PROBLEM

What’s the altitude and Pressure?

What’s the temperature?

How moist is the soil?

PRIME WEATHER STATION

What can Prime Weather Station do?

What can Prime Weather Station do?

Display Temperature, Humidity, Heat Index, Altitude, Pressure, & Soil Moisture (Hardware)

What can Prime Weather Station do?

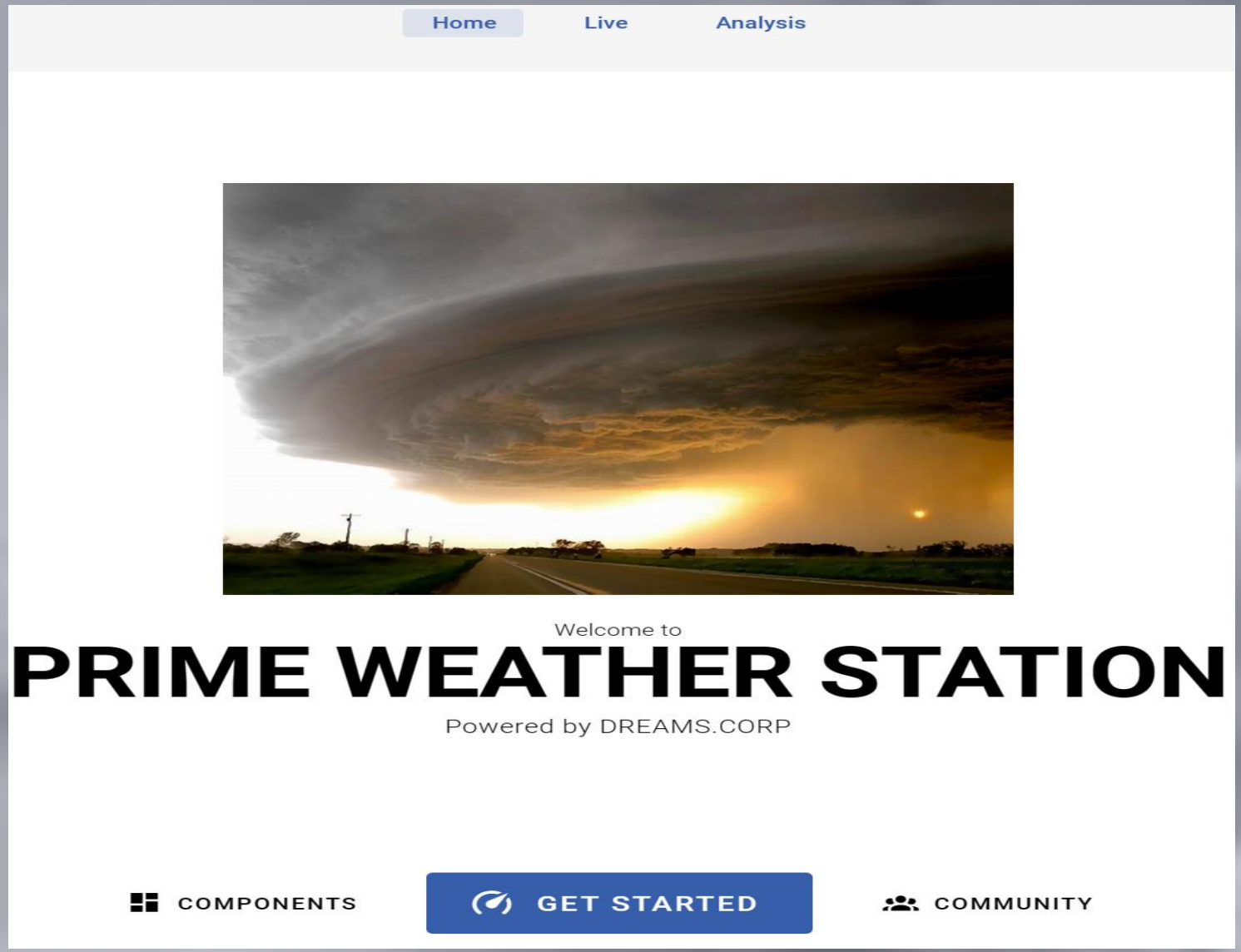

```
_id: ObjectId('65fb3e422fdcc3bdb2874289')
id : "620157609"
timestamp : 14
Temperature : 31.20000076
Farenheit : 88.16000366
Humidity : 65.40000153
Altitude : 150.6259003
Pressure : 99528.85938
SoilMoisture : 1
HeatIndex : 36.75416946
```

```
_id: ObjectId('65fb3e442fdcc3bdb287428b')
id : "620157609"
timestamp : 15
Temperature : 31.20000076
Farenheit : 88.16000366
Humidity : 65.40000153
Altitude : 150.3264313
Pressure : 99532.40625
SoilMoisture : 11
HeatIndex : 36.75416946
```


Publish and store data in an online database for viewing. (Backend)

```
MQTT: Connection successful  ID:  IOT_B_667600
MQTT: Subscribed to ['620157609_pub', '620157609', '620157609_sub']
```

