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Smart Fan Temperature and Motion Detection

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Abstract

This project is to design and develop a " the microcontroller temperature based fan speed controller with motion sensor". This project will present the design, development, control and analysis that can be implemented for home automation system. The home automation system is PIC microcontroller based project which focused on a system to automatically control the speed of a ceiling fan according to the surrounding temperature and the motion sensor detects on human presence. This ceiling fan system and motion sensor contains combination of sensor, controller, driver and motor with integration of embedded controlled programming which means in this case using pic microcontroller as the main controller. This project also presents the expected performance of the automatic fan system and motion sensor, construction of hardware and software development to gather the performance data. Finally, this system performance will be analysed by comparing performance data to the theoretical. End of this project will produce an advance technology with programmable features which control the speed of the fan is depending on the changes in room temperature and the motion sensor detect the presence of a person.

1. Introduction

Manual fan operation in residential settings often leads to energy wastage and inconvenience, especially for elderly or disabled individuals. Traditional fan systems require manual switching and speed control, which is inefficient, particularly during night-time or fluctuating temperatures. Users frequently forget to switch off fans when leaving a room, contributing to unnecessary power consumption [1][2][3]. This project aims to overcome these limitations by developing a Smart Fan system that integrates DHT11 temperature and dual PIR motion sensors with an Arduino microcontroller to automate fan activation and speed control based on both ambient temperature and human presence. The fan operates at different speed levels low (>20°C), medium (>25°C), and high (>30°C) using PWM, and displays temperature, speed, and occupancy on an LCD[4]. Previous research supports this approach: Mashud et al. [5] introduced temperature-based fan control using PT-100, while Yusuf et al. [6] added PIR motion sensing for better efficiency. Singh et al. [2] highlighted the broader value of smart home automation systems, and proposed thermal sensors to improve human detection accuracy without relying solely on movement. Other works examined energy management through predictive control [4], fan-voltage relations [7], and sensor fusion strategies. Microcontrollers like Arduino have been proven effective for such control tasks due to their responsiveness and integration flexibility [8]. Meanwhile, DHT11 is widely adopted for its simplicity, low cost, and dual temperature-humidity sensing [9]. Compared to air conditioning, smart fan systems offer a more energy-efficient alternative for moderate climates [10]. Thus, this project enhances existing methods by combining occupancy-based control with environmental sensing to create an adaptive, user friendly, and energy efficient solution suitable for smart home applications.

2. Methodology

A very detailed plan is being implemented in order to realize this project as a finished product with safety features. In order to finish the Project on time, a step-by-step process is followed. This involves gathering information on the environment's temperature and a sample of people's presence.

2.1 Project Development

Fig. 1 shows the block diagram of the Smart Fan system, illustrating the flow of input from sensors to the output devices. The system receives inputs from the DHT11 temperature sensor and two PIR motion sensors. These inputs are processed by the Arduino Uno microcontroller, which then sends control signals to the LCD display and DC fan via the motor driver. This diagram plays a crucial role in visualizing the logical data flow and helps in understanding how different components interact within the system. The integration between sensor data and the control algorithm is vital for achieving automation and energy efficiency.

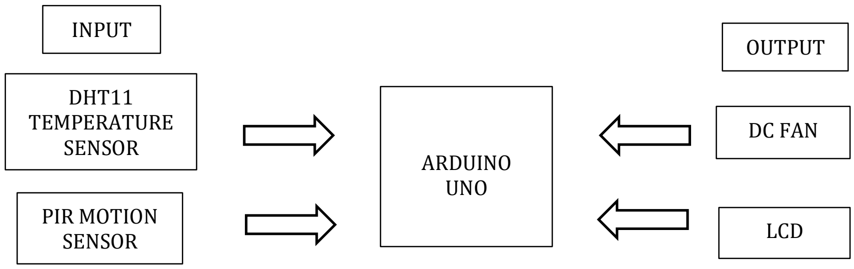

Fig. 1 *Block diagram of project operation*

2.2 Flowchart of the Project

Fig. 2 illustrates the logical flow of the system's operation. The flowchart begins with motion detection via PIR sensors, followed by temperature analysis. Based on the temperature range, specific decisions are made regarding the fan speed. For example, if the temperature is below 20°C, the fan remains off. As the temperature increases above certain thresholds, the system activates the fan at low, medium, or high speeds. This control logic ensures that the system operates only when both motion and temperature conditions are satisfied, enhancing energy conservation and automation reliability.

