Introduction to IoT

PERSONALIZED CLIMATE CONTROL SYSTEM

Team Number 48

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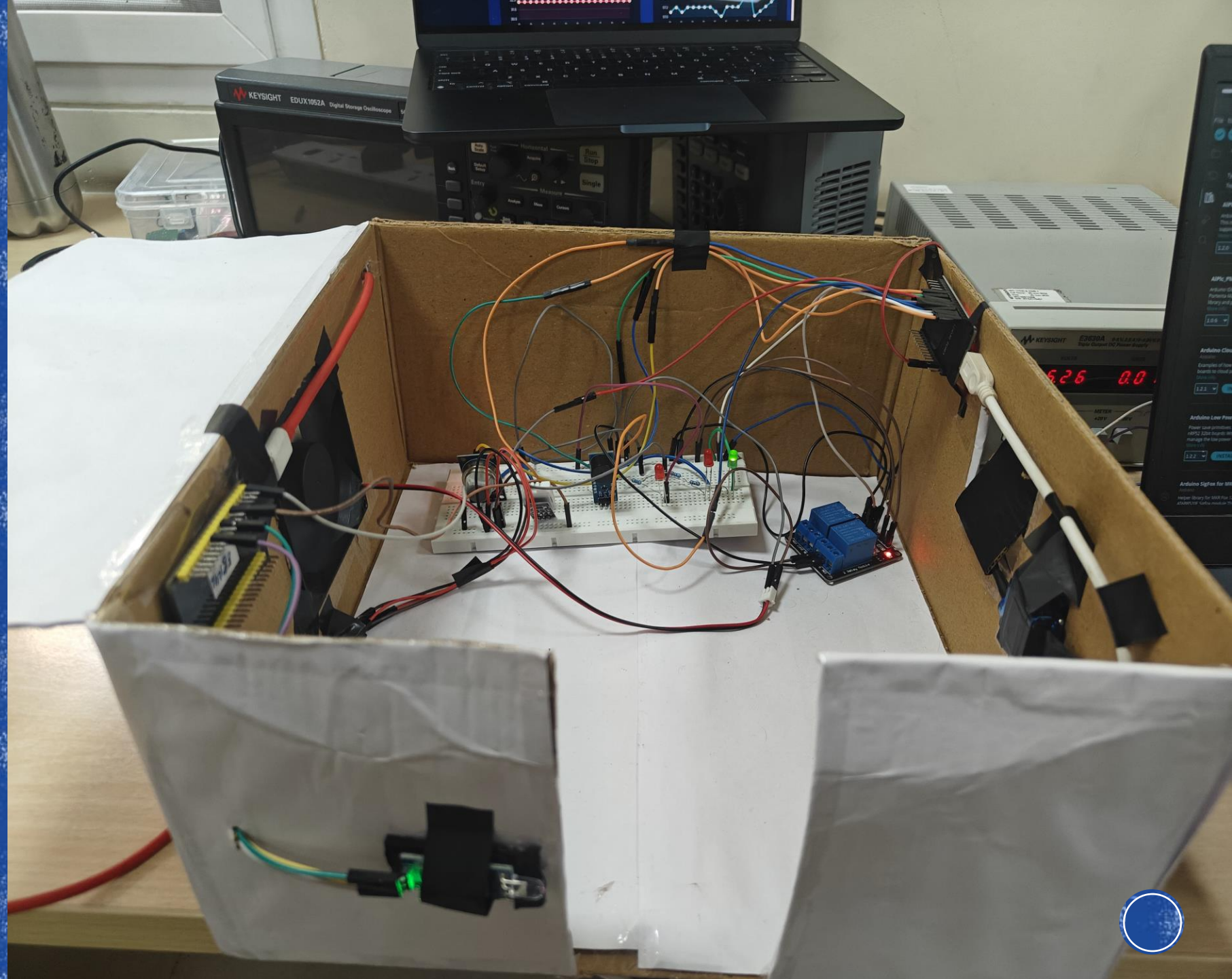
WORKING PROTOTYPE



PROJECT OVERVIEW
TYPE - IOT-BASED SMART HOME PROTOTYPE

- Goal: To create an automated system that intelligently manages indoor climate and air quality using real-time sensor data and smart controls

- Key Features:
  - Real-time monitoring (temp, humidity, CO_2, occupancy)
  - Smart automation of fan, AC (LED), vent, air purifier (LED)
  - Remote control through a web dashboard
  - Data logging into a MySQL database

