ENVIRONMENT QUALITY MONITORING

ABSTRACT

This project presents a sophisticated hybrid air quality monitoring system developed using the ESP32 microcontroller, which is integrated without any issues with a real-time web dashboard and a Neural Network based analytical module.

INTRODUCTION

Environmental quality is a key consideration that affects public health, stability of ecosystems, and general quality of life. The latest developments in embedded systems and the Internet of Things (IoT) have enabled it to be possible to create smart, low-cost, and real-time environmental monitoring solutions

PROBLEM STATEMENT

Air pollution is a serious threat to public health and environmental quality. Existing monitoring systems are costly and not accessible for personal or small-scale use. There is a need for a compact, affordable, and real-time system that helps individuals monitor their immediate air quality.

SOLUTION

We developed a low-cost, real-time air quality monitoring system using the ESP32 and affordable sensors like DHT11, MQ-135, and ML8511. The system displays live data on temperature, humidity, CO_2 levels, and UV intensity through a built-in web dashboard. It's compact, easy to use, and ideal for personal or small-scale environments.

MATERIALS USED

Component - Description
ESP32 Dev Board - WiFi-enabled microcontroller
DHT11 Sensor   -   Measures temperature & humidity
MQ-135 Sensor   -   Detects air quality and CO_2 presence
ML8511 UV Sensor   -   Measures UV radiation intensity
Jumper Wires, Breadboard As needed   For connections and prototyping