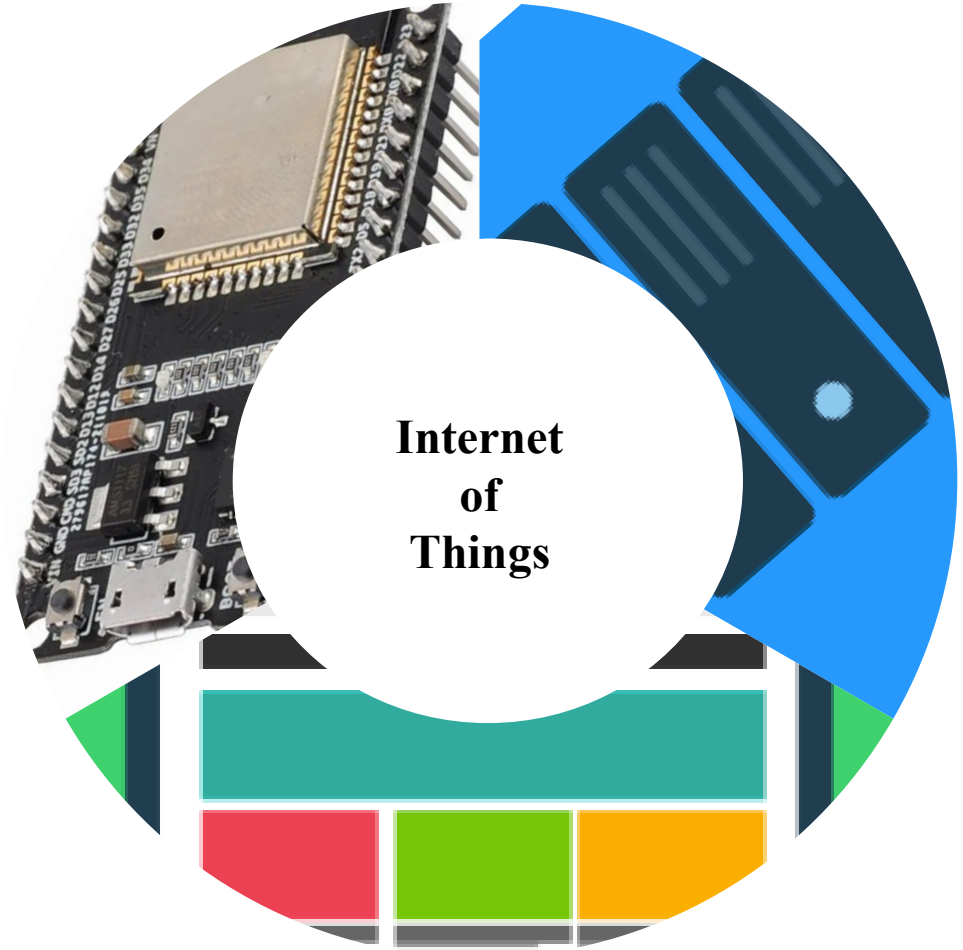
What can Prime Weather Station do?

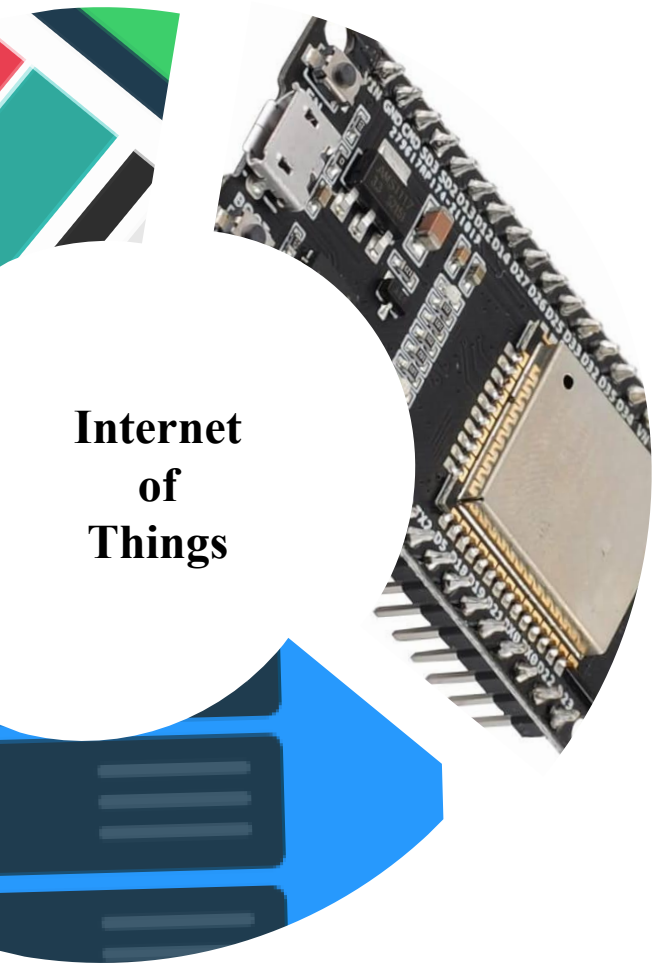


GUI that retrieves information from the online database and presents it on the webpage. (Frontend)

Internet of Things

The Internet of Things, or IoT, is a network of physical devices. These devices are inter-connected and they can transfer data to one another without human intervention. The Internet of Things connects the physical and digital realms using a range of technologies. Physical objects are embedded with sensors—which can monitor things like motion, temperature, humidity, or any change in environment—and actuators—which receive signals from sensors and then do something in response to those changes. The devices communicate via wired (for example, Ethernet) or wireless (for example, WiFi or cellular) networks.