Our Objective

- Automate indoor climate monitoring and control
- Enable real-time device adjustments based on sensor input
- System Behavior:
- Continuously track temperature, humidity, CO_2, occupancy
  - Automatically activate fan, vent, AC (LED), and air purifier (LED)

PROBLEMS WE AIM TO SOLVE

- **Manual Issues:**
  - Users have to constantly monitor and adjust devices
  - Forgetting to switch off devices wastes energy
- **Environmental & Efficiency Concerns:**
  - Devices often run unnecessarily
  - No optimization based on room occupancy or conditions

SYSTEM STRUCTURE OVERVIEW

- Architecture Approach:
  - Modular and scalable design
  - Two ESP32 boards used for division of responsibilities
- Why 2 ESP32s?
  - One for occupancy calculations
  - One for other sensors and actuators

Reason?

- The other sensors can be operated with delay of 5000 but we can not calculate occupancy with that much high delay

SENSORS USED :

- DHT22 – Measures temperature & humidity
- MQ-135 – Detects CO_2 and air quality
- IR/Ultrasonic – Detects room occupancy

$$HI = -8.784 + 1.611 \times T + 2.339 \times RH$$
$$- 0.146 \times T \times RH - 0.0123\, T^2$$
$$- 0.0164 \times RH^2 + 0.0022 \times T^2 \times RH$$
$$+ 0.0007 \times T \times RH^2$$

Heat Index represents "feels-like" temperature

FEELS-LIKE TEMPERATURE

- We calculated the *feels-like* temperature by combining temperature and humidity values to control the operation of various devices.
- The variable **RH** stands for **Relative Humidity**, and **T** stands for **temperature** in degrees Fahrenheit.

ACTUATORS USED :

- Motor for Ventilation – Opens/closes based on air quality
- Fan – Turns on with heat/humidity
- LEDs – Simulate AC and Air Purifier ON/OFF status

