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INTELLEVENT ADAPTIVE FAN CONTROLLER

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Abstract - This paper presents an IntelliVent Adaptive Fan Control system that automatically controls fan speed according to room occupancy and temperature conditions. IR Sensor Module sensors are used to detect the number of people entering and leaving the room, while the DHT11 monitors room temperature continuously. The ESP32 processes the sensor data and controls the fan automatically for better comfort and energy efficiency. The system also includes a 16x2 LCD to display real-time information such as people count and temperature. A Piezo Buzzer is used for alert conditions when temperature exceeds a certain limit. Additionally, a Wi-Fi-based web dashboard provides remote monitoring and control. The proposed system reduces energy consumption, improves smart automation, and demonstrates an effective IoT-based solution for modern indoor environments.

***Keywords*:** IoT, Smart fan control, ESP32, Crow Temperature Monitoring, IR Sensor Module DHT 11, Smart Automation, Web dashboard.

I. Introduction

In today's modern world, energy conservation and smart automation have become important requirements in homes, classrooms, offices, hospitals, and other indoor environments. Most traditional fan systems operate manually without considering room occupancy or temperature conditions. As a result, fans often continue running unnecessarily even when very few people are present, leading to excessive

management. Manual control systems also reduce user comfort because fan speed is not adjusted automatically according to environmental conditions. With the rapid growth of IoT and embedded system technologies, smart automation systems are becoming increasingly popular for improving efficiency, comfort, and energy saving. IoT based systems allow electronic devices to monitor real-time conditions, process data intelligently, and control appliances automatically. Smart environmental control systems are widely used in modern buildings to reduce human effort and optimize energy utilization.[1][3]

II. Literature Review

Various research papers, journals, and existing IoT-based automation systems related to smart environmental control and energy management were studied during the development of this project. Existing smart fan systems mainly focus on automatic fan control using temperature sensing techniques, while some systems use occupancy detection methods for energy saving. However, most traditional systems do not combine both crowd density monitoring and temperature monitoring for intelligent fan control. Several studies based on ESP32 and IoT technology were reviewed to understand real-time monitoring, wireless communication and automation techniques. Research on IR sensor-based people counting systems was also studied to understand occupancy detection methods used in smart indoor applications. These systems help in maintaining accurate crowd count and improving energy efficiency.

Literature related to temperature monitoring systems using DHT11 was reviewed to analyze low-cost and efficient environmental sensing methods. Existing smart monitoring systems also use LCD displays and web dashboards for real-time visualization of system parameters and remote monitoring through IoT platforms from the literature survey, it was observed that many systems focus only on temperature-based fan control or only on occupancy monitoring. Very few systems integrate both parameters into a single automated solution. Therefore, the IntelliVent Adaptive Fan Control project combines occupancy detection, temperature monitoring, automatic fan control, LCD display, buzzer alerts, and Wi-Fi dashboard monitoring into one integrated IoT-based smart automation system for improved comfort and energy conservation.[1][3][5][7]

I. System Architecture

The proposed IntelliVent Adaptive Fan Control system is organized into different functional units for automatic monitoring and fan control.

A. Sensing Unit

The sensing unit consists of two IR Sensor Module sensors and one DHT11. The IR sensors are placed at the entrance to detect people entering and leaving the room and maintain real -time crowd count. The DHT11 sensor continuously measures room temperature and sends the data to the controller for processing.[1]

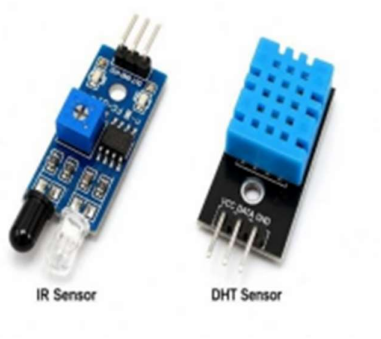

Fig1: IR & DHT11 Sensor

B. Processing Unit

The ESP32 acts as the main processing unit of the system. It receives input data from the IR sensors and DHT11 sensor, processes the crowd density and temperature values, and controls the fan operation according to predefined conditions. The ESP32 also handles Wi-Fi communication. The ESP32 continuously monitors the data received from the sensors and performs intelligent decision-making to maintain proper environmental comfort inside the room. Based on real-time occupancy count and temperature conditions, the controller dynamically adjusts the fan speed to ensure efficient cooling while minimizing unnecessary power consumption. Its high processing capability and built-in Wi-Fi support make the system more reliable, energy-efficient, and suitable for modern IoT-based automation applications.[1]