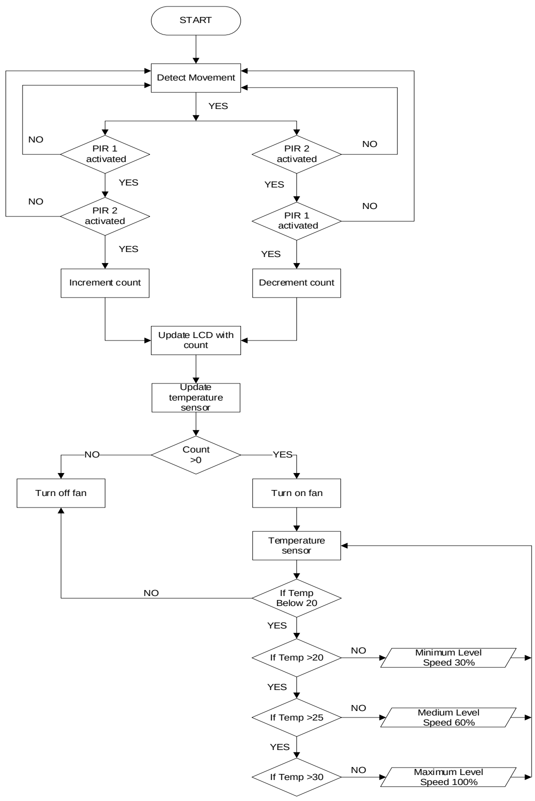

Fig. 2 *Flowchart of the project*

2.3 Schematic Circuit

Fig. 3 presents the full schematic circuit diagram of the smart fan system. It shows the actual hardware connections between the Arduino Uno, DHT11 sensor, dual PIR sensors, LCD, L298N motor driver, and DC fan. The PIR sensors are placed at strategic locations to detect entry and exit, updating the occupancy count. The fan speed is regulated through PWM signals sent from the Arduino to the motor driver. This schematic was used directly in the experimental prototype and accurately represents how the system was built and tested. The successful integration confirmed the circuit's design validity in real-world applications.

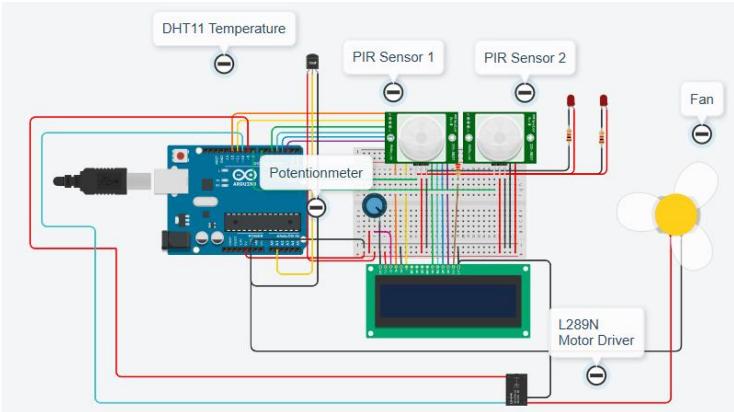

Fig. 3 *Schematic circuit*

3. Result and Discussion

This section presents the results obtained from the development and testing of the Smart Room Fan System. The system integrates dual PIR motion sensors and a DHT11 temperature sensor to automate the control of a DC fan based on human presence and ambient temperature. The objectives of the system were to improve comfort, ensure energy efficiency, and provide reliable automation without requiring manual operation. Each test conducted is supported with visual evidence and corresponding explanation to validate the functionality of the prototype.

3.1 People Count and System Response Demonstration

The result project shown in Figure 4 and Figure 5, in the project was enhanced with the implementation of dual PIR sensors to detect human presence based on movement patterns. The combination of entry/exit detection and temperature sensing allowed for more intelligent control of the fan.

