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AI BASED SMART INDOOR AIR QUALITY PREDICTION AND MONITORING SYSTEM

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Abstract: Indoor Air Quality (IAQ) greatly affects health, comfort, and sustainability in modern spaces. This project introduces an AI-powered Indoor Air Wellness System that uses Kalman Filter and LSTM algorithms to predict and monitor air quality in real time. Sensors for CO_2, CO, NO_2, temperature, humidity, and light work with an ESP32 microcontroller to process and share data via LCD, ThingSpeak, and Telegram. A solar-powered fan system replaces traditional HVAC, promoting energy efficiency and eco-friendly air circulation. By combining AI, IoT, and renewable energy, the system offers a smart and sustainable way to maintain healthy indoor environments.

Keywords: Indoor Air Quality (IAQ), AI, Kalman Filter, LSTM, ESP32, IoT, Smart Monitoring, Renewable Energy, Energy Efficiency, Sustainability

I. INTRODUCTION

AI-Based Indoor Air Purification and Quality Control System uses Kalman Filter and LSTM algorithms to monitor and predict indoor air quality accurately. The Kalman Filter minimizes sensor noise, while LSTM forecasts future pollutant levels. Data from CO_2, CO, NO_2, DHT11, and LDR sensors is processed via an ESP32 microcontroller and displayed on an LCD, LED, and online platforms like ThingSpeak and Telegram. A solar-powered smart fan ensures efficient air circulation, reducing energy consumption. Integrating AI, IoT, and renewable energy, this system provides a sustainable solution for maintaining healthy and efficient indoor environments.

II. METHODOLOGY

The smart environmental prediction and monitoring system operates through continuous sensing, intelligent data processing, and automated response. A network of sensors—CO, CO_2, NO_2, DHT11 (temperature and humidity), and LDR—collects real-time environmental data. This information is transmitted to the ESP32 microcontroller, which acts as the system's core processor. The ESP32 filters and compares data against predefined thresholds, making decisions accordingly. When unsafe gas levels are detected, it activates a buzzer and updates readings on the LCD display for immediate awareness.

For maintaining optimal air conditions, the system uses a relay module to control a fan for ventilation and a servo motor to adjust vents precisely. These actions help maintain steady airflow and reduce pollutant accumulation. The IoT functionality enhances usability by sending alerts and updates via Telegram, allowing users to monitor air quality remotely. Additionally, sensor data is uploaded to the ThingSpeak cloud, enabling storage, visualization, and further analysis for performance tracking and research.

Machine learning is integrated into the system to enable intelligent prediction and adaptive control. The ML Prediction module uses both real-time and historical sensor data to train models capable of forecasting air quality trends. This predictive approach allows the system to act proactively, improving ventilation or issuing warnings before unsafe conditions occur. Overall, the system combines real-time sensing, smart control, remote access, and predictive analytics for efficient, automated indoor air quality management.

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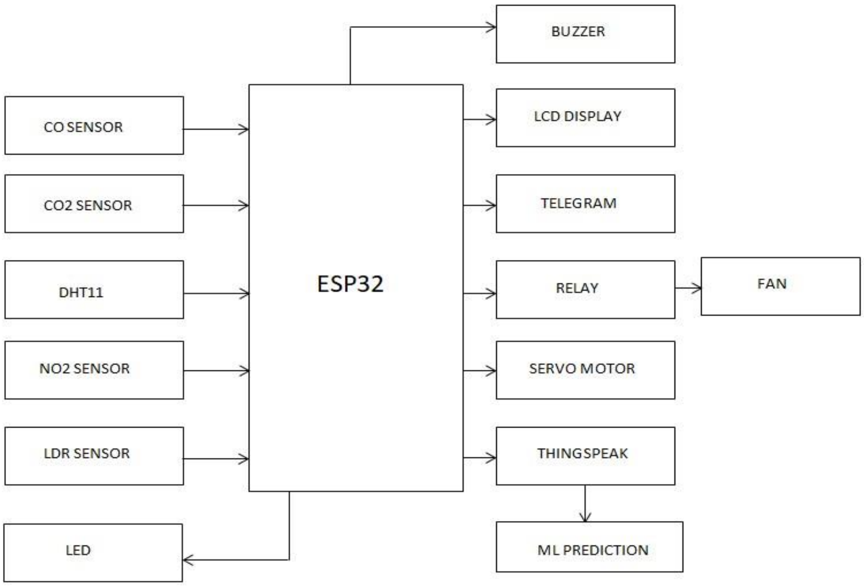