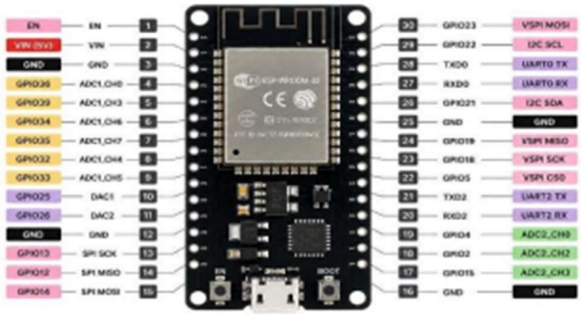

Fig2: ESP32 Module

C. Actuation Unit

A MOSFET driver circuit is used as the actuation unit to control the DC fan safely. Based on the signals generated by the ESP32, the MOSFET adjusts the fan operation automatically according to room occupancy and temperature condition.

D. Communication Layer

The communication layer is implemented using the built-in Wi-Fi feature of the ESP32. The system sends real-time sensor data, crowd count, temperature values, and fan status to a web dashboard for remote monitoring and IoT-based access.[5]

A. User Interface

The user interface includes a 16x2 LCD display and a Wi-Fi-based web dashboard for real-time monitoring and control. The LCD continuously displays important system parameters such as people count, room temperature, and fan speed, allowing users to monitor the environmental conditions easily. The web dashboard enables users to switch between automatic and manual control modes through a simple and user-friendly interface. A Piezo buzzer is also integrated into the system to provide warning indications whenever the room temperature exceeds the predefined threshold limit, thereby improving system safety and reliability. Additionally, the buzzer helps notify users during abnormal environmental conditions and ensures timely response for maintaining proper room comfort.

The IntelliVent Adaptive Fan Controller uses an ESP32 Wi-Fi dashboard for real-time monitoring and remote fan control. The dashboard displays crowd count, temperature, Fan, speed, and fan status, while allowing user to switch between automatic and manual control modes through a simple interface.[2]

III. Methodology

The IntelliVent Adaptive Fan Control system follows an IoT-based smart automation methodology for automatic fan speed control according to crowd density and room temperature

conditions. Initially, the ESP32 initializes all connected sensors, display modules, and control units. Two IR Sensor Module sensors are placed at the entrance to detect people entering and leaving the room and maintain real-time crowd count. Simultaneously, the DHT11 continuously measures room temperature and sends the data to the ESP32 controller.

The ESP32 processes both occupancy and temperature data and compares the values with

predefined operating conditions. Based on these conditions, the controller automatically adjusts the fan operation through a MOSFET driver circuit to maintain a comfortable indoor environment and reduce unnecessary power consumption. A 16x2 LCD displays real-time information such as people count, room temperature, and fan status.

The system also includes a Wi-Fi-based dashboard for remote monitoring and control. Users can monitor fan speed, crowd count, and temperature in real time and operate the fan in both automatic and manual modes through the dashboard interface. [1][2][4][6].