Internet
of
Things



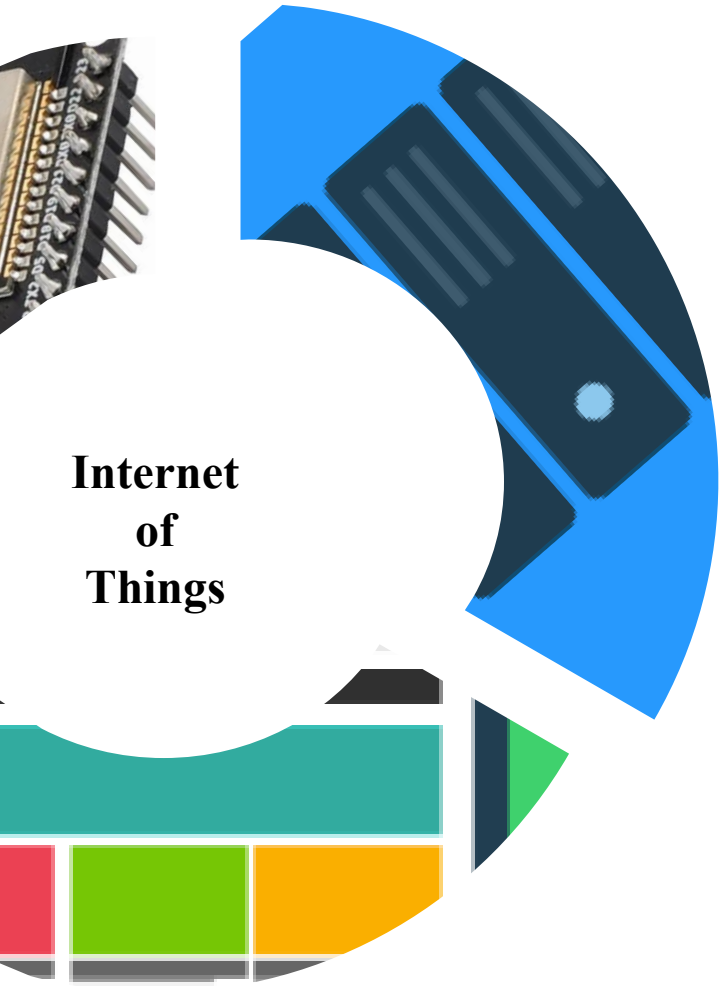
Hardware

The hardware side of an IoT system is all about the physical devices and their inner workings. It all starts with sensors that gather data like temperature or motion. A tiny computer called a microcontroller then crunches those numbers. Connectivity modules like Wi-Fi or Bluetooth get the data out to the internet. Finally, some devices have actuators that can take action based on the data, like smart locks or valves. Depending on the specific device, there might be additional hardware like GPS or a display screen. All this hardware works together to bring the smarts to everyday objects.

Temperature: DHT22 Sensor

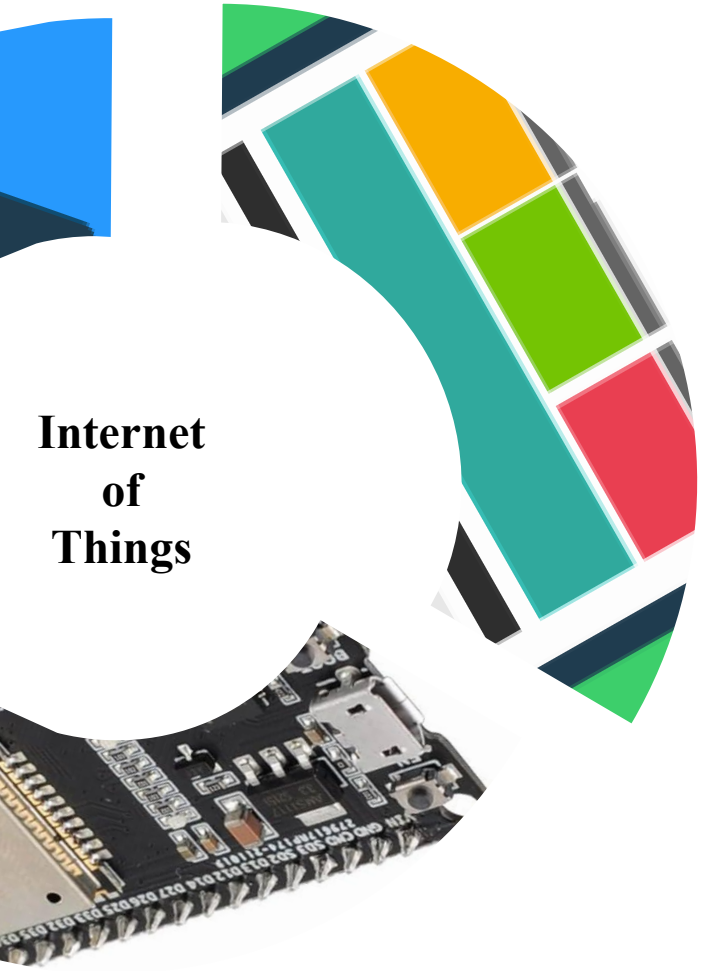
Pressure and Altitude: BMP 280 Pressure Sensor