Figure 1: Block Diagram of AI Based Smart Indoor Air Quality Prediction And Monitoring System

III. IMPLEMENTATION

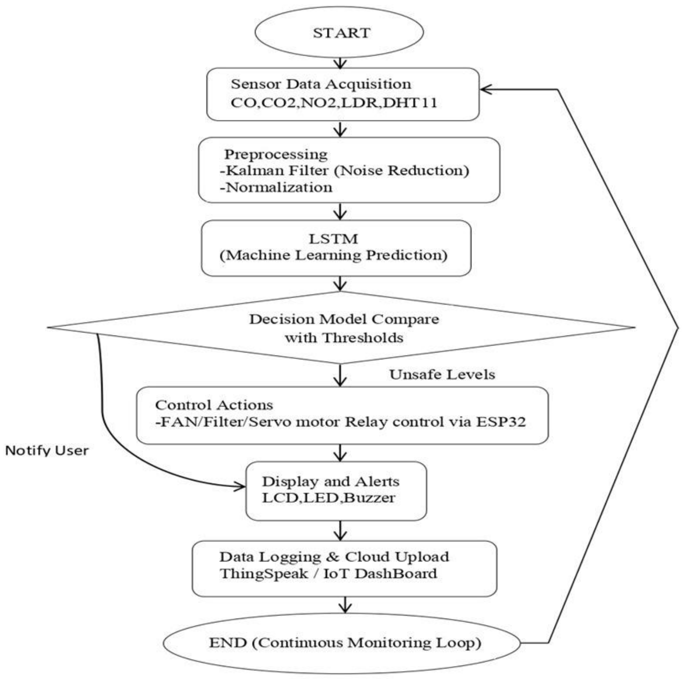

Figure 2: Implementation steps of AI Based Smart Indoor Air Quality Prediction And Monitoring System

