EC281 | MINI PROJECT

ENDSEM PRESENTATION

TEMPERATURE MONITORING AND PREDICTION MODEL

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Introduction

- This project demonstrates the implementation of an IoT-based environmental monitoring system using the ESP8266 microcontroller and the BME280 sensor.
- The system measures temperature, humidity, and atmospheric pressure in real time using I2C communication.
- The ESP8266 operates in Access Point (AP) mode, allowing users to connect directly via Wi-Fi without an external router(portable and no internet needed).
- A ML neural network is trained with temperature of four month ,to predict the temperature in the next hour

motivation

- **To make an offline portable temperature and pressure monitoring system which connects to your mobile phone.**
- **To make an ML model which predicts the future temperature based on the training data.**

problem statement

- simulation constraints.
- trade off between email alerts and real time monitoring via web server(sending emails has to bypass google restrictions).
- need more data for accurate predictions.
- need precipitation data for rain prediction.
- make an automated model of taking the data and making predictions (need front end , back end development to make an interface)

literature review

- R. Patel and P. Mehta, “Smart environmental monitoring using ESP8266 and BME280,” Int. J. Eng. Res. Technol., vol. 8, no. 6, pp. 150–153, 2019.

  it presents a low-cost, real-time environmental monitoring system using the ESP8266 microcontroller and BME280 sensor.

  It highlights the device’s ability to collect and transmit temperature, pressure, and humidity data wirelessly.

- Z. Zhao, W. Chen, X. Wu, P. Chen, and J. Liu, “LSTM network: A deep learning approach for short-term traffic forecast,” IET Intell. Transp. Syst., vol. 11, no. 2, pp. 68–75, 2017.

  LSTM neural networks for accurate short-term traffic forecasting

- V. Kumar and M. Jain, “Hourly temperature forecasting using LSTM: A feature-driven approach,” Int. J. Appl. AI, vol. 9, no. 2, pp. 34–40, 2021

  uses features- time and previous temperature values to predict hourly temperature

methodology

HARDWARE SETUP

1) BME680 Sensor:

Measures temperature, humidity,and pressure with high accuracy.

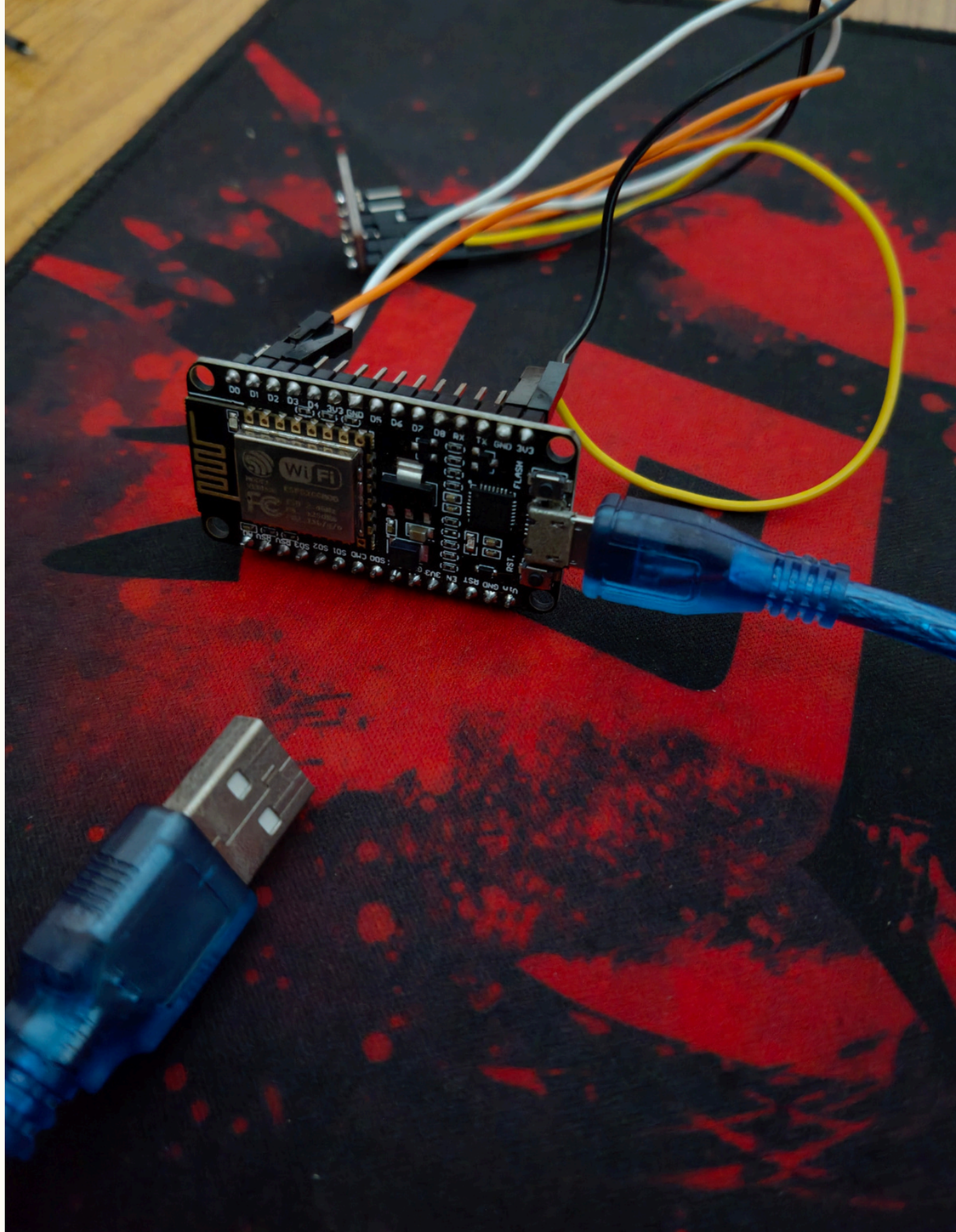
Connected via I2C protocol (SDA=D2, SCL=D1 pins)

2)ESP8266 Microcontroller:

Core unit for processing sensor data and managing communication.