METHODOLOGY

- SENSORS (DHT11, MQ-135, ML8511) ARE CONNECTED TO THE ESP32 AND INITIALIZED.
- MQ-135 IS CALIBRATED TO ESTIMATE CO_2 ACCURATELY.
- ESP32 COLLECTS DATA AT INTERVALS AND CONNECTS TO WIFI.
- A WEB SERVER RUNS ON THE ESP32, SERVING A LIVE HTML DASHBOARD.
- DATA AUTO-REFRESHES EVERY 5 SECONDS.
- DASHBOARD IS ACCESSIBLE VIA ESP32'S IP ON ANY DEVICE IN THE SAME NETWORK.
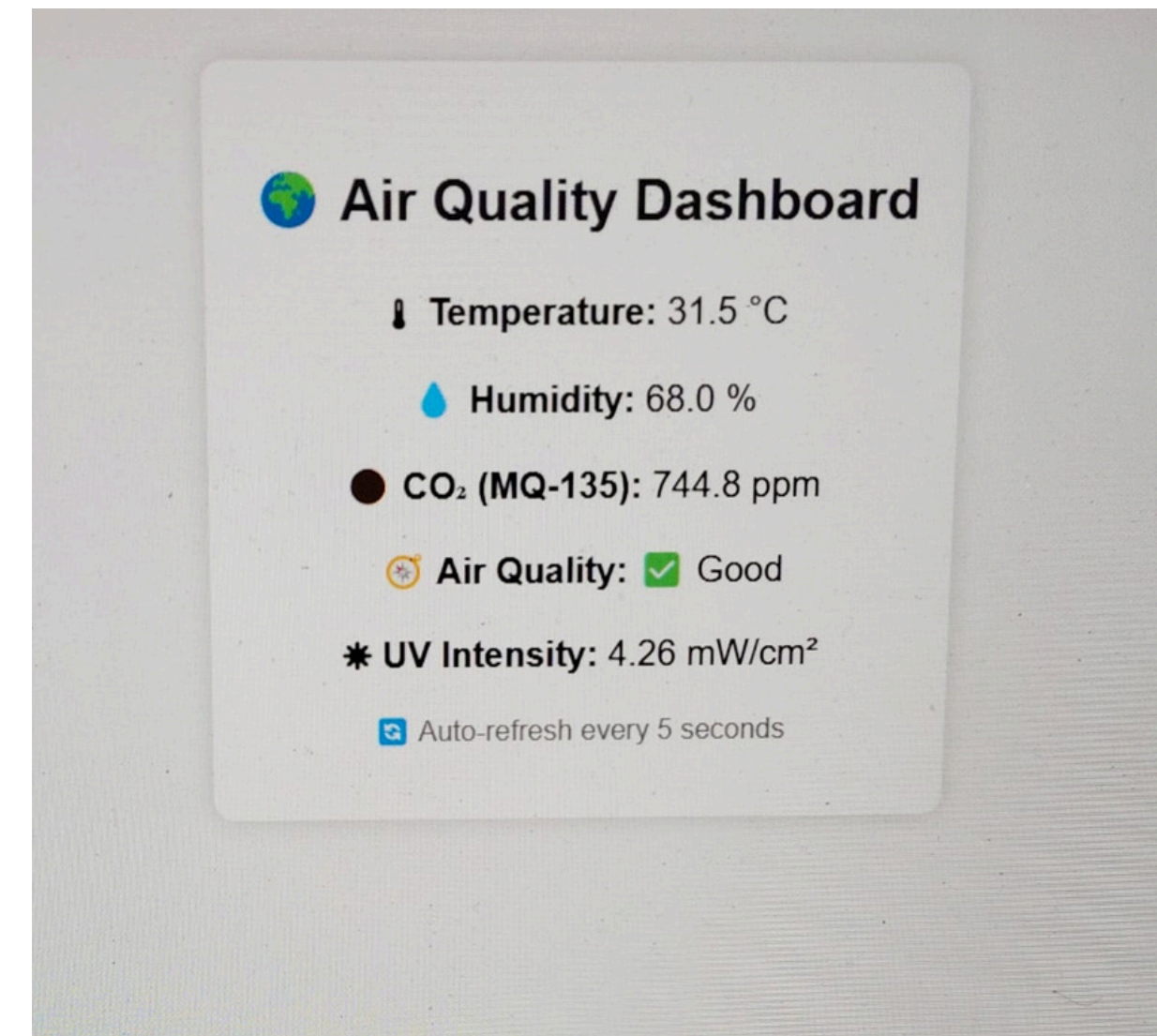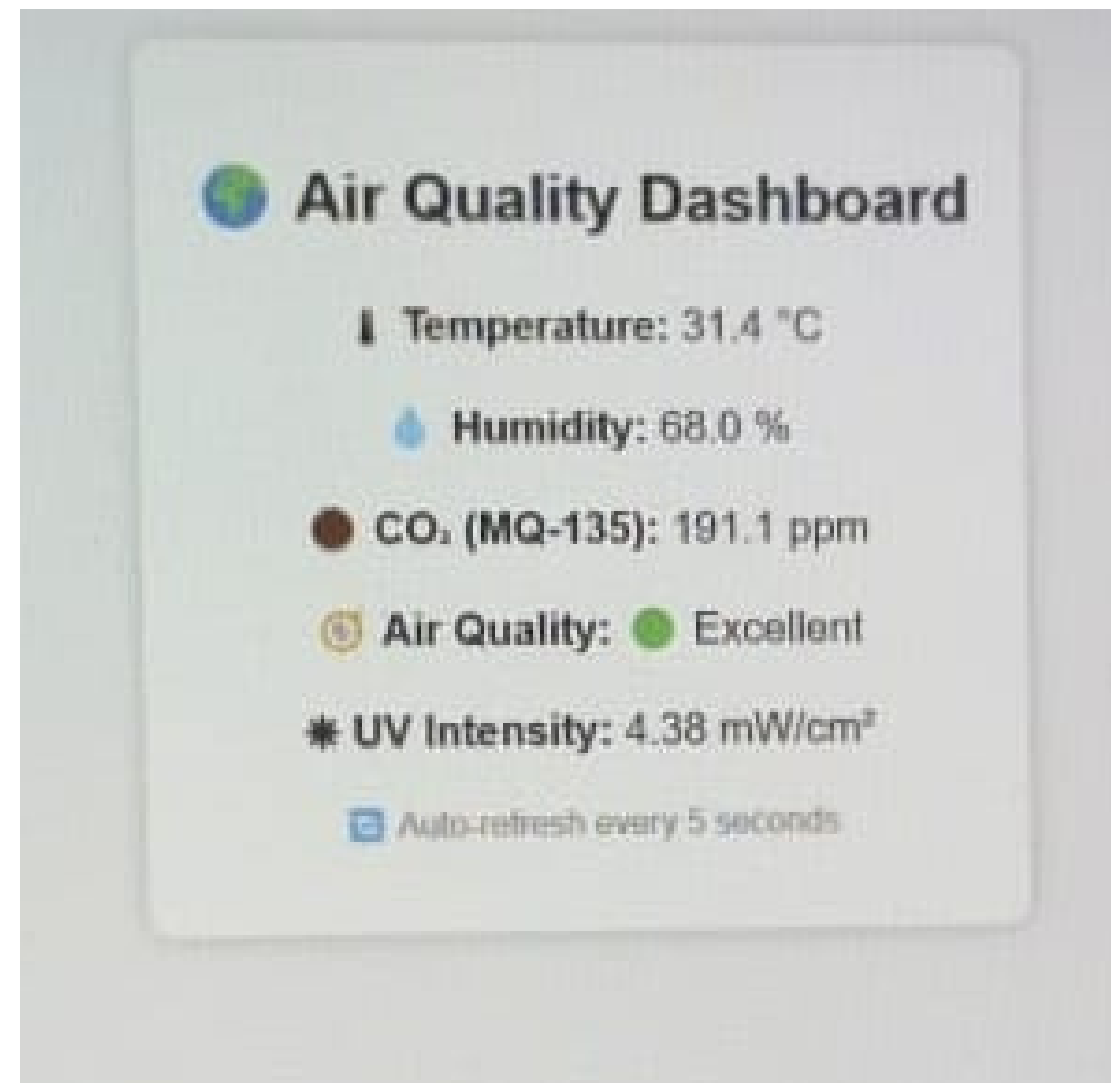