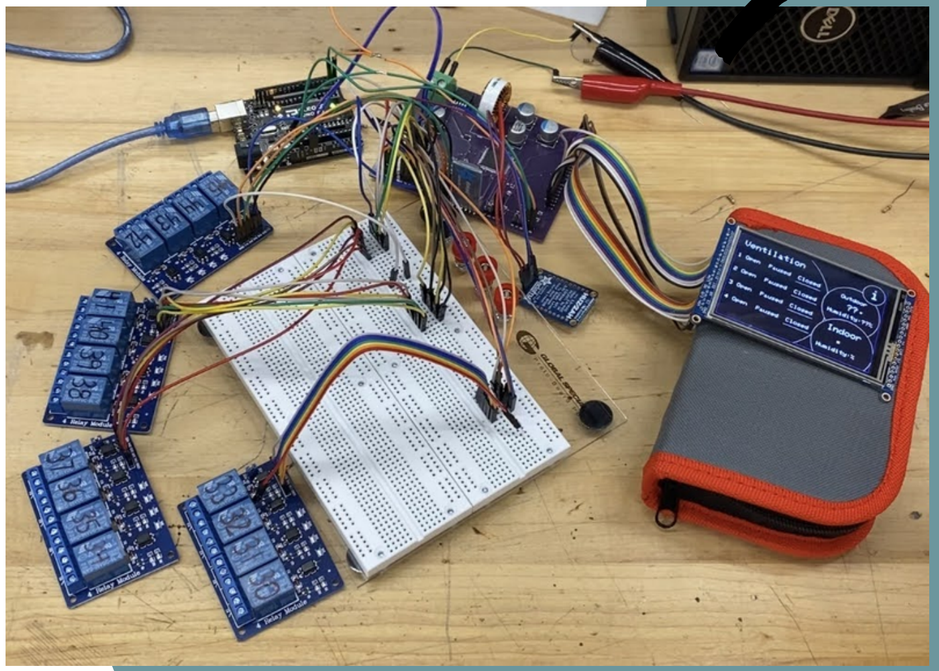
- Our web application was built using HTML, CSS and JavaScript for the front end. It also uses PHP and MySQL for the back end.
- All these files are saved on a private GitHub repository that is connected to our web host, Heroku.
- For the back end we created a use case diagram, to make sure that all features and functionalities were implemented. We also created an ERD diagram to see the relationship between all of the entities that we would need.

FEATURES

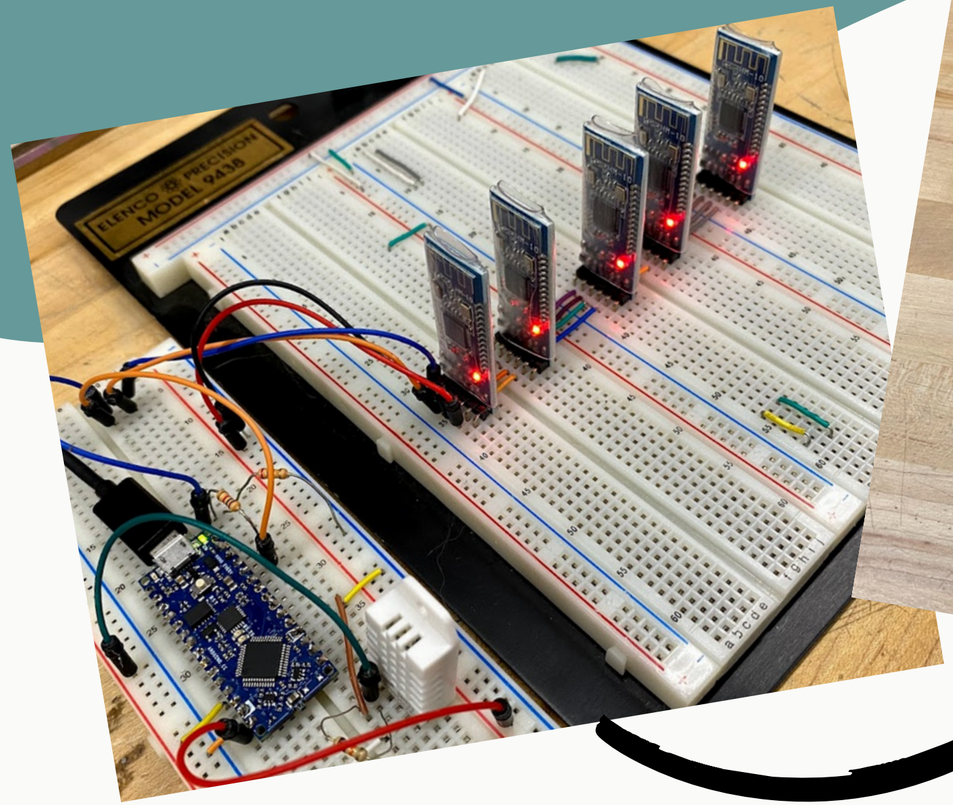
- For security we added an extra step to require the user to connect to the controller which will require the controllers unique ID.
- Free API for email verification.
- Collecting the weather forecast data, temperature and humidity, we used a free prebuilt scraping API, called OpenWeather.