Configured as WiFi Access Point (AP) to create local network.

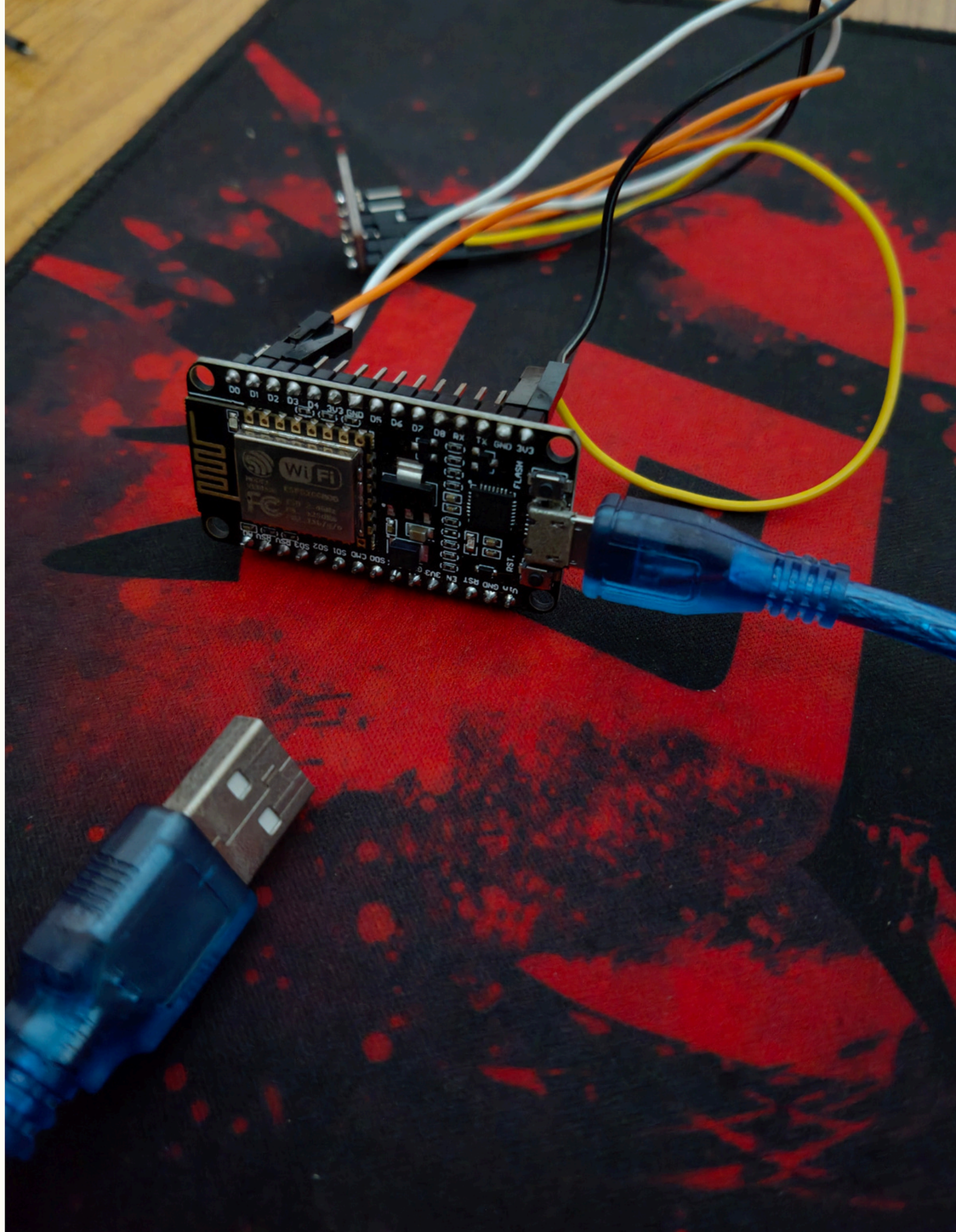
3)battery-powered setup for mobility.