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IV. RESULT

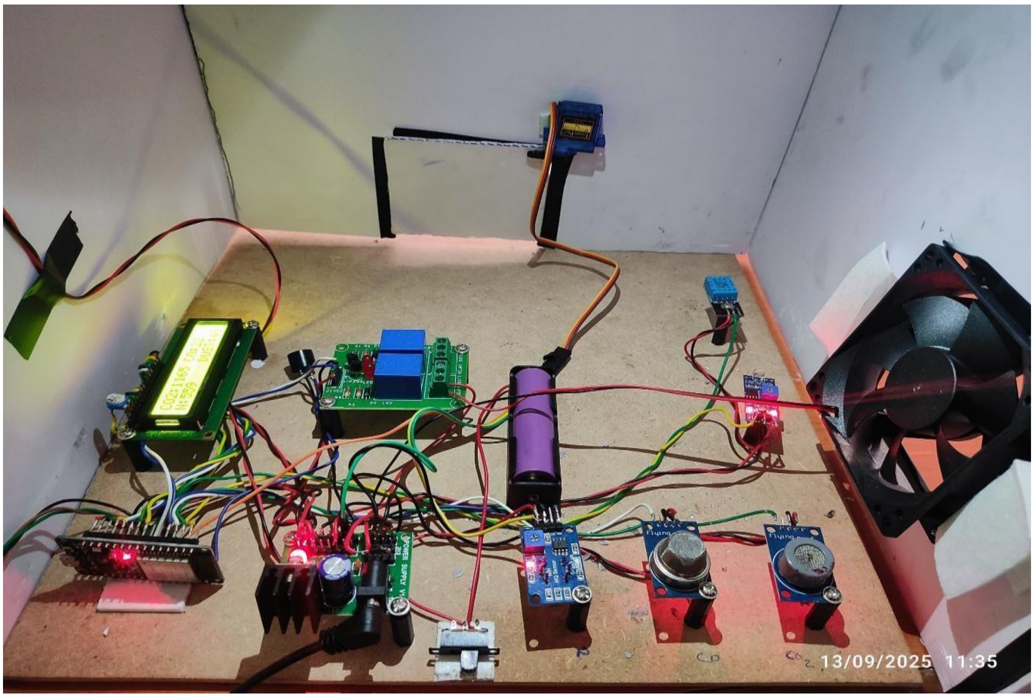

Figure 3 : Working Model

Figure 4: CO2, CO, N & Dust Detection

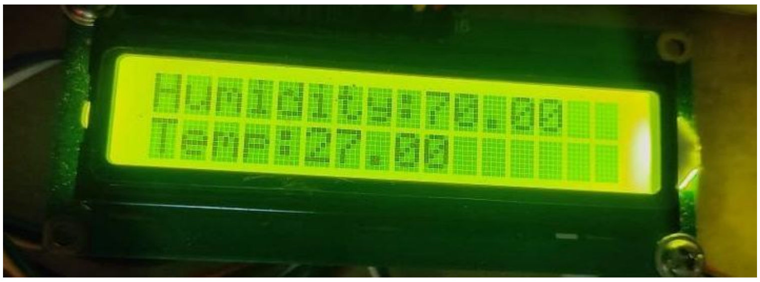

Figure 5: Humidity and Temperature Detection

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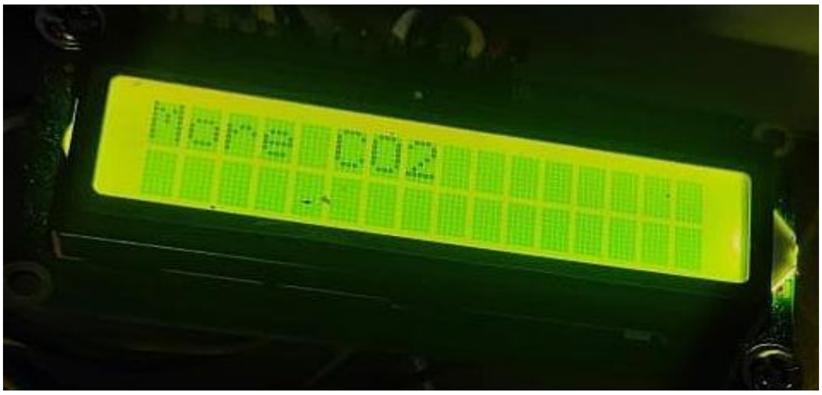