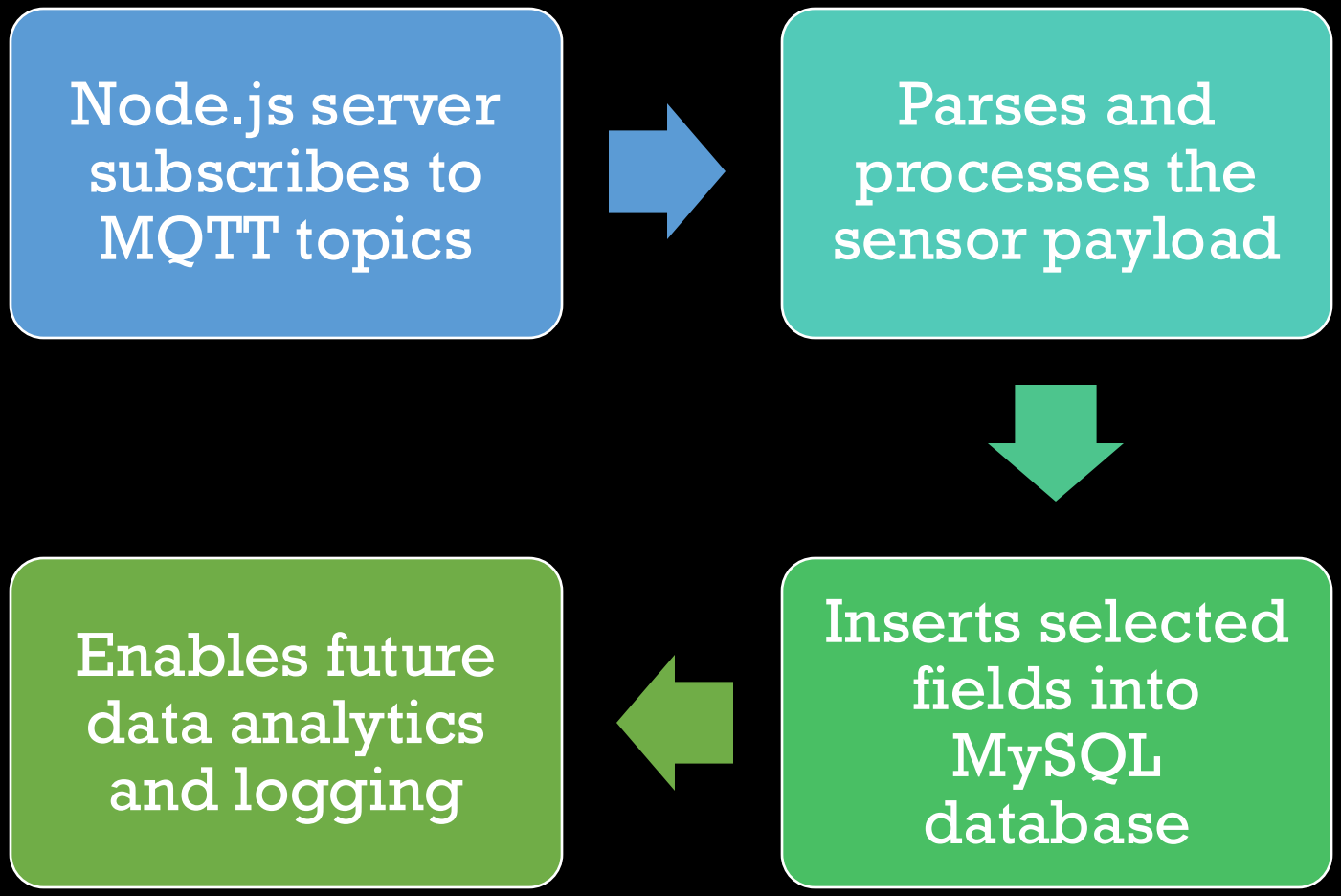
COMMUNICATION PROTOCOL – MQTT

- Protocol: MQTT (Message Queuing Telemetry Transport)
- Broker: EMQX Cloud
- Connection: Secure WebSockets (WSS) on port 8084
- Enables low-latency, lightweight communication ideal for IoT

MQTT – PUBLISH-SUBSCRIBE MODEL

- ESP32 #1 publishes to esp32/sensors
- Dashboard subscribes and updates charts in real time
- ESP32 #2 subscribes to esp32/control for device instructions
- Occupancy updates via esp32/occupancy
- Decoupled, real-time, flexible communication model