methodology

COMMUNICATION & DISPLAY

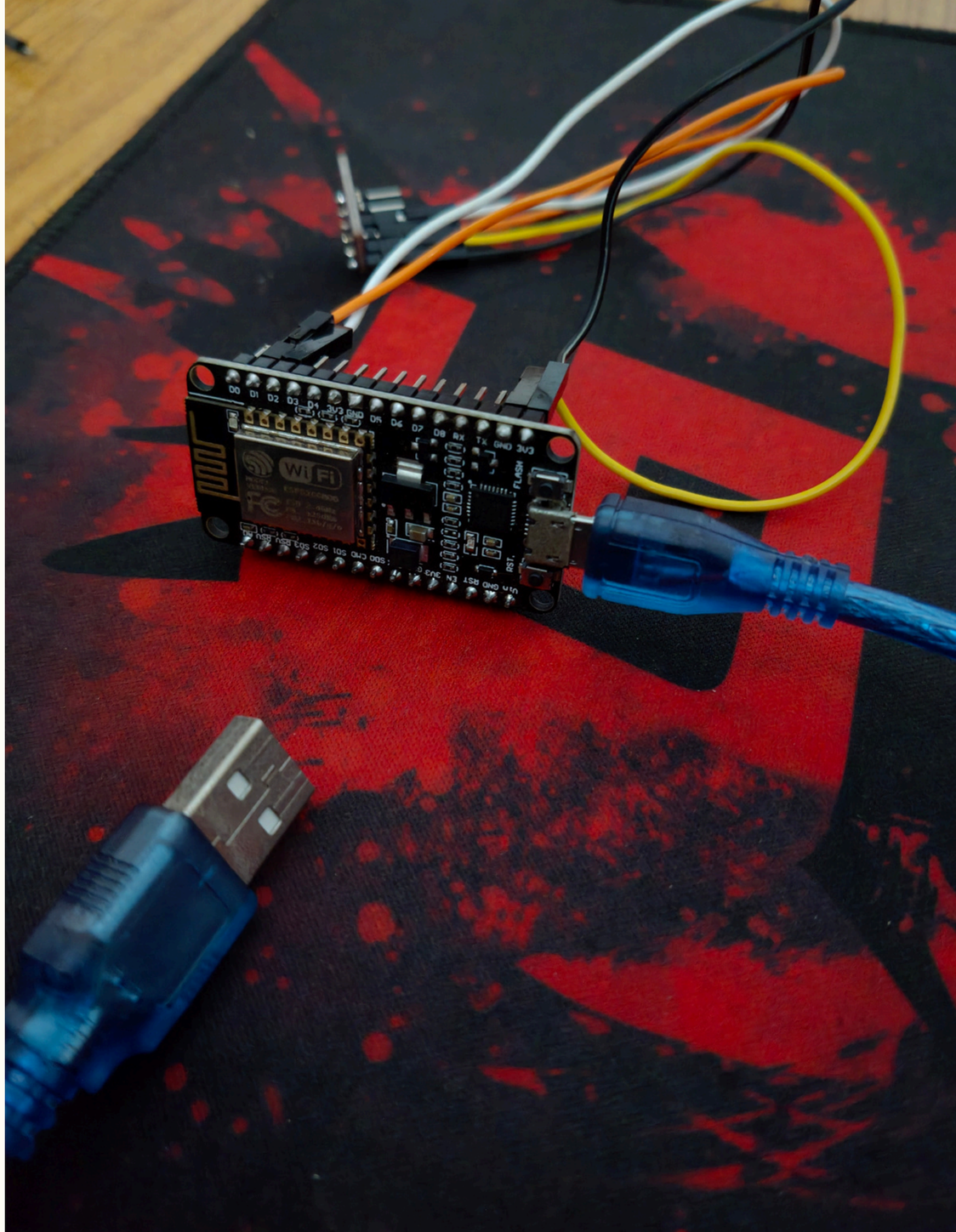
- ESP8266 hosts a local web server Displays live sensor data on browser when mobile/PC connects to ESP8266 network
- Configured with ESPAsyncWebServer and Adafruit BME280 libraries.
- Regular 5-second sampling for serial monitor output.
- Auto-refreshing HTML page (5-second interval).
- SSID: "ESP8266_AP"
- Password: "12345678"



methodology

DATA PREDICTION(ML MODEL)

- Normalize temperature and humidity using MinMaxScaler to scale values between 0 and 1.
- Compile with Adam optimizer and mean squared error (MSE) loss.
- Train for 20 epochs on temperature sequences.
- Build an LSTM model with 50 units (ReLU activation) and a single output dense layer.
- Use an identical LSTM architecture for humidity prediction.
- for precipitation probability Train a RandomForestRegressor (100 estimators) using normalized temperature, humidity, and hour as features.