Soil Moisture: Capacitive Soil Moisture Sensor



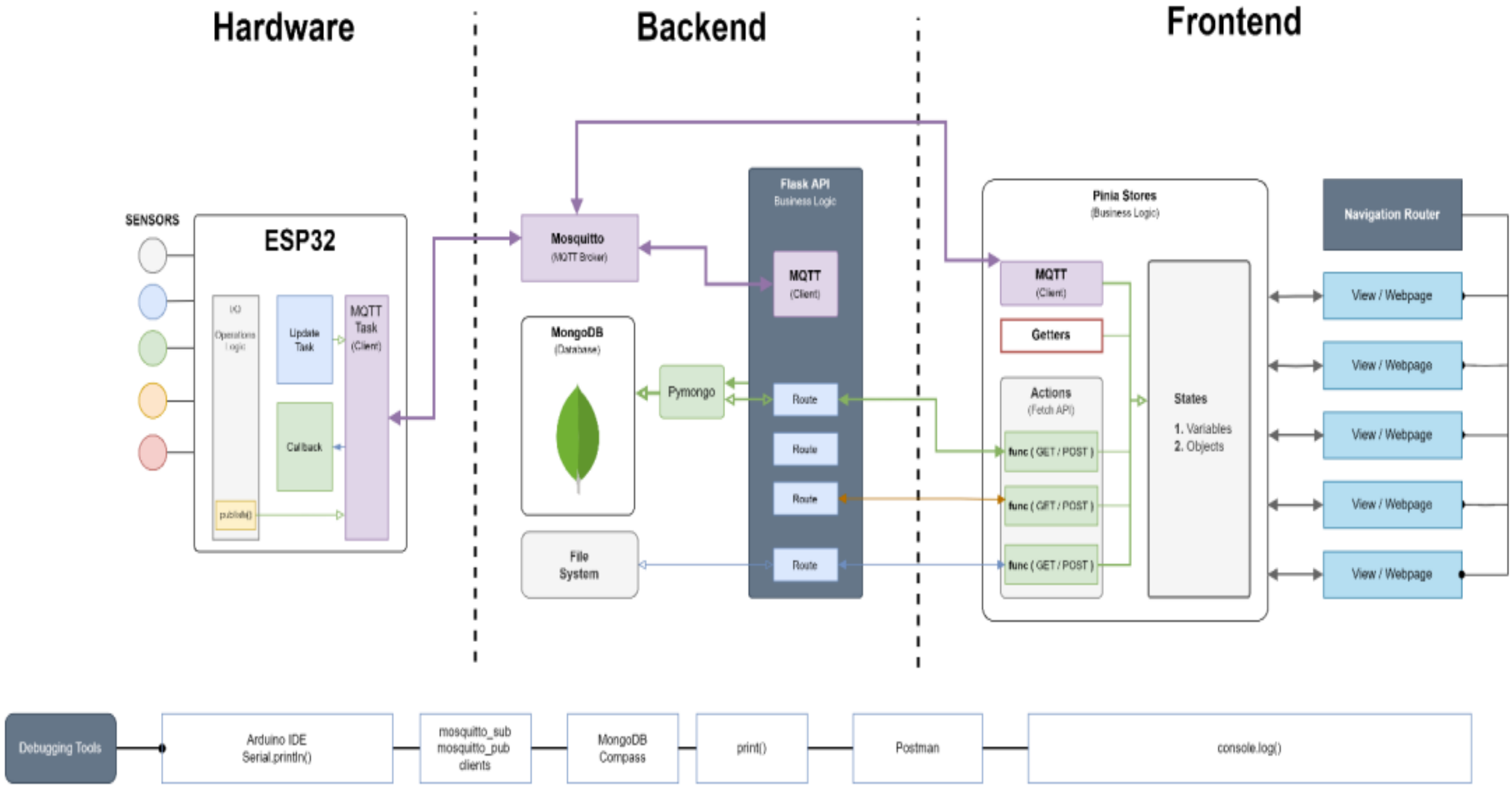
Backend

The core of this system lies in the backend, which utilizes a combination of three powerful tools. First, the Message Queuing Telemetry Transport (MQTT) acts as a communication hub. Devices publish sensor data, and the MQTT broker, Mosquitto, securely manages this data, ensuring only authorized devices can publish and only interested parties can receive it. Our ESP32 device leverages MQTT to publish meteorological data. Next, Node.js, a versatile JavaScript runtime environment, plays a crucial role. It subscribes to the relevant MQTT topic, processes the incoming sensor data, and formats it appropriately. Finally, MongoDB, a document-based database, serves as the storage solution. The formatted data is stored in JSON-like documents within MongoDB, readily accessible for further analysis and visualization. In essence, this backend seamlessly collects data, processes it, and stores it for future use.