Table 1 presents the logic table for determining fan status based on the direction of motion detected by the PIR sensors. A sequence of PIR1 followed by PIR2 indicates a person entering (Count = 1, Fan ON), while PIR2 followed by PIR1 indicates a person exiting (Count = 0, Fan OFF). This occupancy-based logic ensures that the fan operates only when people are present in the room. This approach improves accuracy compared to motion-only systems, which can misinterpret still occupants as absent.

Table 1 *People counting and fan operation based on occupancy*

Condition	Count	Fan Status
PIR1 → PIR2 triggered	1	ON
PIR2 → PIR1 triggered	0	OFF

Fig. 4 demonstrates the fan's state when the room is empty (occupancy count = 0). The fan remains off, conserving energy. This behavior confirms that the dual PIR sensors and occupancy logic work correctly, preventing unnecessary fan operation. It also verifies the system's responsiveness in detecting when no user is present, addressing one of the key energy-saving objectives.

Fig. 5 shows the fan switching on when one person is detected in the room (occupancy count = 1). The fan activates automatically, demonstrating the proper functioning of the dual PIR sensors in identifying valid entry sequences. This result also indicates that the system can dynamically adjust its behavior based on real-time human activity, increasing convenience and user comfort.

Fig. 4 *Count = 0, fan switch turns off*

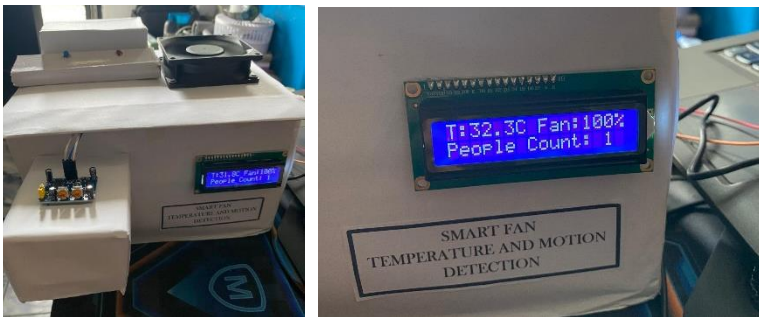

Fig. 5 *Count > 0, fan switch turns on, count = 1*

3.2 Fan Voltage Measurement Based on Speed

In this section, voltage output to the DC fan was measured to verify the effectiveness of PWM (Pulse Width Modulation) in controlling fan speed based on temperature. The PWM signal from the Arduino is sent to the motor driver (L298N), which modulates the power delivered to the fan. Voltage was measured at different PWM levels corresponding to specific temperature thresholds.

Table 2 summarizes the voltage values measured at different PWM duty cycles (30%, 60%, 100%) used to control the fan speed. The results (3.66V, 6.53V, 9.53V) show a linear relationship between PWM signal and fan speed, validating the motor driver's ability to modulate speed effectively. This functionality is essential for delivering responsive, real-time temperature-based adjustments that maximize comfort without unnecessary energy use.

Table 2 *Speed fan in voltage*

Fan Speed (%)	Speed Level	Voltage
30%	Fan ON at low speed	3.66 V
60%	Fan ON at medium speed	6.53 V
100%	Fan ON at maximum speed	9.53 V

Fig. 6 displays the fan voltage measured using a multimeter at three different PWM settings corresponding to low, medium, and high-speed levels. The voltage outputs 3.66V, 6.53V, and 9.53V align with the expected behavior for PWM-driven motor control. This confirms that the Arduino and motor driver effectively modulate power delivery to the fan, allowing fine-tuned speed control based on temperature.

Fig. 6 *Measure voltage fan speed using multimeter*

3.3 DHT11 Temperature Sensor Detect Environment Temperature

The system utilizes a DHT11 temperature sensor to monitor the ambient temperature of the room. Based on the detected temperature, the system adjusts the speed of the fan using PWM (Pulse Width Modulation) signals sent to the L298N motor driver.