methodology

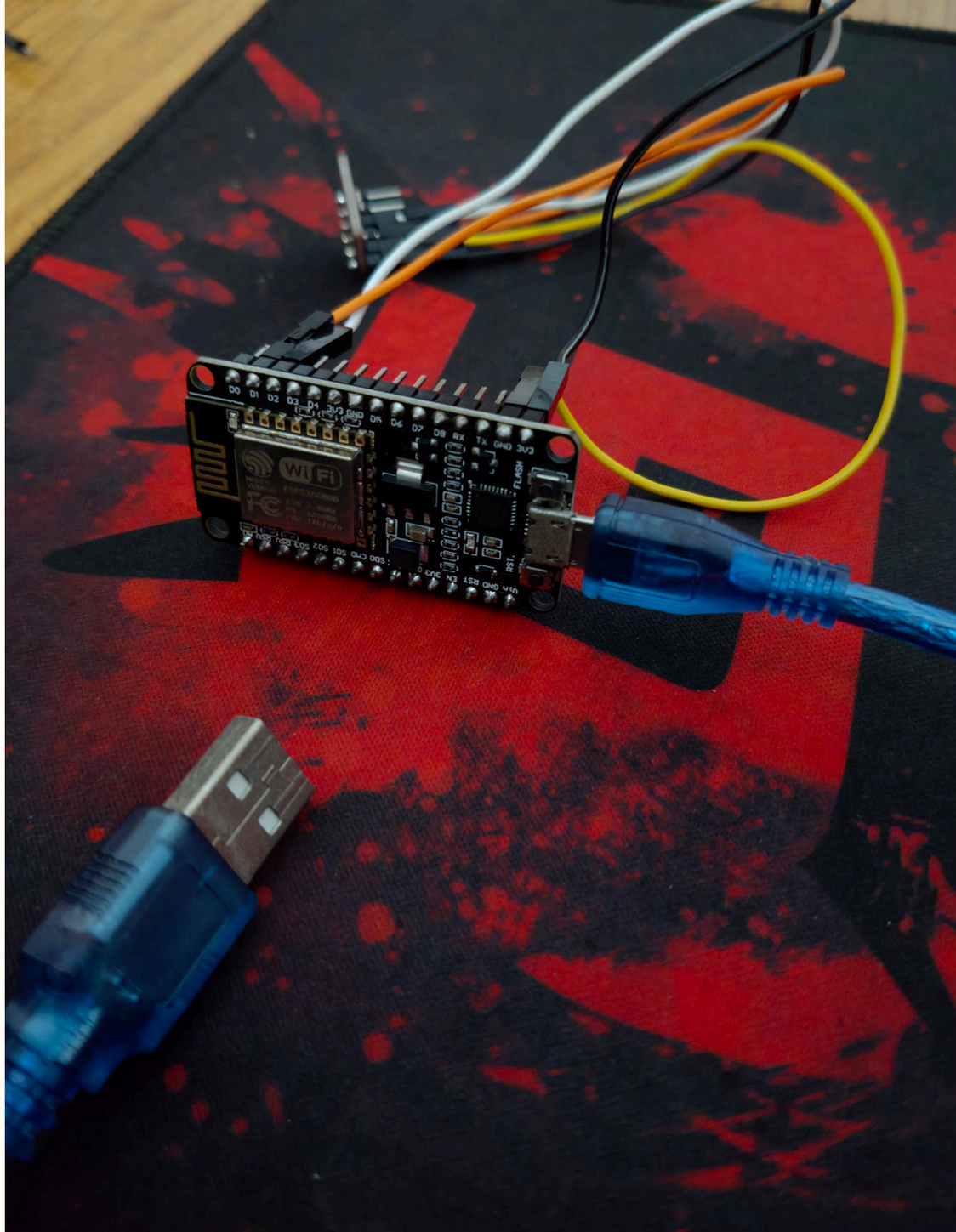
TOOLS

HARDWARE

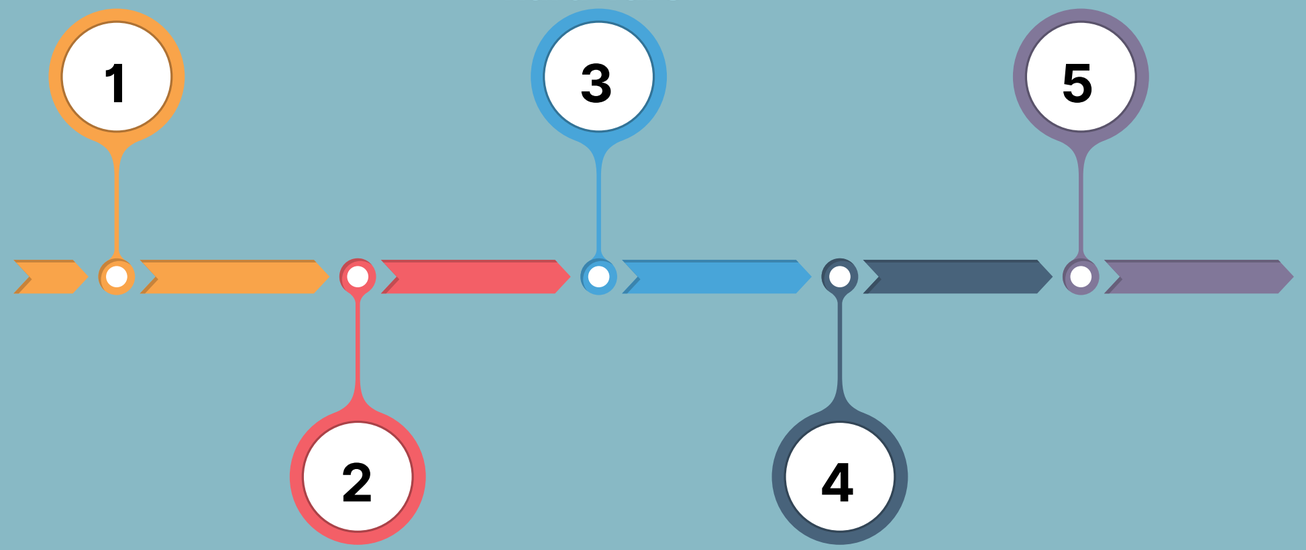
- ESP8266WIFI
- BME280I2C

SOFTWARE

- ARDUINO IDE
- GOOGLE COLAB
- PYTHON
- TENSORFLOW/KERAS



project timeline



march 4

got approved the project from our guide

march 15

collected training data for ML model and conformed the hardware

april 10

coded the ML model for predicting temperature and placed order for hardware

may 2

coded wifi module and tested with hardware

may 7

results shown to our guide and got approval for presentation

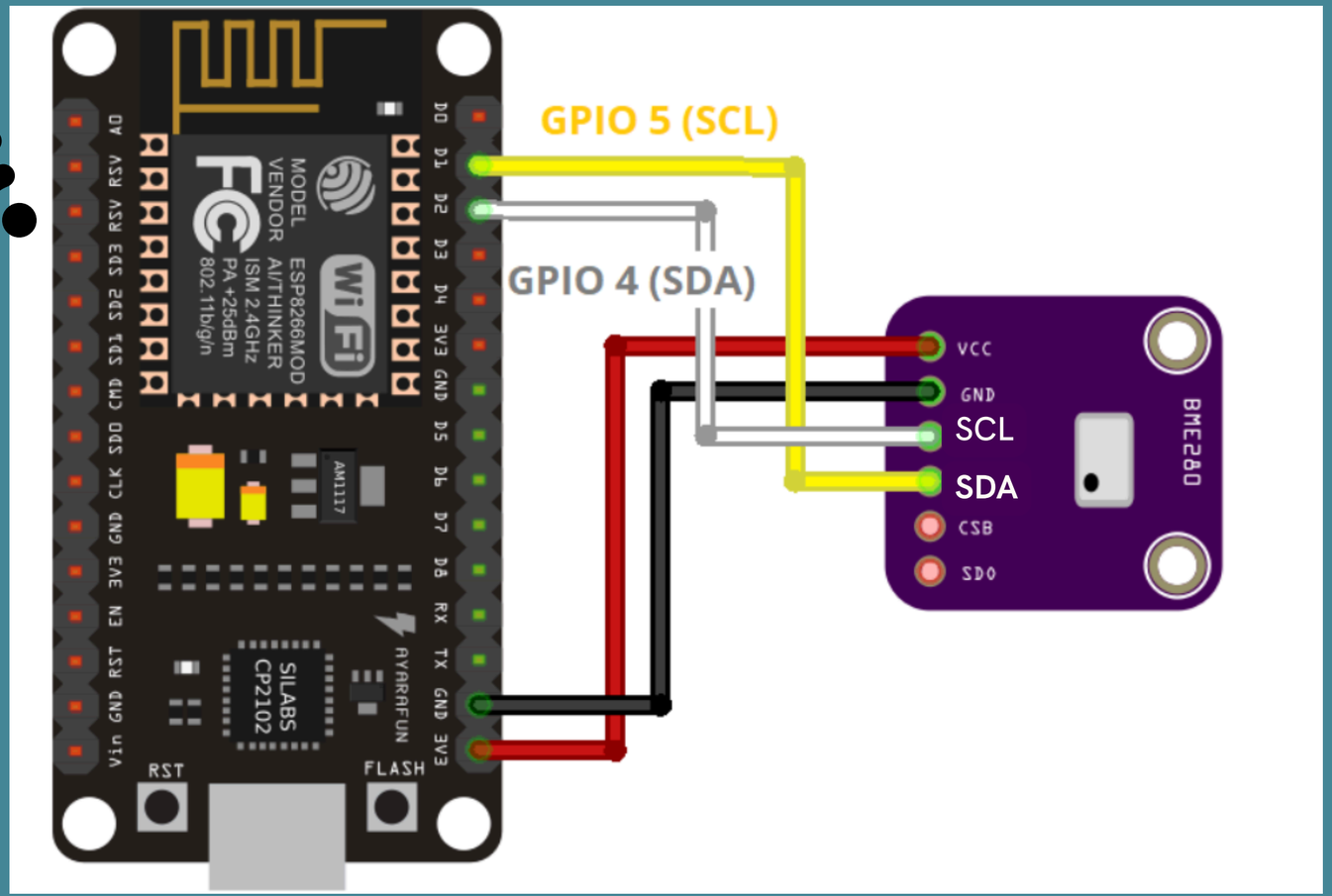
work progress

COMPLETED WORK

- Hardware implementation is done.
- Configured the ESP8266 as a Wi-Fi Access Point (AP) with SSID "ESP8266_AP" and password "12345678".
- Established a web server on port 80 to serve real-time sensor data.
- Implemented periodic data collection (every 5 seconds) for temperature, pressure, and humidity.
- collected temperature and humidity data of surathkal of four months and made a ML model.
- Implemented user input handling for current temperature, humidity, and hour.
- Successfully made a model which predicts the temperature,humidity and precipitation probability in next hour.