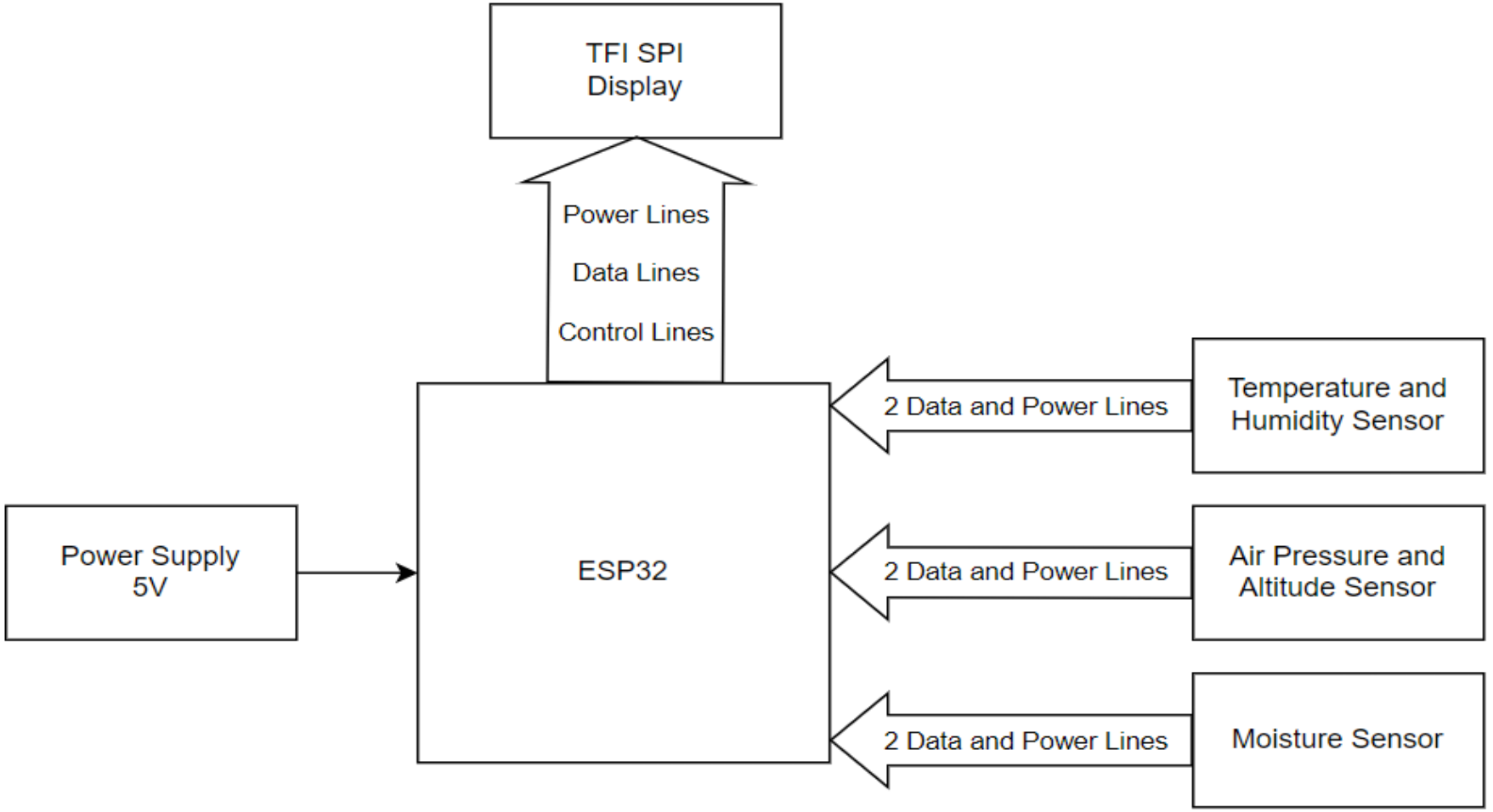


Frontend

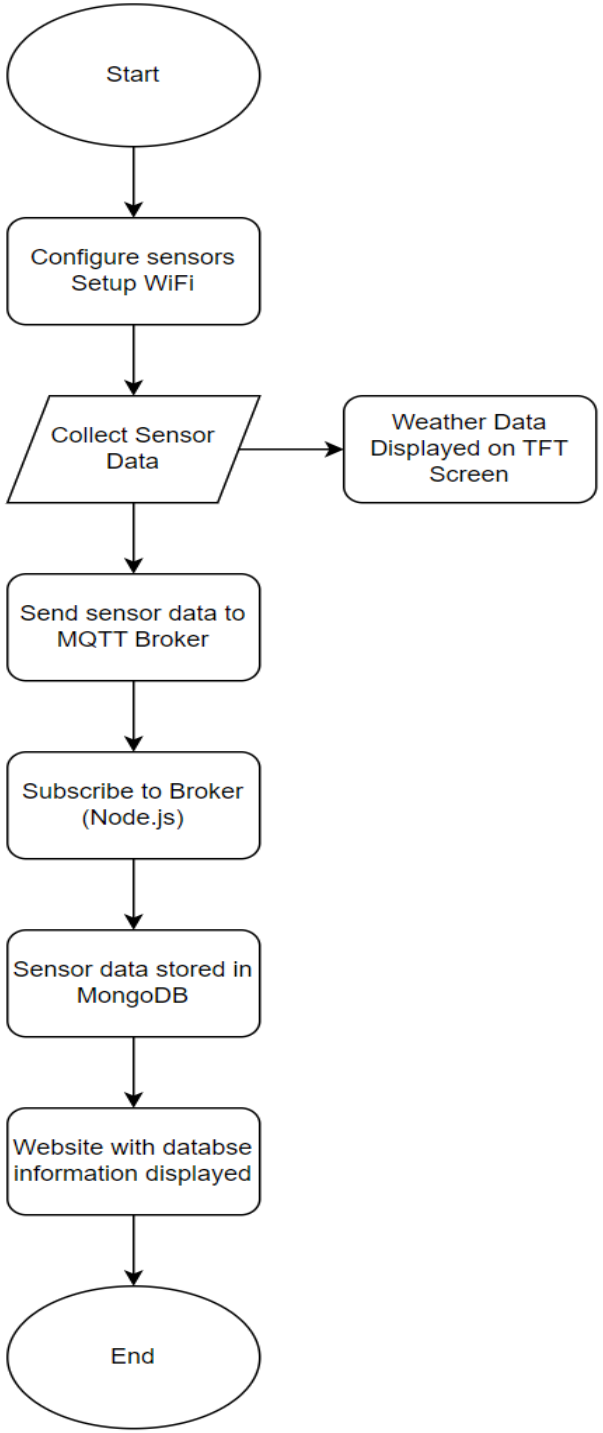
The front end of an IoT system is all about user interaction. It's the stage where the collected data is transformed into a user-friendly format, allowing users to visualize trends, monitor devices, and interact with the system. Imagine a user-friendly mobile app displaying real-time temperature readings from your smart thermostat or a web interface showcasing energy consumption patterns. These interfaces, built with technologies like web frameworks or UI toolkits, are the bridge between the complex backend and the human user. They present the data clearly and concisely, enabling users to make informed decisions and control their connected devices with ease. In short, the front end breathes life into the data, making the power of IoT accessible and user-friendly.


