TEMPERATURE CONTROLLED FAN

Omkar Shete, Viyan Shetty, Aaryan Shinde, Harshvardhan Shinde, Mansi Shinde & Megha Shinde

Abstract — (in 250 words)
This project introduces an automated smart fan system that adjusts its speed based on ambient temperature. Manual adjustment of fan speed is often inconvenient and energy-inefficient, especially in varying climatic conditions. This system utilizes a temperature sensor (LM35/DS18B20) interfaced with NodeMCU ESP8266, using Pulse Width Modulation (PWM) for controlling fan speed based on sensed temperature. The fan speed increases or decreases depending on the measured temperature, with the system also supporting IoT capabilities through mobile phone integration for remote monitoring and control. The display module (LCD/OLED) shows real-time temperature and fan speed. The device proves to be energy-efficient, user-friendly, and scalable, applicable in homes, offices, or industrial environments. The main advantage of this design is its ability to minimize power usage while maintaining thermal comfort. Additional features such as Wi-Fi-based switching and optional AC load control extend its usefulness as part of a smart environment.

Keywords — Temperature Controlled Fan, ESP8266, PWM (Pulse Width Modulation), IoT, NodeMCU, LM35, DS18B20, Smart Home

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I. INTRODUCTION

II. In the fast-changing technological environment of today, there is increasing demand for automation and energy-saving measures across industries, especially in home automation. In home electrical appliances, cooling products like fans are crucial in ensuring thermal comfort, particularly in tropical climates with hot and humid conditions. Apart from being more cost-effective than air conditioners, fans are also popularly used because they are simple and consume less energy. But the conventional approach of controlling fan speed manually through regulators or switches is usually cumbersome, wasteful, and incompatible with the ideals of a smart and energy-efficient living space.

III. One of the most significant limitations of traditional fans is their failure to adjust room temperature automatically

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in response to variable room conditions. Consequently, users tend to forget to switch off or reduce fan speed in line with ambient conditions, generating discomfort or consuming unnecessary energy. For example, at night, when the ambient temperature is low, excessive fan speed can be uncomfortable, and during business hours of the day, low fan speed can be insufficient to deliver comfort. This problem can be resolved by means of a system that automatically adapts to changes in the environment without anyone's assistance.

IV. In order to overcome this obstacle, the present project suggests the fabrication of an IoT-based temperaturecontrolled smart fan. The device combines a temperature sensor (LM35 or DS18B20) with an Internet-enabled microcontroller (NodeMCU ESP8266) so that ambient temperature can be sensed in real-time and fan speed controlled intelligently using Pulse Width Modulation (PWM). This makes the fan rotate at a speed directly proportional to the sensed temperature, thereby maximizing user comfort as well as energy efficiency.

V. Additionally, the addition of IoT functionality allows users to remotely control and monitor the fan via web or smartphone application. This remote monitoring feature adds more convenience, particularly in smart homes with several appliances controlled by integrated systems. The system is cost-effective, user-friendly, and can be made suitable for multiple environments like homes, offices, hospitals, and classrooms.

VI. In short, the envisioned smart fan system not only solves the drawbacks of conventional fan control but also is consistent with the prevailing trend toward smart automation by providing an intelligent, adaptive, and energy-efficient solution for daily cooling requirements.

VII. LITERATURE REVIEW

1. *G. Jamuna et al. (2024) developed a fan control system using an Arduino board and LM35 temperature sensor. Their work focused on adjusting fan speed using PWM (Pulse Width Modulation) based on real-time temperature readings. The system also included mobile application control using the Blynk platform, allowing users to override automatic control manually. The implementation demonstrated how*

low-cost components could be integrated to provide both automation and remote accessibility. However, limitations were noted in terms of power optimization and scalability.

2. *Keertheghaa S. et al. (2025) presented a hybrid controller that adjusts both fan and AC load operation based on ambient and body temperature. Using the DS18B20 sensor and NodeMCU ESP8266, the project focused on enhancing personal comfort by considering multiple temperature points (such as room temperature and body temperature). The system demonstrated versatility but added complexity in terms of sensor calibration and code logic.*

3. *G. Joga Rao et al. (2018) proposed a temperaturecontrolled fan system utilizing the LM35 sensor, Arduino UNO, and the ESP8266 Wi-Fi module. Their design emphasized the use of the Ubidots cloud platform for IoT integration, which allowed remote switching of the fan. The fan speed was varied based on surrounding temperature conditions, with clear logic defined for different temperature ranges. Their work provided a foundational concept for integrating IoT in basic appliances, although the UI design and user interaction were minimal.*