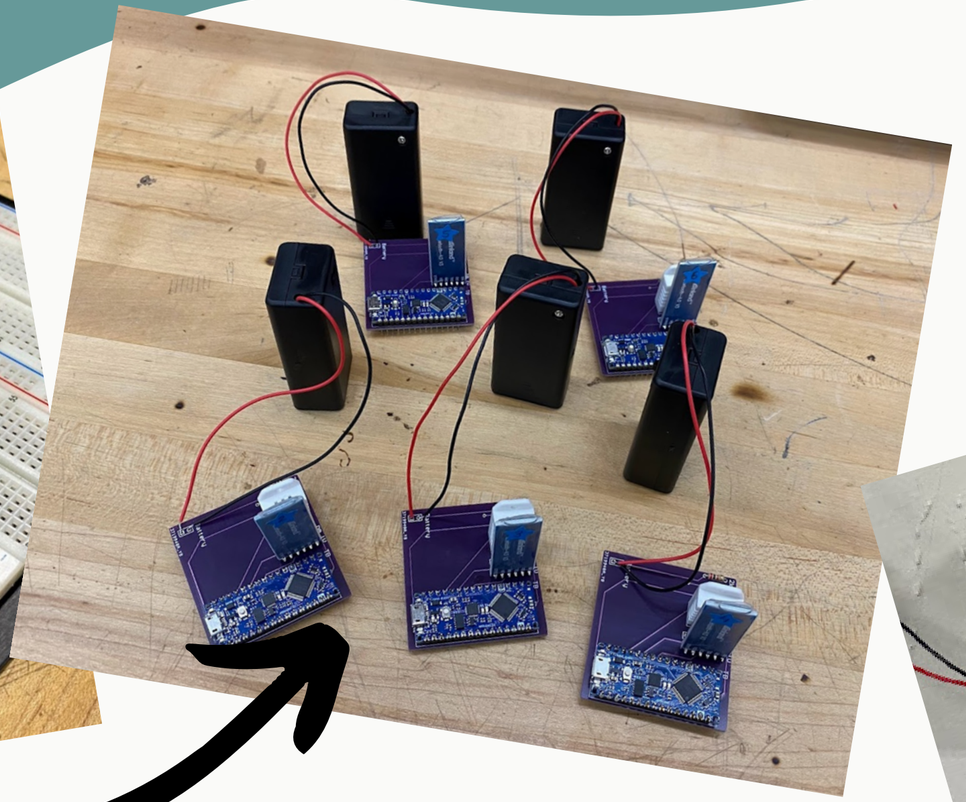


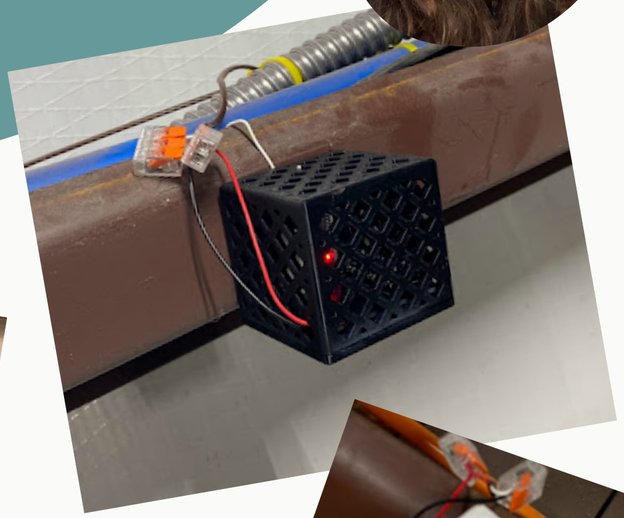
FINAL DESIGN: CONTROL UNIT

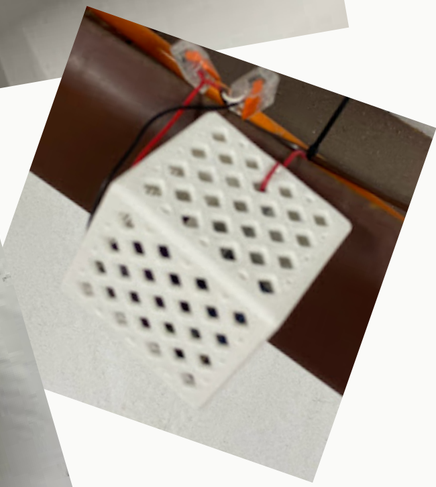


FINAL DESIGN: SENSOR UNITS



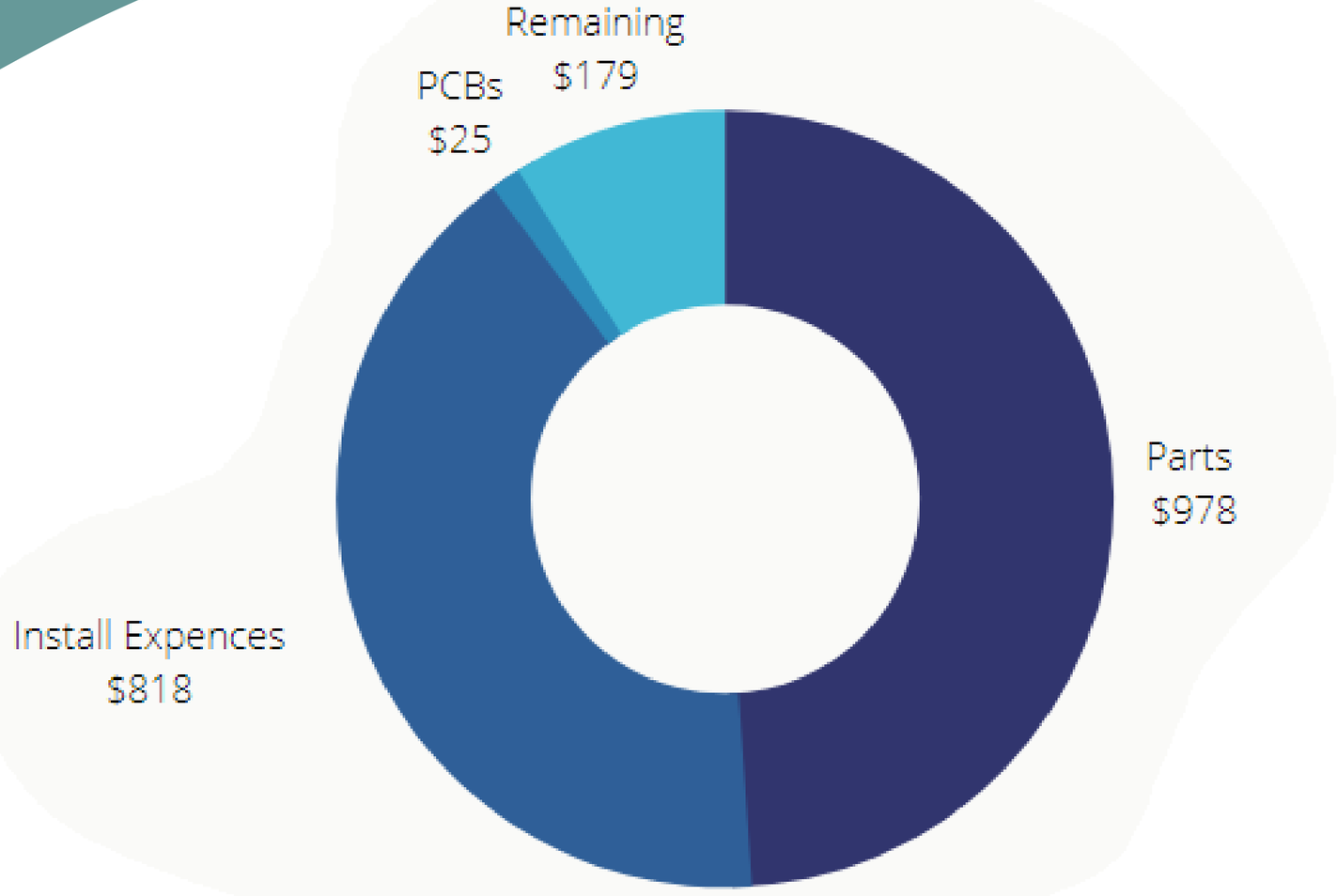






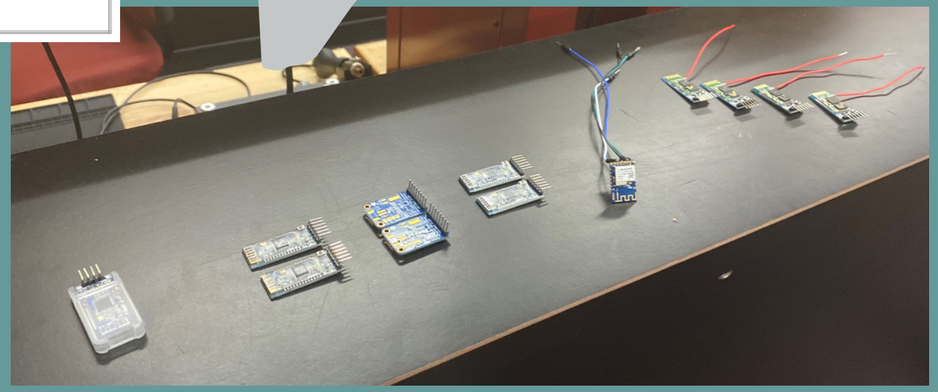
FINANCE & BUDGET

Total Budget:
$2000



CHALLANGES FACED: HARDWARE

Problem	Solution
Bluetooth Module Testing	Use a reliable and well-known retailer
Learning New Skills	Research to learn best practices
UART Communication between multiple devices	Trial and error in finding Baud rates
Installation	Follow a Plan and be prepared



CHALLANGES FACED: SOFTWARE

Problem	Solution
Executing several instructions on a single core micro-controller *(touch screen doesnt work while gathering data)*	Simulate multi-threading
Quirks mode enabled when styling regardless of doctype declaration	Changed placement of styling
Our original hosting service had many issues with updating styling and access went down for a week	Switched to Heroku which is run by salesforce
Implementing the back-end development for website	Researched how to fully understand the calls being made

Hello,

There is currently ongoing maintenance on the free hosting servers.
We are posting regular updates to http://status.x10hosting.com/ regarding this. If your site is down or you have a problem you believe may be associated, please wait until this maintenance is announced as completely finished before opening a support ticket. Doing so before this time will swamp our support ticket system and reduce the efficiency of our (volunteer) support staff, making it more difficult for us to answer the questions that are not related to maintenance.

Thank you for your co-operation
x10Hosting Support.

THANK YOU FOR LISTENING!