Table 3 details how fan speed is mapped to ambient temperature levels as sensed by the DHT11. At temperatures above 20°C, 25°C, and 30°C, the fan operates at 30%, 60%, and 100% speed respectively. This table acts as the core reference for the PWM control logic. By mapping temperature to specific speed levels, the system ensures adequate cooling without excessive power consumption.

Table 3 *Fan speed based on temperature readings*

Temperature (°C)	Fan Speed (%)	Speed Level
Temperature > 20°C	30%	Fan ON at low speed
Temperature > 25°C	60%	Fan ON at medium speed
Temperature > 30°C	100%	Fan ON at maximum speed

Fig. 7 shows the fan operating at low speed (30%) when the room temperature exceeds 20°C. This behavior indicates that the system successfully detects a moderate rise in ambient temperature and activates the fan at the lowest programmed speed. This threshold ensures that the fan does not turn on unnecessarily in cool environments, thereby contributing to energy savings. The temperature reading was verified using a multimeter and compared with LCD display output, both of which showed consistent data.

Fig. 7 *Measure temperature > 20°C using fan*

Fig. 8 illustrates the system's response when the temperature crosses the 25°C threshold. At this point, the Arduino commands the motor driver to increase the fan's speed to a medium level (60%). The test was conducted by applying heat using a lighter near the DHT11 sensor. The PWM signal increased accordingly, and the voltage output to the fan rose, confirming successful execution of the speed control logic. This response demonstrates the fan's ability to adapt smoothly to warmer conditions, enhancing user comfort.

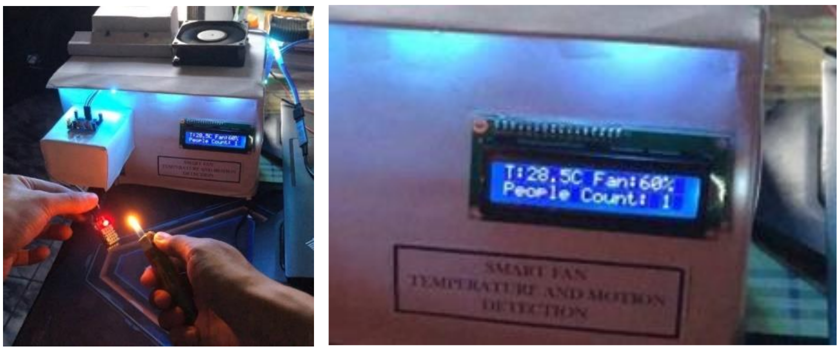

Fig. 8 *Measure temperature > 25°C using lighter*

Fig. 9 demonstrates the fan running at full speed (100%) when the temperature exceeds 30°C. This test condition simulates a hot room environment, and the system reacts by delivering maximum airflow. This capability is crucial in tropical or poorly ventilated spaces where effective cooling is needed. The output voltage measured approximately 9.53V, matching the expected value for full-speed operation under PWM control. The consistent behavior highlights the reliability of the temperature-to-speed mapping logic in real-world applications.

Fig. 9 *Measure temperature > 30*°C *using lighter*

4. Conclusion

This project has successfully developed a Smart Room Fan System that integrates temperature and motion detection to automate fan control. The system utilizes two PIR motion sensors for precise detection of entry and exit, enabling an accurate people counting mechanism. A DHT11 temperature sensor continuously monitors the room's ambient temperature, and the fan speed is adjusted accordingly through PWM using an L298N motor driver.

The Arduino Uno acts as the central controller, processing sensor data in real time and executing control commands. The 16x2 LCD display provides clear, real-time feedback to the user by showing temperature, fan speed, and the current number of occupants in the room. The implementation ensures minimal manual interaction, especially beneficial for elderly or disabled users.

Overall, the system was tested under various temperature and motion scenarios, and it performed reliably. By activating the fan only when needed and at the appropriate speed, it helps conserve energy. Furthermore, the use of dual PIR sensors eliminates false triggering and ensures accurate differentiation between entry and exit actions. This project demonstrates how embedded systems and sensor integration can be used to develop efficient, user-friendly smart home solutions.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The author attests to having sole responsibility for the following: planning and designing the study, data, collection, analysis and interpretation of the outcomes, and paper writing.

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