DATA STORAGE NODE.JS + MYSQL



DATA STORED IN MYSQL-DATABASE

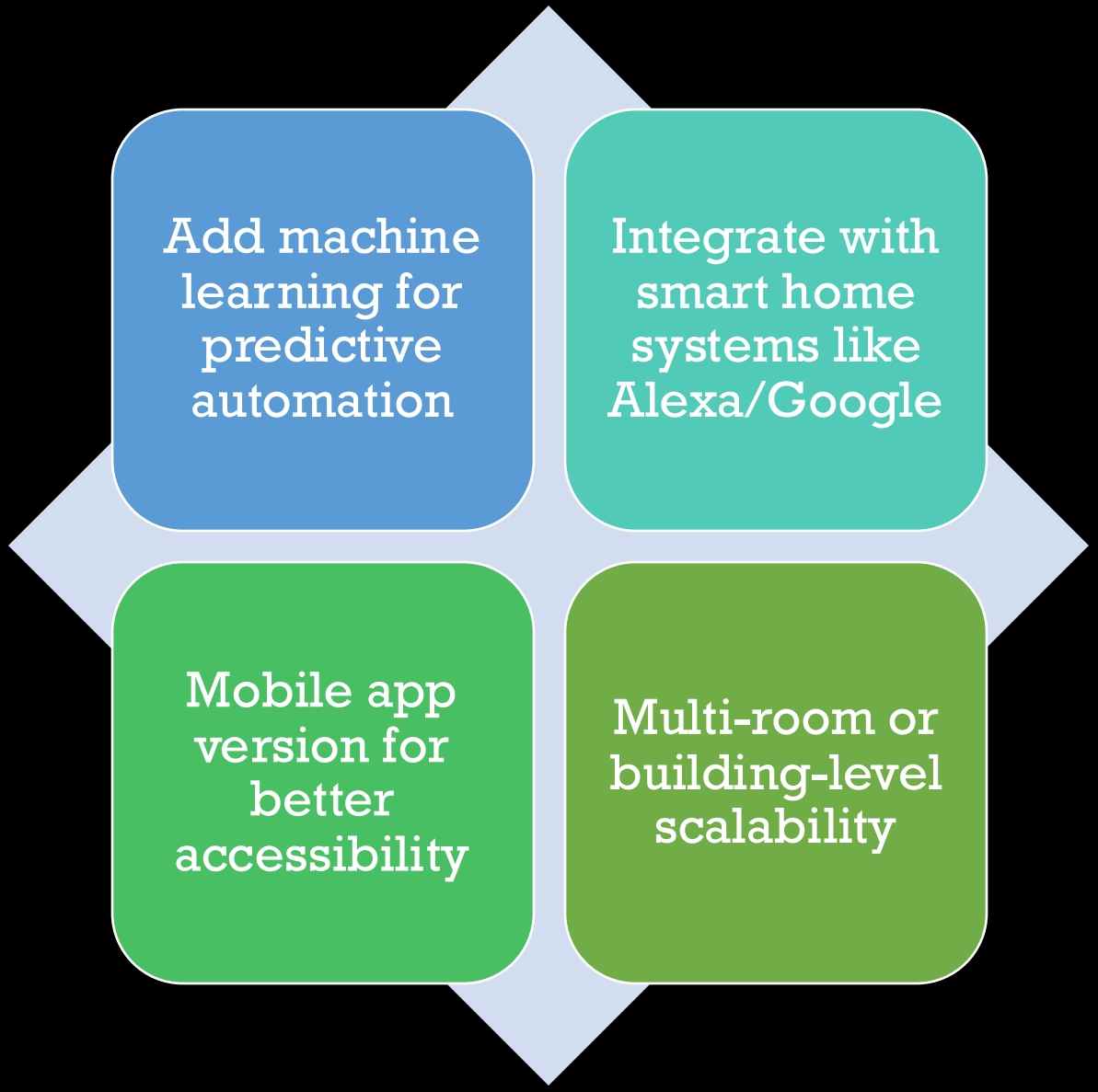
1846	32.5	52.4	480	37.7	2025-04-20 18:53:33
1847	32.5	52.5	479	37.8	2025-04-20 18:53:38
1848	32.5	52.8	475	37.8	2025-04-20 18:53:43
1849	32.5	52.8	496	37.8	2025-04-20 18:53:48
1850	32.5	52.9	494	37.8	2025-04-20 18:53:53
1851	32.5	52.5	490	37.8	2025-04-20 18:53:58
1852	32.5	52.3	490	37.7	2025-04-20 18:54:03
1853	32.5	52.3	477	37.7	2025-04-20 18:54:08
1854	32.5	52.3	480	37.7	2025-04-20 18:54:13
1855	32.5	52.3	486	37.7	2025-04-20 18:54:18
1856	32.5	52.3	483	37.7	2025-04-20 18:54:23
1857	32.5	52.3	473	37.7	2025-04-20 18:54:28
1858	32.5	52.2	511	37.7	2025-04-20 18:54:33
1859	32.5	52.2	487	37.7	2025-04-20 18:54:38
1860	32.5	52.2	487	37.7	2025-04-20 18:54:43
1861	32.5	52.2	475	37.7	2025-04-20 18:54:48
1862	32.4	52.2	487	37.6	2025-04-20 18:54:53
1863	32.5	52.2	477	37.7	2025-04-20 18:54:58

- We stored the values over a period of 3-4 days to enable better analysis.