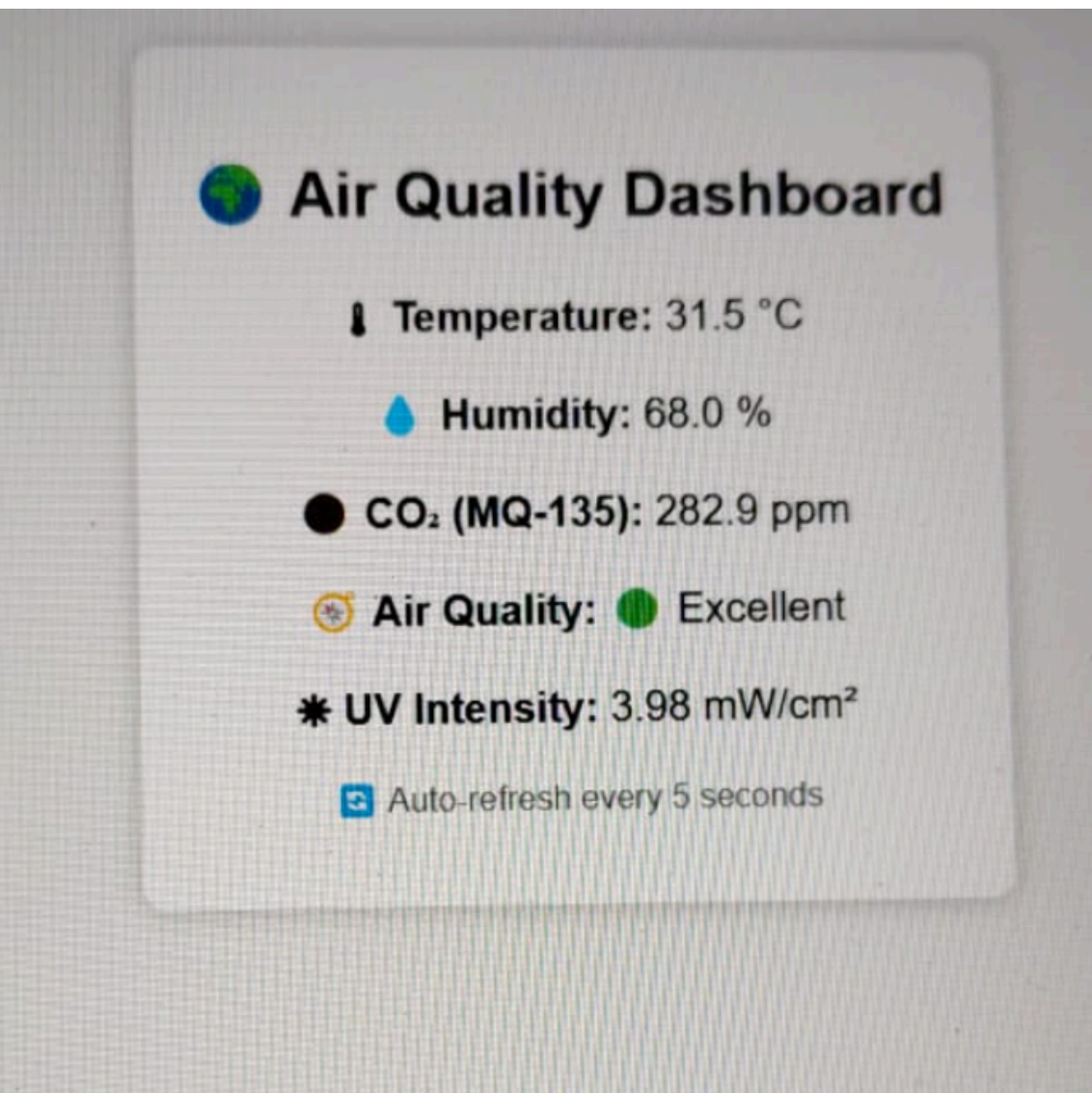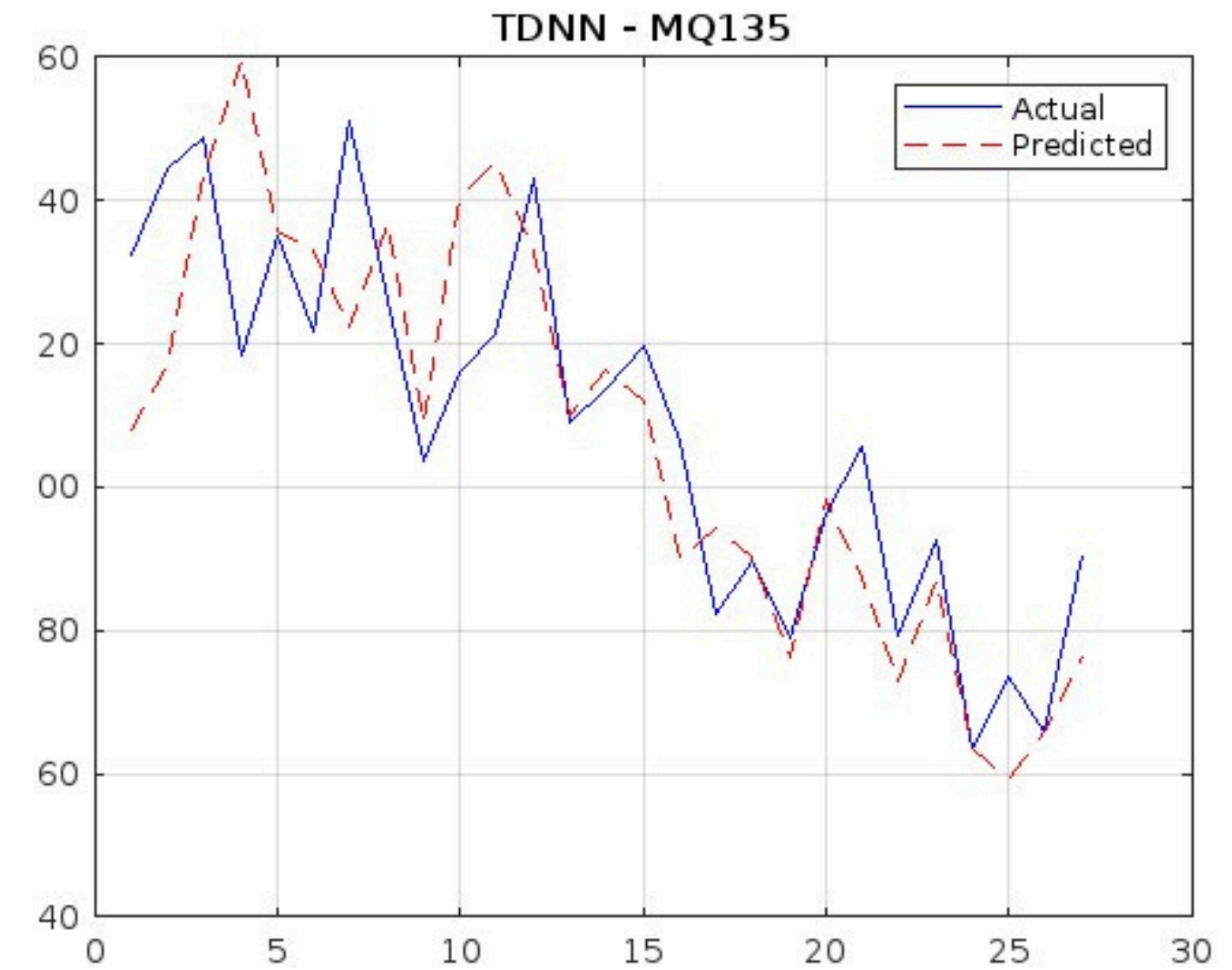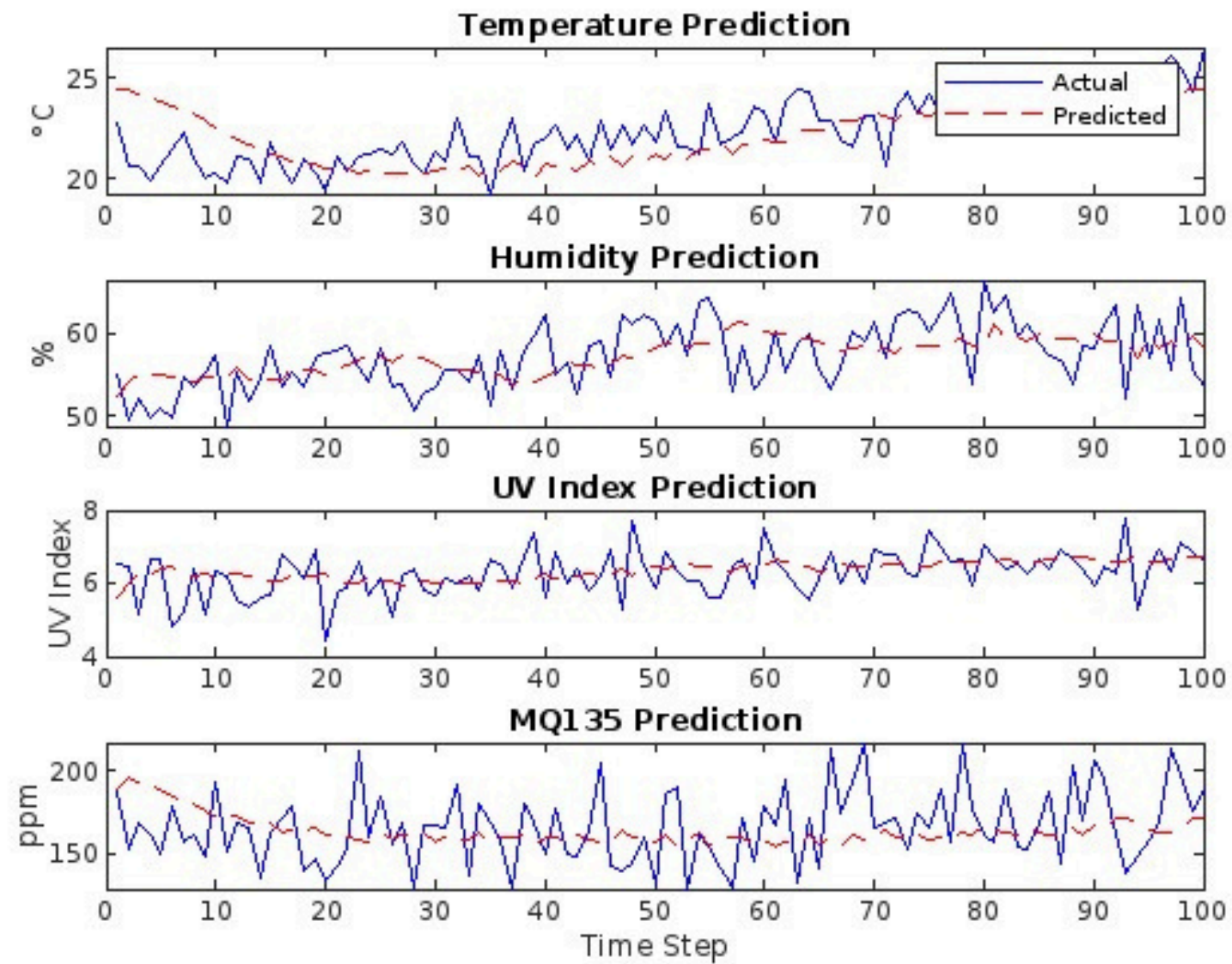
IMPLEMENTATION