4. *Vaibhav Bhatia and Gavish Bhatia (2013) implemented a fan control system using PWM, emphasizing the importance of smooth speed variation. Their work explored multiple control algorithms and compared PWM efficiency against traditional analog methods. Though it lacked IoT integration, the study contributed to understanding the effectiveness of PWM in fan control systems and highlighted its energy efficiency advantages.*

5. *J. Holtz (1992) conducted a comprehensive survey on Pulse Width Modulation and its applications in industrial electronics. His work is foundational in understanding PWM theory, control methods, and modulation strategies. It supports the technical feasibility of implementing PWM in microcontroller-based systems for motor and fan speed control.*

These studies collectively demonstrate the evolution of fan speed control systems from manual methods to smart, automated solutions leveraging sensors, microcontrollers, and IoT. They underline the potential of low-cost embedded systems to improve energy efficiency and user comfort. However, they also reveal certain gaps—such as the need for enhanced user interfaces, more robust sensor networks, and integration with modern smart home ecosystems—which the proposed system aims to address.

VIII. METHODOLOGY

IX. In the fast-changing technological environment of today, there is increasing demand for automation and energy-saving measures across industries, especially in home automation. In home electrical appliances, cooling products like fans are crucial in ensuring thermal comfort, particularly in tropical climates with hot and humid conditions. Apart from being more cost-effective than air conditioners, fans are also popularly used because they are simple and consume less energy. But the conventional approach of controlling fan speed manually through regulators or switches is usually cumbersome, wasteful, and incompatible with the ideals of a smart and energy-efficient living space.

X. One of the most significant limitations of traditional fans is their failure to adjust room temperature automatically in response to variable room conditions. Consequently, users tend to forget to switch off or reduce fan speed in line with ambient conditions, generating discomfort or consuming unnecessary energy. For example, at night, when the ambient temperature is low, excessive fan speed can be uncomfortable, and during business hours of the day, low fan speed can be insufficient to deliver comfort. This problem can be resolved by means of a system that automatically adapts to changes in the environment without anyone's assistance.

XI. In order to overcome this obstacle, the present project suggests the fabrication of an IoT-based temperaturecontrolled smart fan. The device combines a temperature sensor (LM35 or DS18B20) with an Internet-enabled microcontroller (NodeMCU ESP8266) so that ambient temperature can be sensed in real-time and fan speed controlled intelligently using

Pulse Width Modulation (PWM). This makes the fan rotate at a speed directly proportional to the sensed temperature, thereby maximizing user comfort as well as energy efficiency.

XII. Additionally, the addition of IoT functionality allows users to remotely control and monitor the fan via web or smartphone application. This remote monitoring feature adds more convenience, particularly in smart homes with several appliances controlled by integrated systems. The system is cost-effective, user-friendly, and can be made suitable for multiple environments like homes, offices, hospitals, and classrooms.

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2. System Circuit Design

The design starts by interfacing the LM35/DS18B20 sensor with the NodeMCU. For LM35, the analog output is connected to the NodeMCU's ADC pin, while DS18B20 uses a digital GPIO pin. The sensor is powered with 5V and grounded appropriately.

The fan is connected to the 12V supply through the BD139 transistor. The base of the transistor is connected to a PWM-capable digital pin of NodeMCU via a resistor to limit current. A diode is placed parallel to the fan to protect against voltage spikes.

The display module is connected via I2C (SDA/SCL) pins, which makes it efficient in terms of wiring and code complexity.

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3. Software and PWM Logic

The control logic is written in the Arduino IDE using C++. The temperature value is continuously read and compared against preset thresholds.

The logic follows:

- *Below 28°C: Fan is turned off to conserve energy.*
- *Between 28°C – 35°C: Fan speed increases linearly with temperature.*
- *Above 35°C: Fan runs at full speed for maximum cooling.*

This is implemented using the analogWrite() function for PWM in Arduino IDE:

cpp CopyEdit

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int fanSpeed = map(temperature, 28, 35, 0, 255);
analogWrite(fanPin, fanSpeed);
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The code also includes functions to display the temperature and fan speed on the LCD/OLED and establish a Wi-Fi connection for remote operation using Blynk or Ubidots platforms.

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4. IoT Integration

Using the ESP8266's Wi-Fi module, the device connects to a local network. The Blynk app or Ubidots dashboard is configured to allow users to remotely:

- *Turn the fan ON or OFF.*
- *Monitor live temperature.*
- *Check current fan speed.*

This adds an extra layer of control and monitoring, ideal for smart home ecosystems.