FEATURES AT A GLANCE

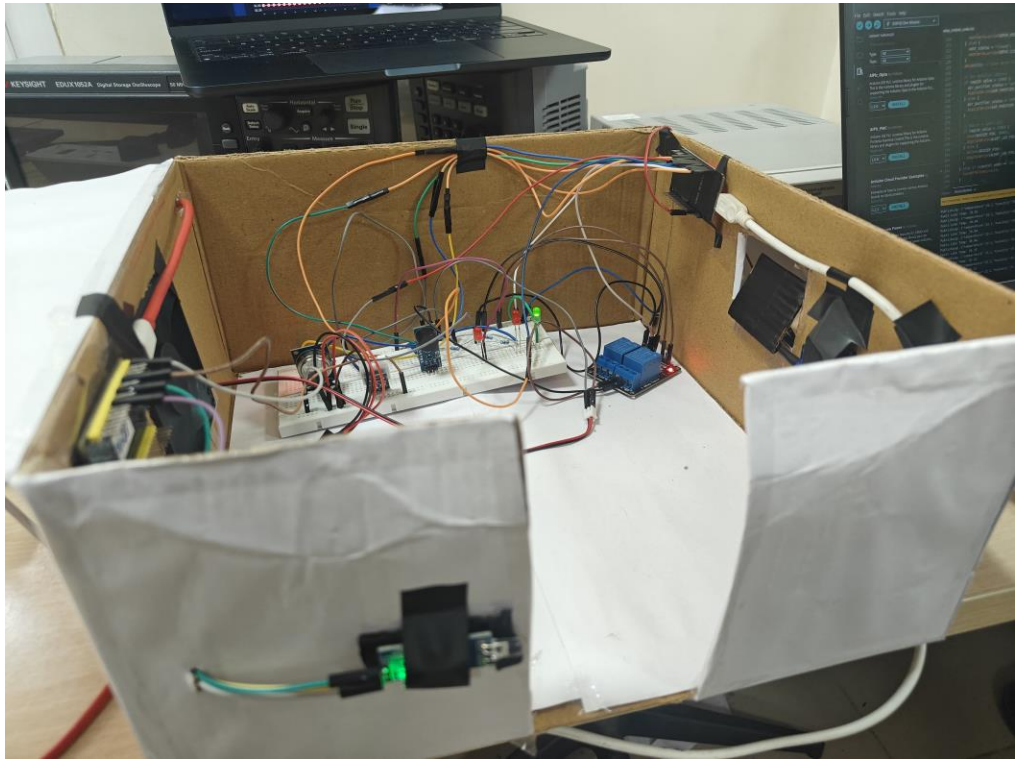
- Real-time dashboard (graphs + device control)
- Auto/Manual mode toggle
- Live occupancy detection
- Historical data storage
- Fully remote control over the web

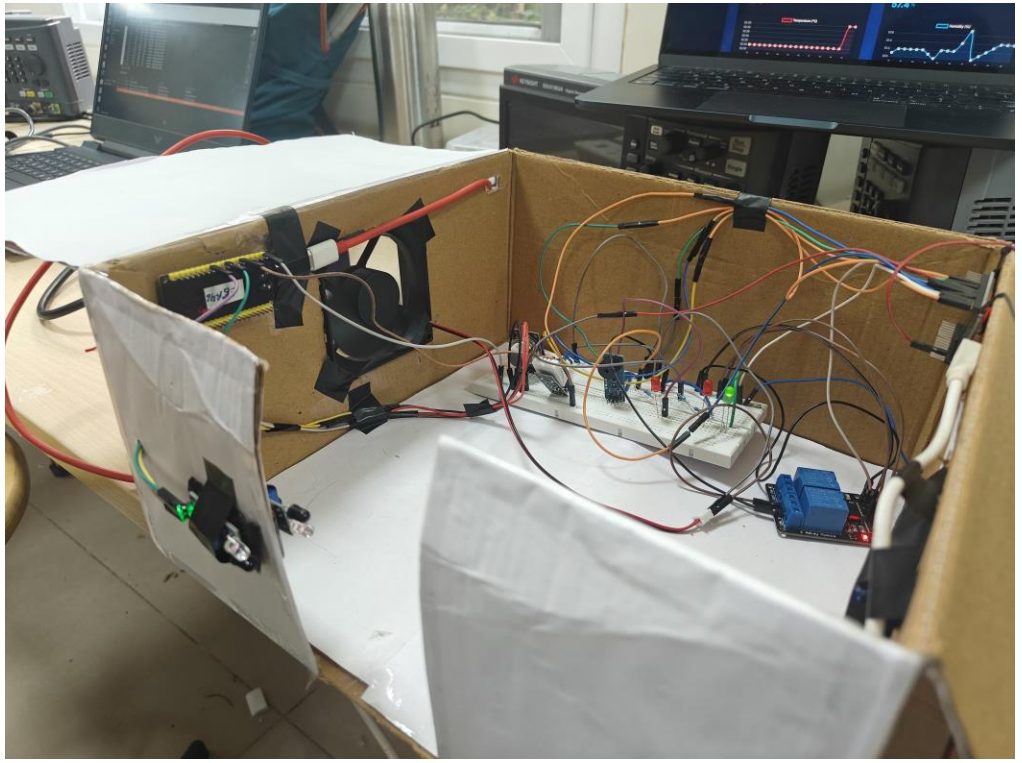
FUTURE SCOPE (OPTIONAL)