- Real-Time Air Monitoring – Continuously tracks temperature, humidity, CO_2, and UV to promote environmental awareness.
- Detection of Harmful Gases – The MQ-135 sensor identifies elevated levels of gases like CO_2, smoke, and LPG. This can help in detecting potential gas leaks or early signs of fire, especially in closed environments like kitchens or labs.
- WiFi-Enabled Dashboard – A live web dashboard, accessible via any device on the same network, auto-refreshes every 5 seconds for seamless real-time updates.

RESULT

🌍 **Air Quality Dashboard**

🌡 Temperature: 31.5 °C

💧 Humidity: 68.0 %

⚫ CO_2 (MQ-135): 282.9 ppm

⏱ Air Quality: 🟢 Excellent

✳ UV Intensity: 3.98 mW/cm²

🔄 Auto-refresh every 5 seconds

🌍 **Air Quality Dashboard**

🌡 Temperature: 31.4 °C

💧 Humidity: 68.0 %

⚫ CO_2 (MQ-135): 191.1 ppm

⏱ Air Quality: 🟢 Excellent

✳ UV Intensity: 4.38 mW/cm²

🔄 Auto-refresh every 5 seconds

🌍 **Air Quality Dashboard**

🌡 Temperature: 31.5 °C

💧 Humidity: 68.0 %

⚫ CO_2 (MQ-135): 744.8 ppm

⏱ Air Quality: ✅ Good

✳ UV Intensity: 4.26 mW/cm²

🔄 Auto-refresh every 5 seconds

TDNN - UV

COMPARISION

Model	Memory	Time-Series Friendly	Training Time	Accuracy	Best For
FNN	No	No	Fast	~80–85%	Static or simple data
TDNN	Short-term	Yes (with delays)	Medium	~85–90%	Short sequence trends
LSTM	Long-term	Yes (inherently)	Slow	~90–95%	Complex time-series prediction

CONCLUSION

THIS PROJECT EFFICIENTLY SHOWCASES A LOW-COST, COMPACT AIR QUALITY MONITORING SYSTEM USING THE ESP32 AND LOW-COST SENSORS. IT PROVIDES REAL-TIME TEMPERATURE, HUMIDITY, CO_2, AND UV LEVEL INFORMATION IN AN INTUITIVE WEB DASHBOARD. ALONG WITH ENVIRONMENTAL AWARENESS, THE SYSTEM CAN ALSO BE USED AS AN EARLY WARNING FOR HAZARDOUS LEVELS OF GAS—RENDERING IT A GREAT ASSET FOR HOMES, SCHOOLS, AND SMALL LABS. WITH RELIABLE OPERATION AND EASY ACCESS, IT IS A HELPFUL STEPPING STONE TO INTELLIGENT, SECURE SPACES.

THANK YOU