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5. Testing and Calibration

Before full implementation, the system was simulated in Proteus to ensure proper circuit functionality. Post simulation, the hardware prototype was built and tested in real conditions.

Calibration of temperature sensors was done using a reference thermometer, and PWM signal behavior was tuned for smooth fan transitions.

This methodology ensures that the system is not only functional but also optimized for user comfort, energy saving, and modern connectivity.

XIV. Results and Discussions

Having designed and constructed the prototype of the temperature-regulated smart fan successfully, various tests were run to assess how it performs across different environmental conditions. The tests targeted the system's capacity for accurate temperature sensing, fan speed adjustment according to temperature, and smooth IoT control.

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1. Temperature-Based Speed Regulation The main aim of this system was to provide dynamic fan speed regulation based on real-time temperature reading.
The tests proved the following behaviors:
●\tBelow 28°C, the fan remained off, saving energy.

●\tWhen the temperature rose between 28°C and 35°C, the fan speed rose linearly, creating smooth transition and improving thermal comfort.

●\tAbove 35°C, the fan automatically ran at full speed (100%), offering maximum cooling.

This linear scaling was attained successfully through the use of PWM signals produced by the NodeMCU. The changes were smooth and showed no sudden transitions or jittering in fan speed, confirming the success of the control algorithm.

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2. Accuracy and Responsiveness of the Temperature Sensor Both DS18B20 and LM35 temperature sensors were compared. The DS18B20, being a digital sensor, gave more consistent and precise readings over time and was less prone to voltage noise. The LM35 was found adequate for simple use cases and had a quicker response time in open-air testing, although. Calibration was done with a digital thermometer for reference. The mean error margin was still within ±0.5°C, which is tolerable for lab use.

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3. Real-Time Feedback and User Interaction The 16x2 LCD and OLED units employed in various configurations gave immediate and readable feedback regarding:
●\tCurrent temperature

●\tFan speed percentage or PWM duty cycle

●\tSystem status (ON/OFF)

This enhanced user interaction and enabled users to check system performance without the requirement of a monitoring device.

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4. Remote Control Performance of IoT Combining Blynk and Ubidots platforms made it possible for the user to remotely control the system. Users were able to:

- Control fan ON/OFF using a smartphone application.
- Display real-time room temperature and fan speed.
- Override automatic control when necessary.

The ESP8266 Wi-Fi module was stable inside a typical home router's range. The action lag from app command input to system response was about 1–2 seconds, which is acceptable for such non-critical control.

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6. Limitations Observed

While the system functioned effectively, a few limitations were noted:

- *Dependency on Wi-Fi network for IoT features; in areas with poor connectivity, remote features may not function optimally.*
- *DS18B20 requires more precise coding and digital pin configurations, which may be slightly complex for beginners.*
- *The fan type must support PWM control. AC fans or low-quality motors may require additional interfacing or modification.*

Overall Analysis

The results confirm that the temperature-controlled fan system performs as expected and meets the design objectives. It adapts well to varying environmental conditions, reduces manual effort, saves energy, and enhances comfort. The integration of IoT makes the system more versatile and suitable for modern applications.

V. CONCLUSION

The temperature-controlled smart fan based on IoT offers a pragmatic, effective, and technologically pertinent solution for current cooling needs. By regulating the speed of the fan automatically according to ambient room temperature, the system avoids excess energy consumption while ensuring optimum user comfort. In contrast to traditional fans that involve manual speed adjustment, this automatic setup incorporates convenience and responsiveness into everyday use, qualifying it as a worthwhile addition to smart homes. The use of temperature sensors (LM35 or DS18B20) and the NodeMCU ESP8266 microcontroller provides real-time monitoring and intelligent speed adjustment through Pulse Width Modulation (PWM). In addition, the provision of integration with IoT platforms such as Blynk or Ubidots enables users to observe and regulate the fan remotely using mobile apps, improving accessibility and user convenience. The system is low-cost and simple to install yet scalable for use across multiple settings like homes, offices, schools, and hospitals. The modular approach makes it simple to add or integrate with additional smart systems like HVAC, automated lighting, or home assistants.

In the future, the system provides a few directions toward improvement and personalization. Future development can involve the integration of AI or machine learning algorithms into predictive climate control such that the system adapts to user preferences and changes operation accordingly. It can also be developed to enable AC-based fan support or interfacing with voice assistants such as Alexa or Google Home for hands-free use. Cloud-based logging and analytics can enable energy use patterns and enable further optimization and sustainability.

Essentially, this project shows that even basic embedded systems, when incorporated with IoT technology, can greatly improve the day-to-day appliances—rendering them smarter, more responsive, and energy-efficient.

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