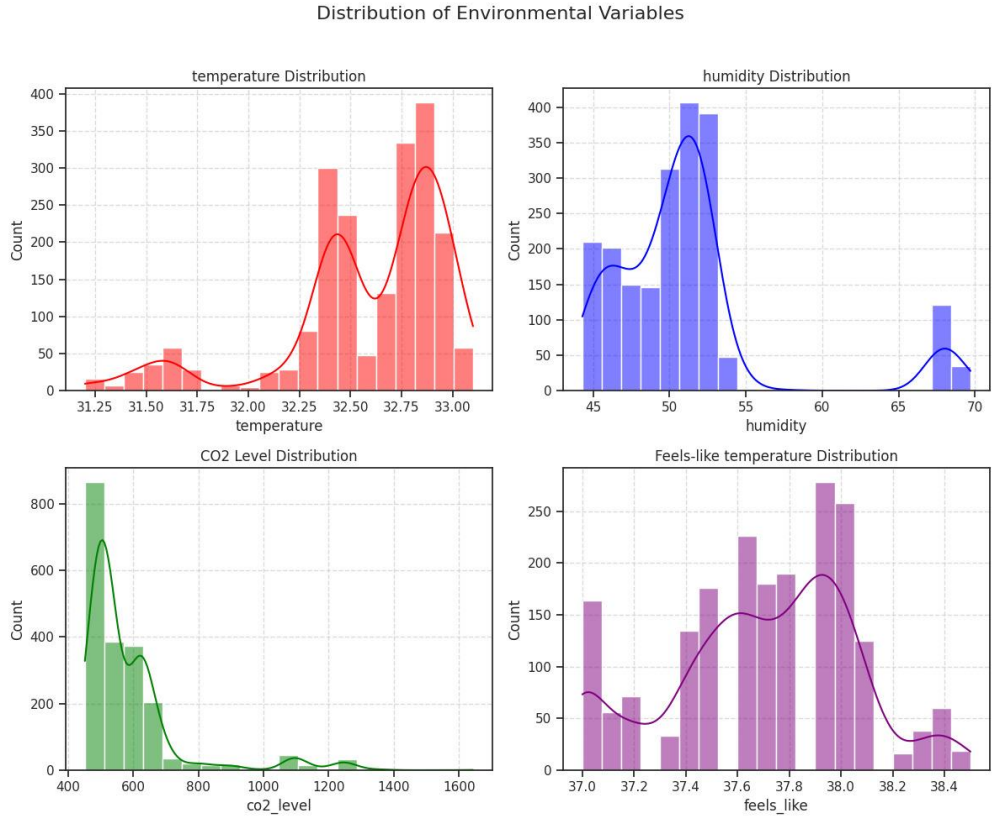
WORKING PROTOTYPE + SCHEMATIC + DATA GRAPHS