work showcase

circuit of wi-fi module

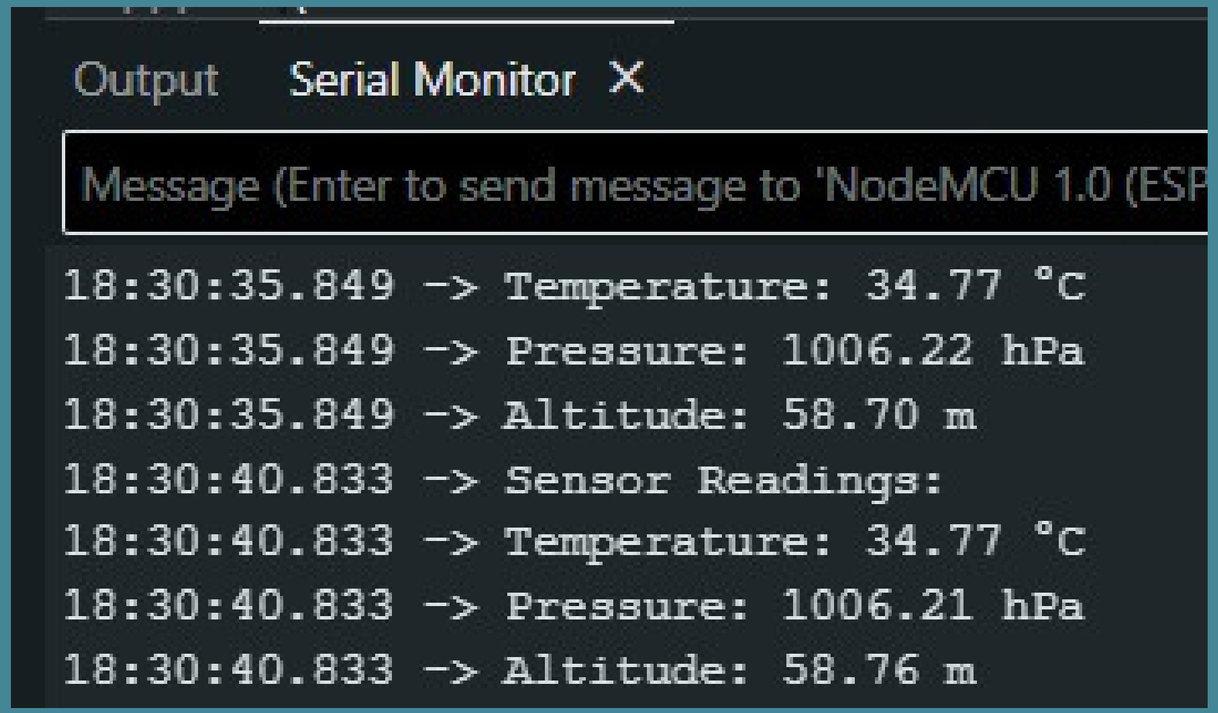


ESP 8266 WIFI MODULE

BME680 SENSOR

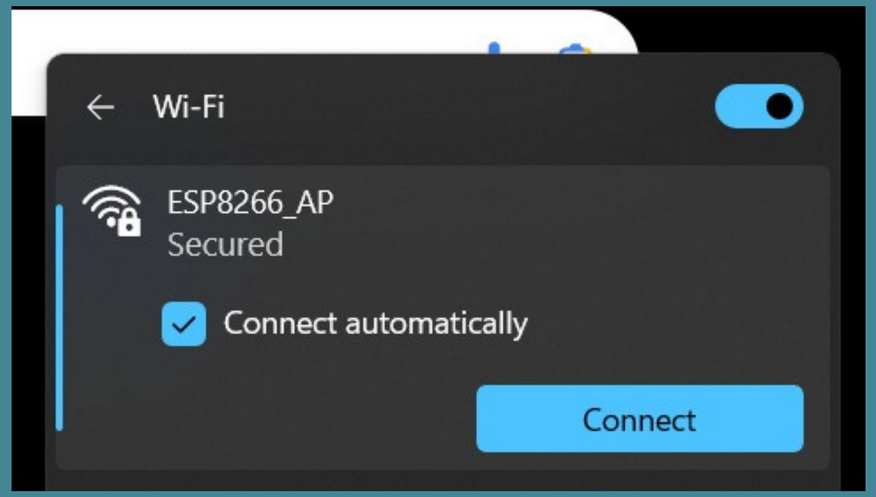
CONNECTED VIA I2C PROTOCOL (SCL=D2, SDA=D1 PINS)

results

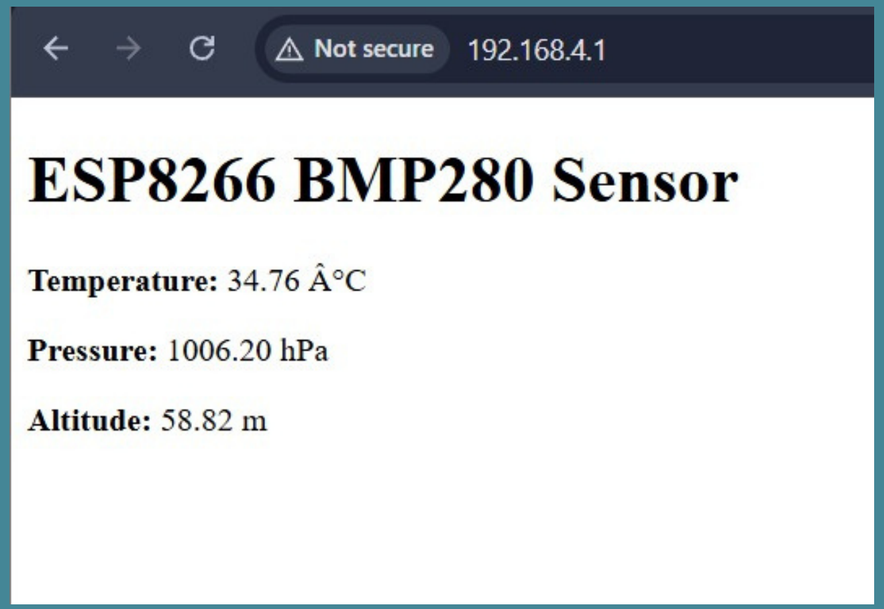


we get readings from sensor in serial monitor every five seconds

results



Wi-Fi from module can be detected in any laptop or mobile phone.