Figure 6: More CO2 detected

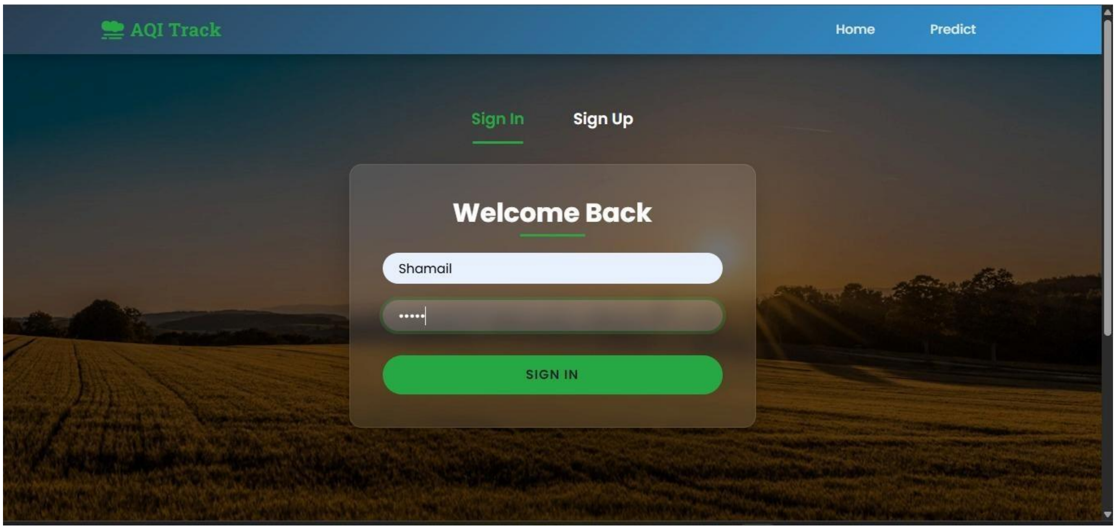

Figure 7: AQI Track sign in page

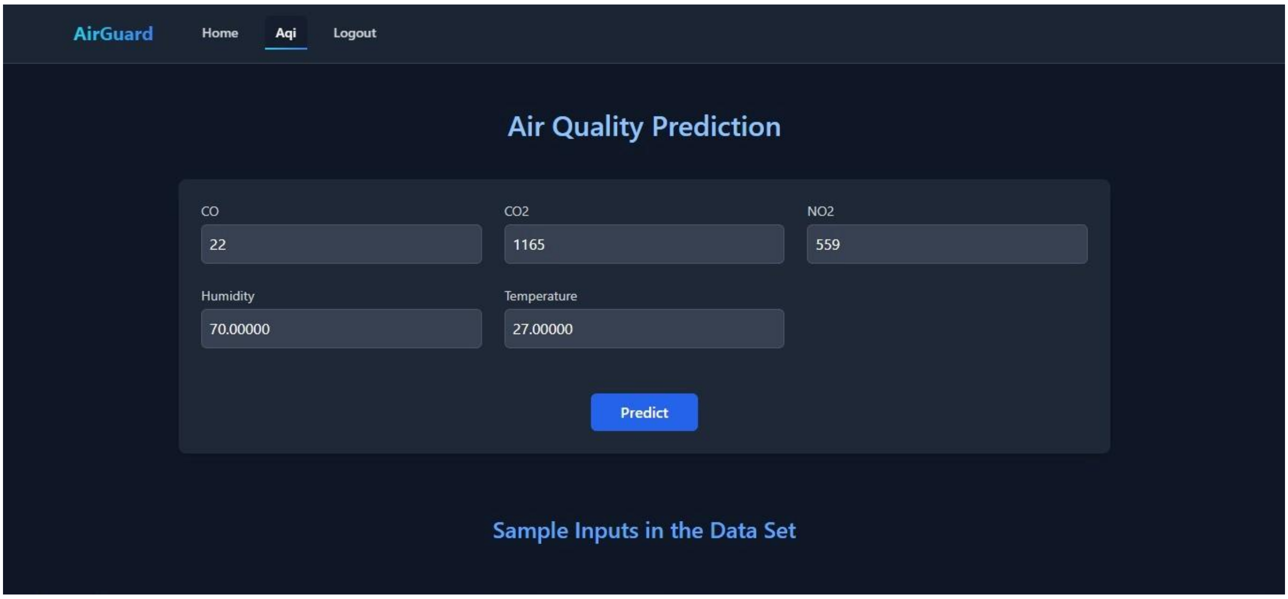

Figure 8: Air Quality Prediction

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Figure 9: Air Quality Index

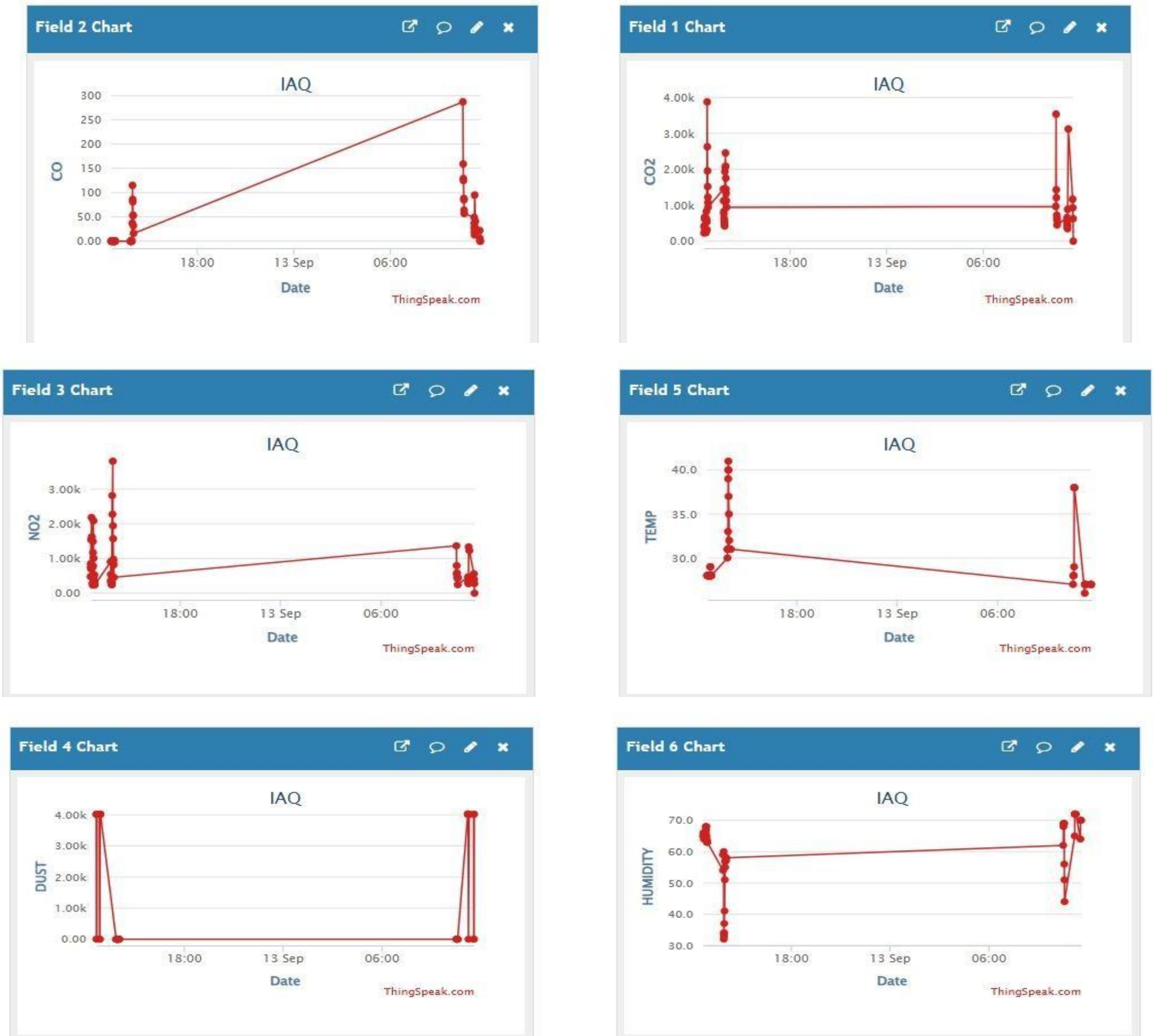

Figure 10: Graphical representation of all the parameters in ThingSpeak

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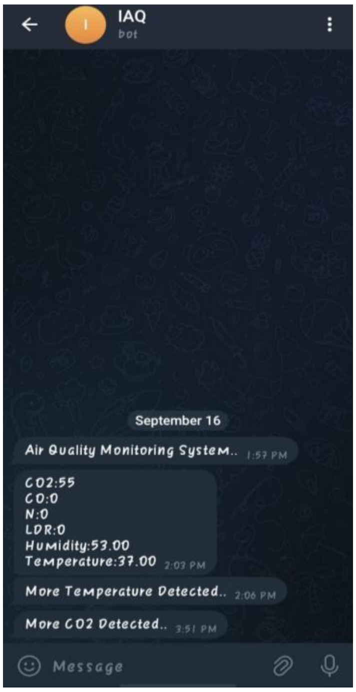

Figure 11: Telegram alert

V. CONCLUSION

The AI-Based Smart Indoor Air Quality Prediction and Monitoring System offers a practical solution for keeping indoor spaces healthy. The system constantly monitors temperature, humidity, and pollutant levels. It also predicts air quality trends using machine learning. Real-time visualization through ThingSpeak and instant alerts via Telegram make it easy for users to engage with.

With features like Kalman filtering for precision and automatic fan activation for ventilation, the model responds quickly to poor air conditions. It combines IoT and AI to provide a smart, reliable, and energy-efficient method for managing indoor air.

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