Hardware
Backend
Frontend
SENSORS
ESP32
I/O
Operations
Logic
Update
Task
MQTT
Task
(Client)
Callback
publish()
Mosquitto
(MQTT Broker)
MongoDB
(Database)
Pymongo
File
System
Flask API
Business Logic
MQTT
(Client)
Route
Route
Route
Route
Pinia Stores
(Business Logic)
MQTT
(Client)
Getters
Actions
(Fetch API)
func (GET / POST)
func (GET / POST)
func (GET / POST)
States
1. Variables
2. Objects
Navigation Router
View / Webpage
View / Webpage
View / Webpage
View / Webpage
View / Webpage
Debugging Tools
Arduino IDE
Serial.println()
mosquitto_sub
mosquitto_pub
clients
MongoDB
Compass
print()
Postman
console.log()

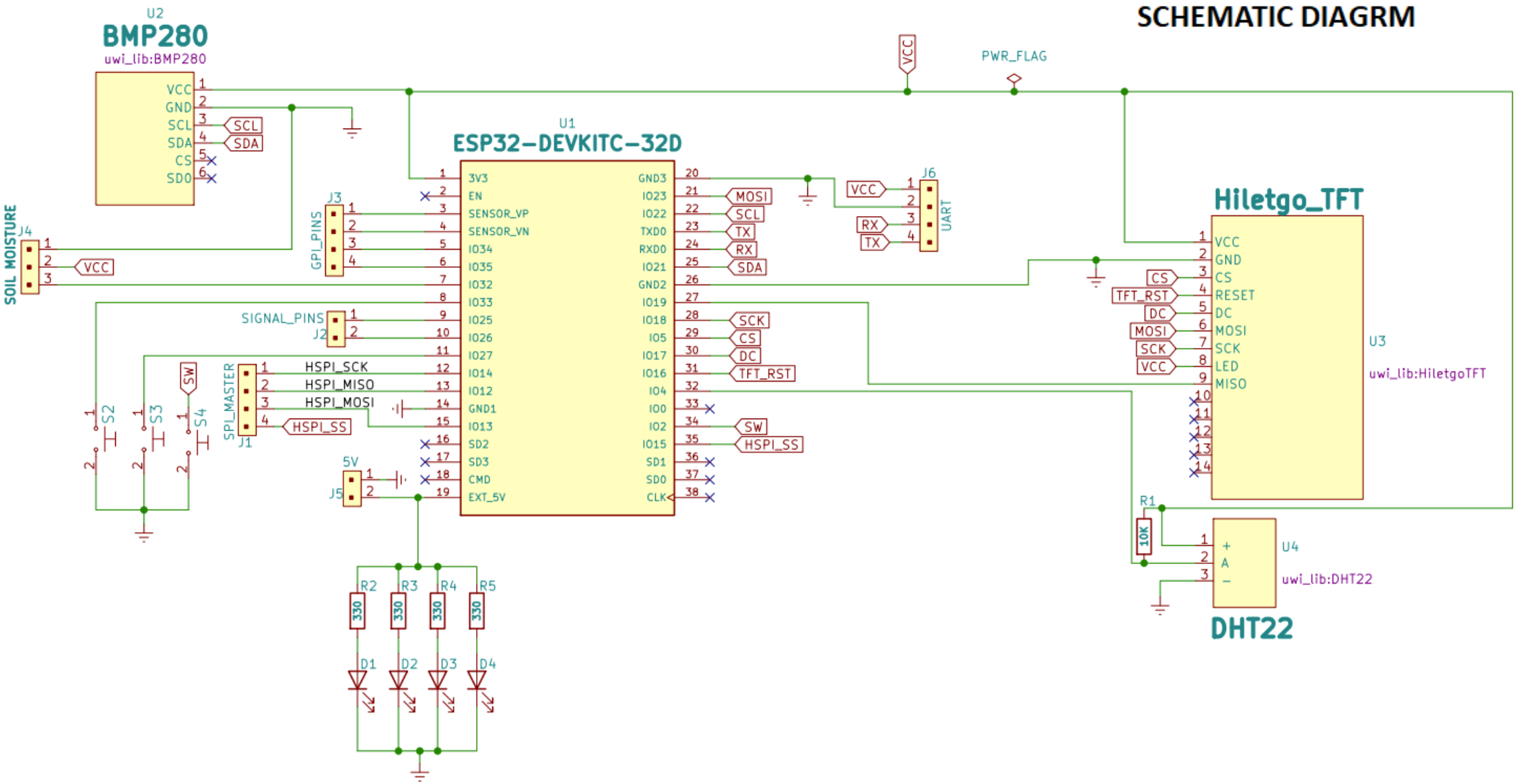
BLOCK DIAGRAM



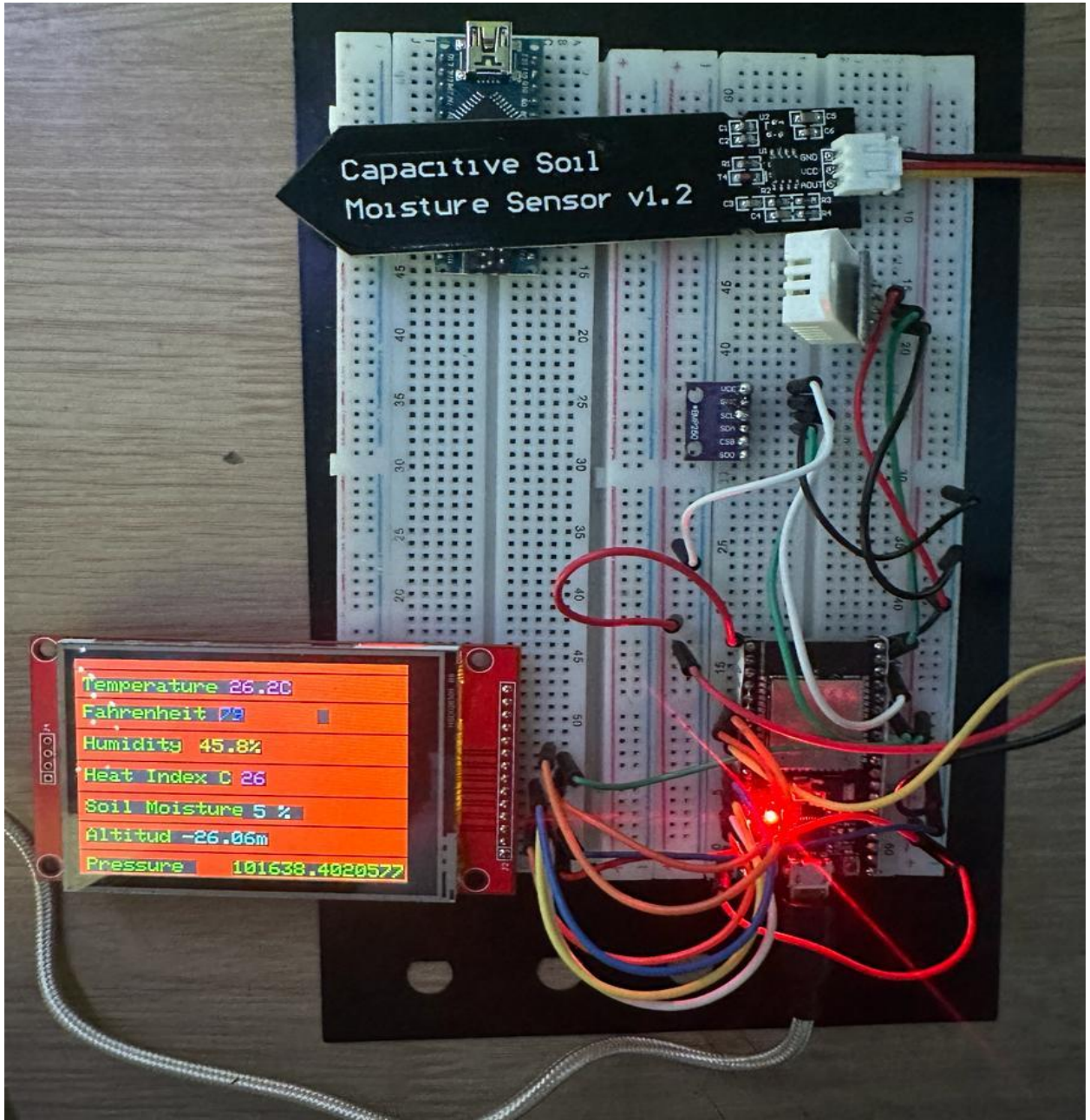
FLOW CHART


Start
Configure sensors Setup WiFi
Collect Sensor Data
Weather Data Displayed on TFT Screen
Send sensor data to MQTT Broker
Subscribe to Broker (Node.js)
Sensor data stored in MongoDB
Website with databse information displayed
End