search for: http://192.168.4.1
we can view the live readings

calculating altitude

barometric formula:

$$altitude = 44330 \times (1 - (P/P_0)^{0.1903})$$

P = Measured pressure in hPa
P_0 = Reference pressure at sea level (1013.25 hPa)

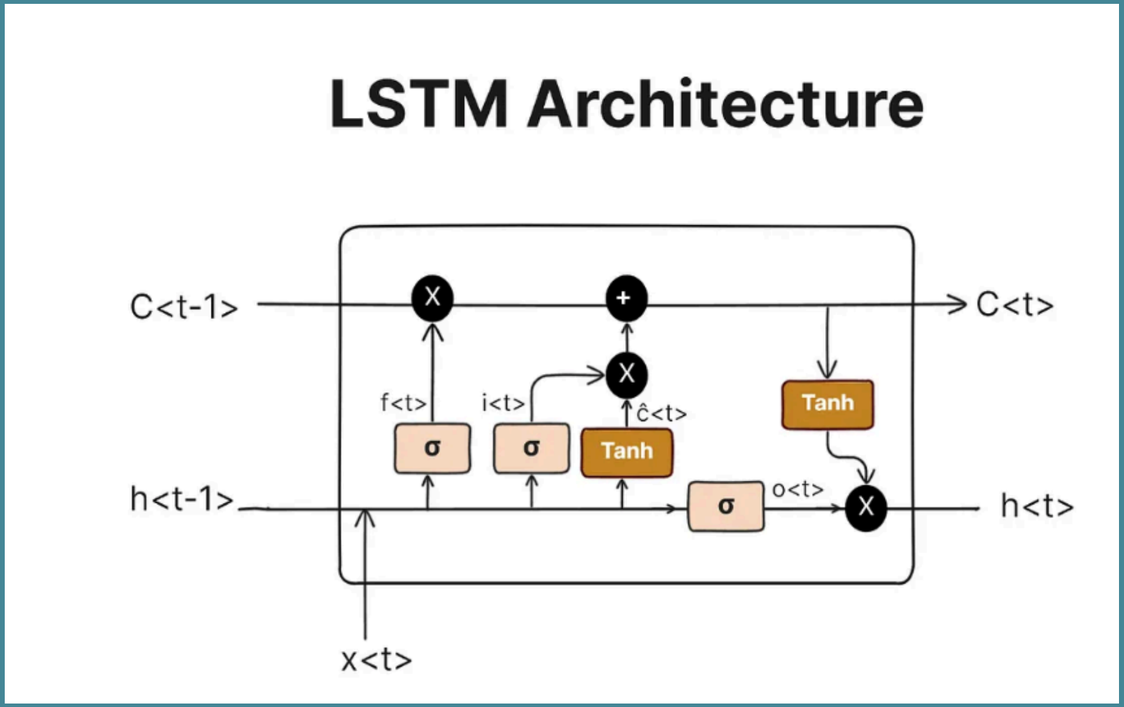
training data

	A	B	C	D	E
1	time	temperature_2m (°C)	precipitation (mm)	relative_humidity_2m (%)	precipitation_probability (%)
2	2025-01-19T00:00	22.1	0	85	0
3	2025-01-19T01:00	21.9	0	85	0
4	2025-01-19T02:00	22	0	82	0
5	2025-01-19T03:00	22.1	0	76	0
6	2025-01-19T04:00	22.1	0	70	0
7	2025-01-19T05:00	21.8	0	69	0
8	2025-01-19T06:00	21.7	0	68	0
9	2025-01-19T07:00	22.1	0	68	0
10	2025-01-19T08:00	24.9	0	61	0
11	2025-01-19T09:00	28.3	0	53	0
12	2025-01-19T10:00	31.2	0	47	0
13	2025-01-19T11:00	33.7	0	40	0
14	2025-01-19T12:00	36	0	36	0
15	2025-01-19T13:00	33.5	0	42	0
16	2025-01-19T14:00	28	0.1	59	0
17	2025-01-19T15:00	28.6	0	57	6
18	2025-01-19T16:00	29.5	0	55	14
19	2025-01-19T17:00	28.5	0	61	19
20	2025-01-19T18:00	26.7	0	70	16

hourly data of four months

total data points=8,640

LSTM RNN ARCHITECHTURE



- LSTM(50, activation='relu'): A single LSTM layer with 50 units (neurons).
- The relu (Rectified Linear Unit) activation function is used
- This layer processes the 24-step sequence and outputs a vector of 50 values (one for each unit).
- Dense(1): A fully connected layer with one unit.
- It takes the 50-dimensional output from the LSTM layer and produces a single scalar value, representing the predicted temperature or humidity for the next time step.