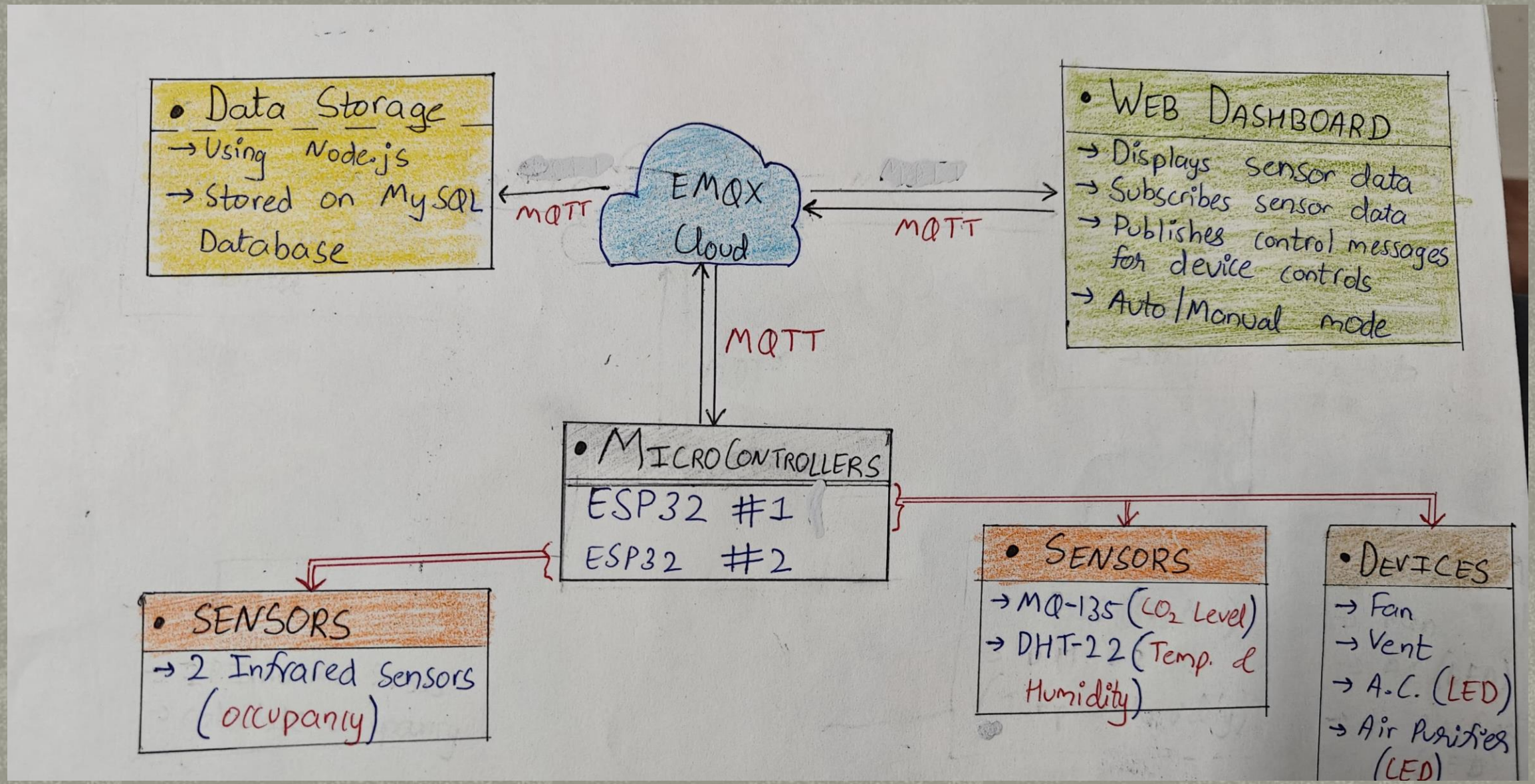
IN UPCOMING SLIDES

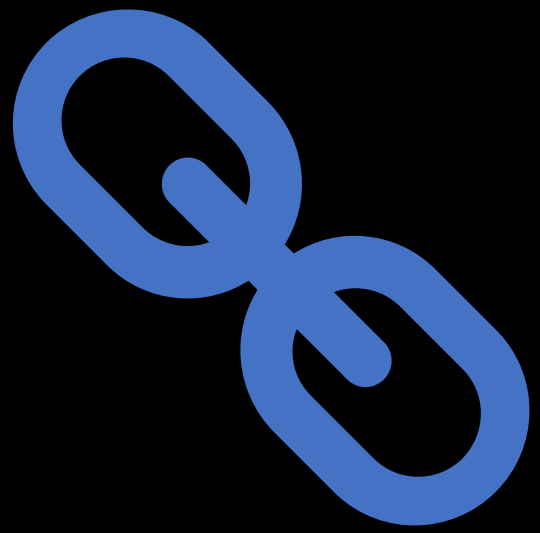

KEYSIGHT




Temperature Over Time
temperature
Humidity Over Time
humidity
CO2 Level Over Time
co2_level
Feels Like Temperature Over Time
feels_like
timestamp


Distribution of Environmental Variables
temperature Distribution
humidity Distribution
CO2 Level Distribution
Feels-like temperature Distribution
Count
temperature
humidity
co2_level
feels_like


• Data Storage
→ Using Node.js
→ Stored on MySQL Database
MQTT
EMQX Cloud
MQTT
MQTT
• WEB DASHBOARD
→ Displays sensor data
→ Subscribes sensor data
→ Publishes control messages for device controls
→ Auto / Manual mode
MQTT
• MICROCONTROLLERS
ESP32 #1
ESP32 #2
• SENSORS
→ 2 Infrared Sensors (occupancy)
• SENSORS
→ MQ-135 (CO_2 Level)
→ DHT-22 (Temp. & Humidity)
• DEVICES
→ Fan
→ Vent
→ A.C. (LED)
→ Air Purifier (LED)



THANK YOU !

Link of dashboard : Click here

Link of video of working dashboard : Click here

Link of main GitHub repository : Click here