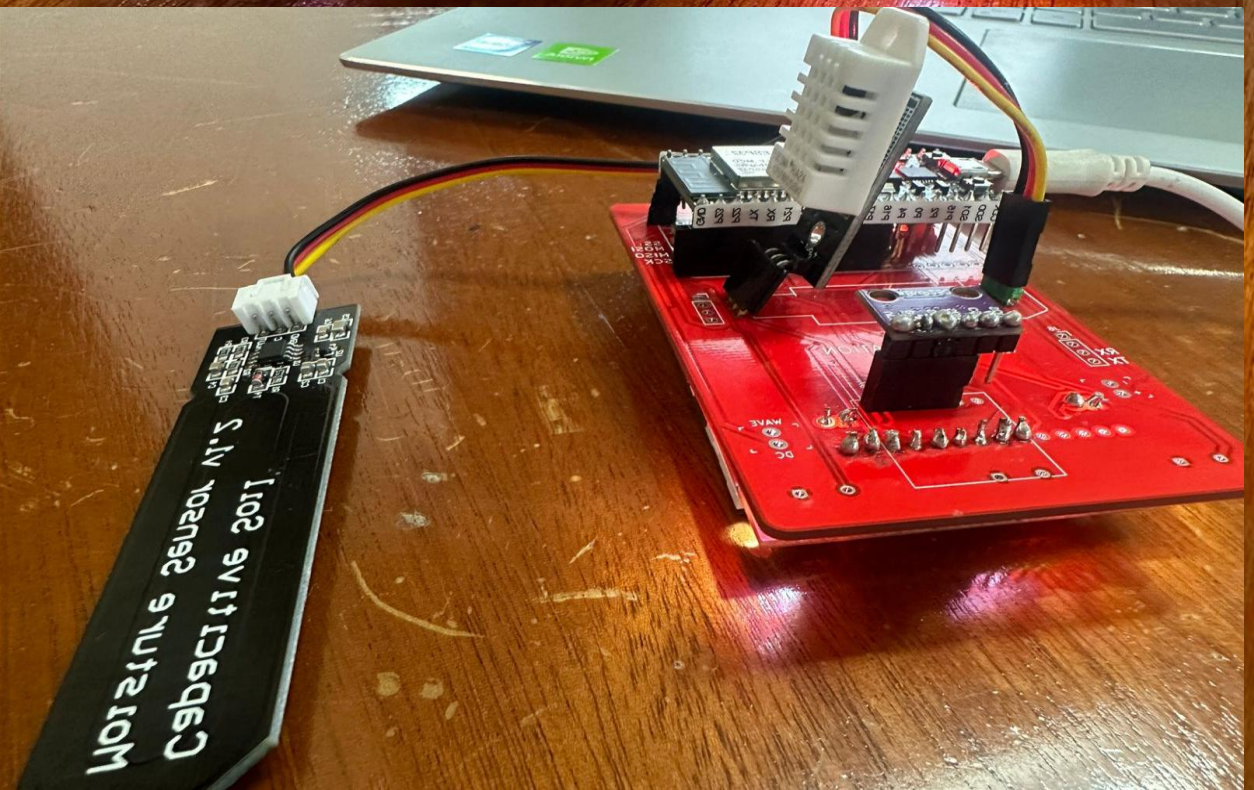
DEVELOPMENT PERIOD

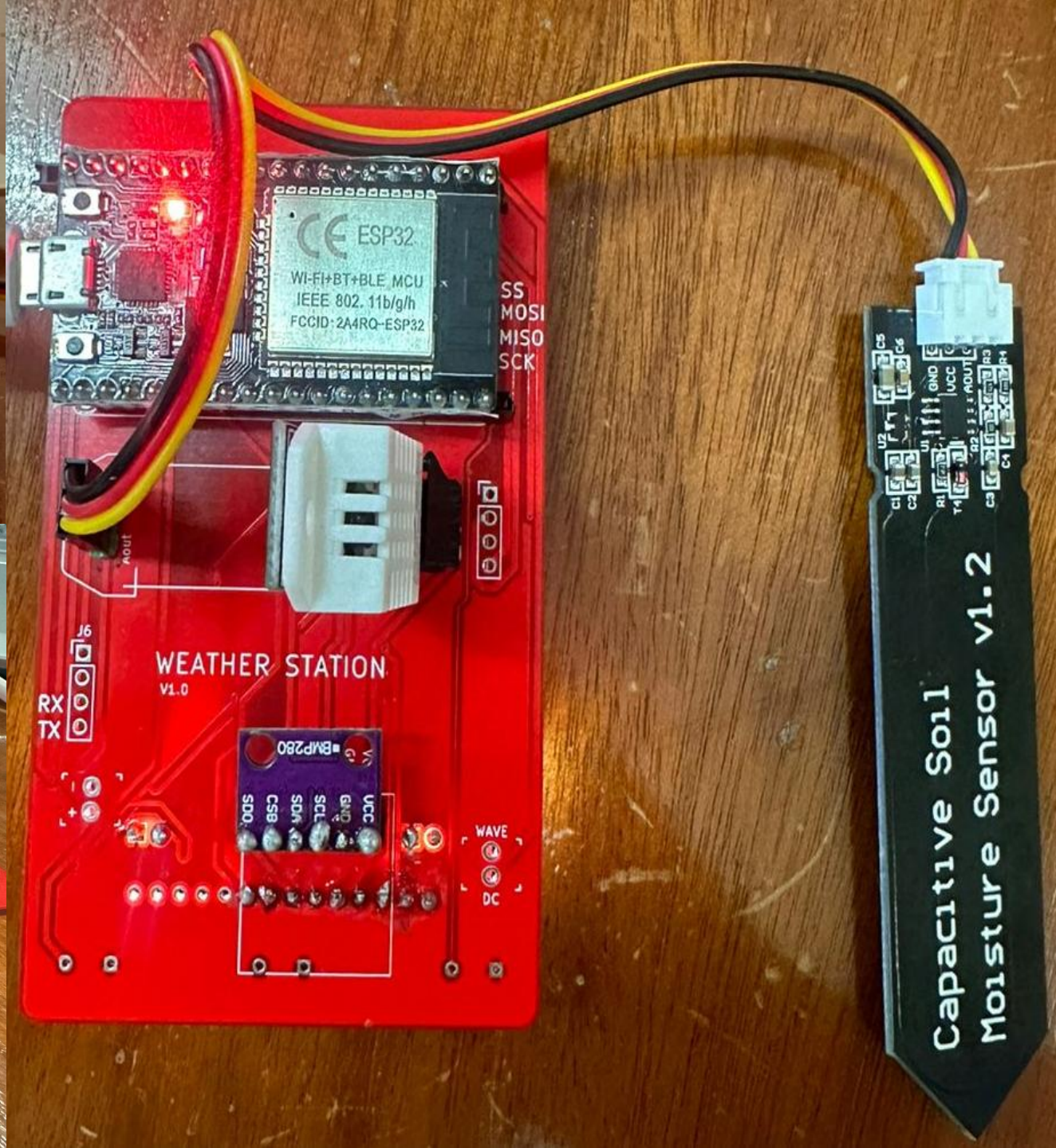


Bread Board


Capacitive Soil
Moisture Sensor v1.2
Temperature 26.20
Fahrenheit 79
Humidity 45.8%
Heat Index C 26
Soil Moisture 5 %
Altitud -26.06m
Pressure 101638.4020577


Temperature 32.7C
Fahrenheit 91
Humidity 57.3%
Heat Index C 38
Soil Moisture 3 %
Altitud 150.31m
Pressure 99528.8620577
SW1
SW2
SW3


Capacitive Soil
Moisture Sensor v1.2


ESP32
Wi-Fi+BT+BLE MCU
IEEE 802.11b/g/h
FCCID:2A4RQ-ESP32
SS
MOSI
MISO
SCK
WEATHER STATION
V1.0
RX
TX
J6
BMP280
SDO
CSB
SDA
SCL
GND
VCC
WAVE
DC
Capacitive Soil
Moisture Sensor v1.2

Components List and Price

Components

ESP32 Microcontroller- $2,200.00

Weather Station Blank PCB- $500.00

Soil Moisture Sensor- $1,200.00

DHT22 Humidity Sensor- $1,200.00

BMP 280 Pressure Sensor- $850.00

2.8” TFT Display Module- $3,200.00

10k ohm Resistor- $100.00

4 220 ohm Resistors- $200.00

4 LED- $350.00

Total: $10,000 (Approx.)

Equipment

Computer with the latest version of:

- Microsoft VS Code Editor
- Postman
- KiCad Suite
- Arduino IDE
- Eclipse Mosquitto MQTT Broker
- Node.js JavaScript Engine
- MongoDB Database

Micro USB Cable

THE END

Reference

IBM. “What Is the Internet of Things?” *Www.ibm.com*, 2024, www.ibm.com/topics/internet-of-things.

Schulze, Jessica. “What Is the Internet of Things (IoT)? With Examples.” *Coursera*, 16 June 2023, www.coursera.org/articles/internet-of-things.

“Tajay59 - Overview.” *GitHub*, github.com/tajay59. Accessed 8 Apr. 2024.