ML model predcitions

used google colab

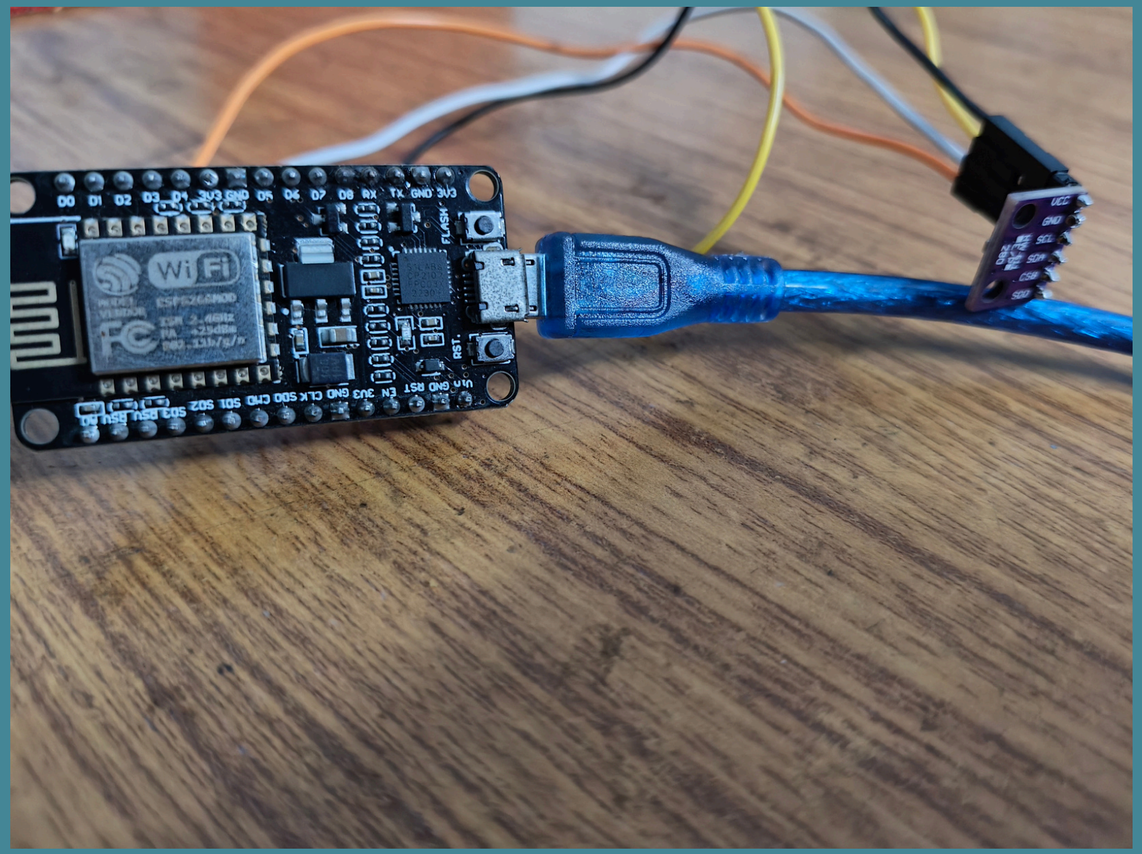
```
input_data = pd.DataFrame([[pred_scaled_temp, pred_scaled_hum, next_hour]],
                          columns=['temperature_2m (°C)', 'relative_humidity_2m (%)', 'hour'])

pred_precip = precip_model.predict(input_data)[0]

# Output predictions
print(f" Predicted temperature 1 hour later: {pred_temp_real:.2f} °C")
print(f" Predicted humidity 1 hour later: {pred_hum_real:.2f} %")
print(f" Predicted precipitation probability: {pred_precip:.2f} %")
```

```
Precipitation model trained successfully.
Enter the current temperature (°C): 35
Enter the current humidity (%): 75
Enter the current hour (0-23): 14
 Predicted temperature 1 hour later: 31.78 °C
 Predicted humidity 1 hour later: 74.37 %
 Predicted precipitation probability: 4.36 %
```

HARDWARE


D0 D1 D2 D3 D4 3V3 GND D5 D6 D7 D8 RX TX GND 3V3
FLASH
RST
WiFi
ESP8266MOD
VCC
GND
SCL
SDA
CS
SDO

CONCLUSION

- This project successfully integrates IoT and machine learning to deliver real-time environmental monitoring and weather forecasting.
- The ESP8266, paired with a BME280 sensor, accurately captures temperature, humidity, and pressure data, accessible via a web interface for seamless user interaction.
- The machine learning component employs LSTM models and a RandomForestRegressor to predict temperature, humidity, and precipitation probability with high precision, using historical data and user inputs.

CONCLUSION

FUTURE SCOPE

- develop a website or an interface which automatically shows future data without entering manually.
- train the model with large datasets for more features like rain prediction,wind speed.
- cloud integration and data storage of sensor values.
- adding features of sending messages and email alerts.
- increasing the range of wi-fi module.

SUMMARY

This project integrates an ESP8266-BME280 IoT weather station with LSTM and RandomForest models to monitor and predict temperature, humidity, and precipitation. Real-time data is displayed via a web interface, while ML models forecast weather one hour ahead, offering a scalable solution for environmental monitoring and forecasting.

REFERENCES

- R. Patel and P. Mehta, “Smart environmental monitoring using ESP8266 and BME280,” Int. J. Eng. Res. Technol., vol. 8, no. 6, pp. 150–153, 2019.

- Z. Zhao, W. Chen, X. Wu, P. Chen, and J. Liu, “LSTM network: A deep learning approach for short-term traffic forecast,” IET Intell. Transp. Syst., vol. 11, no. 2, pp. 68–75, 2017.

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