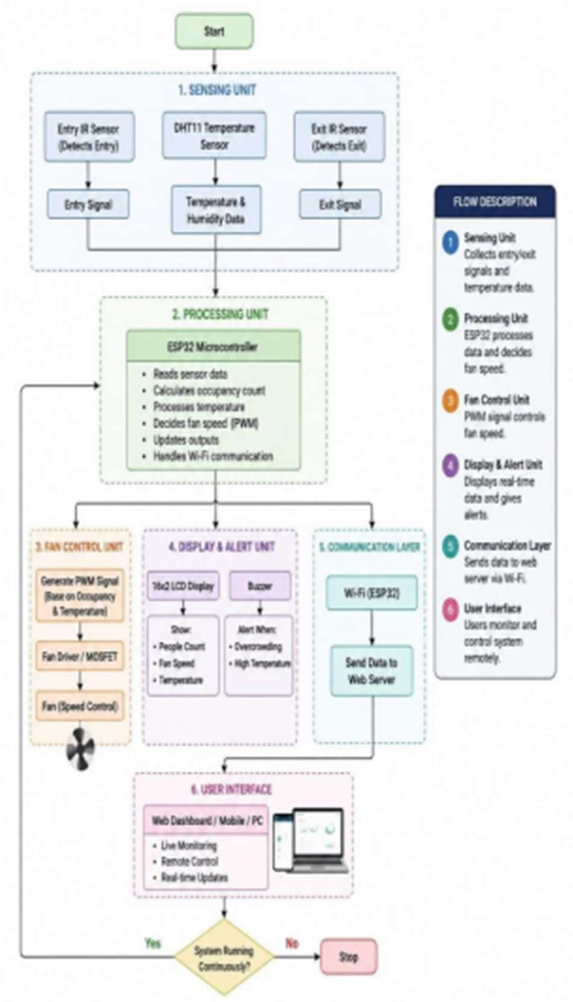

Fig3: Working Flow

III. Implementation

The implementation of the IntelliVent Adaptive Fan Control system is carried out using IoT and embedded system technologies for automatic environmental control. The hardware setup consists of two IR Sensor Module sensors, DHT11, ESP32, MOSFET driver circuit, DC fan, 16x2 LCD, and Piezo Buzzer connected according to the system architecture.

Initially, all sensors and modules are interfaced with the ESP32 using GPIO pins. The IR sensors are used to detect people entering and leaving the room, while the DHT11 sensor continuously monitors room temperature. The ESP32 processes the sensor data and automatically controls the fan operation according to crowd density and temperature conditions through the MOSFET driver circuit.

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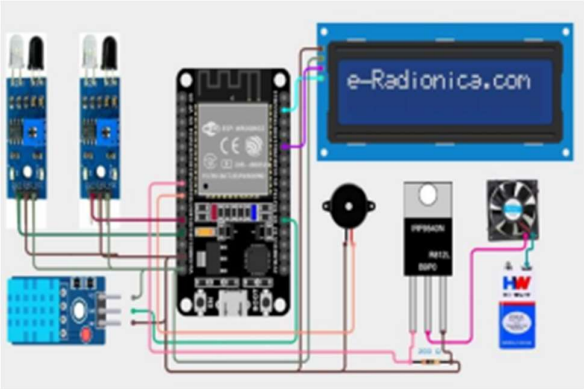

Fig4: Circuit Diagram

The LCD module displays real-time information such as crowd count, temperature, and fan speed. The buzzer activates whenever the temperature exceeds the predefined limit. The system also includes a Wi-Fi-based dashboard that allows users to monitor and control fan speed in both automatic and manual modes remotely. The complete system is tested under different environmental conditions to verify accurate monitoring, automatic control and energy -efficient operation.[1]

IV. Result & Discussion

1. Automatic Crowd Detection

The system successfully detects people entering and leaving the room using two IR Sensor Module sensors and maintains real-time crowd count accurately.

2. Temperature Monitoring Performance

The DHT11 continuously monitors room temperature and provides stable real-time temperature data to the system.

3. Automatic Fan Control

The ESP32 automatically controls fan operation according to crowd density and temperature conditions for better comfort and smart automation.

4. Real-Time Display and Monitoring

The 16x2 LCD and Wi-Fi dashboard display crowd count, temperature, fan status, and fan speed in real time for easy monitoring.

Fig5: User Interface

5. Energy Efficiency

The system reduces unnecessary fan operation and improves power efficiency through automatic control based on real-time environmental conditions.[7]

III. Future Scope

The IntelliVent Adaptive Fan Control system can be further improved by integrating advanced technologies such as artificial intelligence and machine learning for smarter environmental control. A dedicated mobile application can also be developed for easier remote monitoring and fan control through smartphones. In future, advanced occupancy detection methods such as camera-based or AI-based monitoring can replace IR sensors for improved accuracy. The system can also be integrated with smart home platforms and voice assistants for fully automated operation.

Cloud storage and data analysis features may be added for better energy management and performance monitoring. Additionally, the project can be implemented in classrooms, offices, hospitals, auditoriums, and smart buildings for large-scale smart environmental automation.

IV. Conclusion

The IntelliVent Adaptive Fan Control system successfully demonstrates an IoT-based smart automation solution for automatic fan control using crowd density and temperature monitoring. The system effectively uses IR Sensor Module sensors for people counting, DHT11 for temperature monitoring, and the ESP32 for intelligent processing and control. The project improves energy efficiency and user comfort by automatically adjusting fan operation according to

room conditions. Furthermore, the system reduces unnecessary power consumption and provides a cost-effective, eco-friendly solution. Overall, the IntelliVent system demonstrates the importance of intelligent automation in creating energy-efficient and user-friendly environments.

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