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Temperature Based Fan Speed Control Using Arduino

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Abstract: In this project, we present an efficient temperature-based speed control system for a DC motor using an Arduino microcontroller. The system is designed to automatically regulate the speed of the motor in response to temperature variations, making it suitable for applications like cooling systems, industrial automation, and smart appliances. The system consists of a temperature sensor (such as an LM35 or DHT11) that continuously monitors the ambient temperature and sends data to the Arduino. Based on predefined threshold values, the Arduino processes the d and adjusts the motor speed accordingly using a PWM (Pulse Width Modulation) signal. A motor driver (L298N or MOSFET-based circuit) is used to control the DC motor efficiently. This automation eliminates manual intervention, optimizes energy consumption, and enhances system performance. The proposed design is cost-effective, easy to implement, and adaptable to various applications where temperature-dependent motor control is required.
Keywords: DHT 11 Sensor , Arduino , Motor driver , DC Fan , Lcd

I. INTRODUCTION

In the modern era of automation and smart systems, precise control of motor speed is essential for optimizing efficiency, reducing energy consumption, and enhancing operational reliability. Many industrial, automotive, and household applications rely on DC motors, which require efficient speed regulation for better performance. Traditional speed control methods often involve manual adjustments or complex hardware circuits, making them less flexible and responsive to real-time environmental changes.

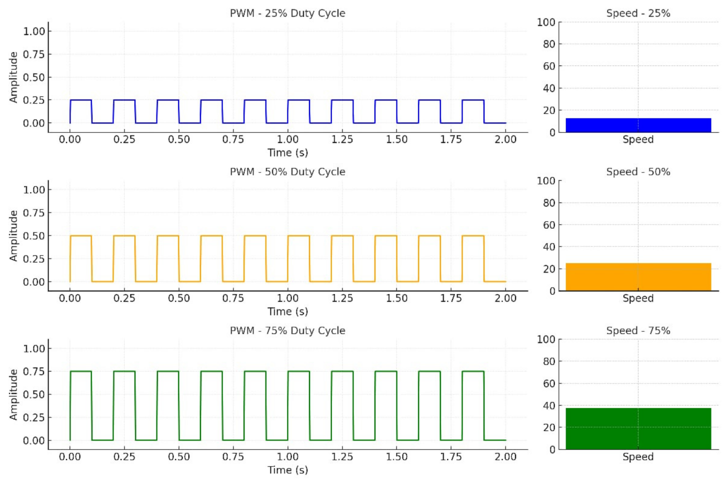
This project, "Temperature-Based Speed Control of DC Motor Using Arduino," introduces an intelligent system that automatically adjusts the speed of a DC motor based on temperature variations. The system employs a temperature sensor (LM35) to continuously monitor ambient temperature, only enhances operational efficiency but also contributes to energy conservation by ensuring that motors operate at optimal speeds based on real-time temperature data, an Arduino microcontroller to process the data, and a motor driver module (L298N or MOSFET-based driver) to efficiently regulate the motor speed using Pulse Width Modulation (PWM).

The need for automated speed control arises in various applications, particularly where temperature fluctuations directly impact system performance. For example, in industrial cooling systems, exhaust fans, automotive radiators, and thermal management units, motor-driven fans or pumps must operate at variable speeds to maintain optimal temperature conditions. Manually adjusting motor speed in such systems is impractical and inefficient, highlighting the importance of an automated solution.

By integrating sensor-based automation, this project offers a cost-effective, energy-efficient, and highly reliable solution. As the temperature increases, the system dynamically increases the motor speed, ensuring adequate cooling or heat dissipation. Conversely, at lower temperatures, the motor runs at reduced speed, conserving energy and extending the motor’s lifespan. This adaptive approach eliminates the need for continuous human intervention, making the system more practical and efficient.

A crucial component of this project is the motor driver module, which acts as an interface between the low-power Arduino microcontroller and the high-power DC motor. Since Arduino alone cannot provide sufficient current to drive a motor, a motor driver module such as L298N (Dual H-Bridge Motor Driver) or a MOSFET-based driver is used to handle the required voltage and current efficiently. These drivers ensure smooth speed transitions, protect against overcurrent, and allow precise control of motor operation.

The proposed system can be implemented in various industries where temperature-dependent motor control is essential, including HVAC (Heating, Ventilation, and Air Conditioning) systems, smart agriculture (for automated irrigation and ventilation), and automotive cooling systems. The project not only enhances operational efficiency but also contributes to energy conservation by ensuring that motors operate at optimal speeds based on real-time temperature data.



This graph represents Pulse Width Modulation (PWM) control for adjusting the speed of a DC motor, which is relevant to your project "Temperature-Based Speed Control of DC Motor Using Arduino."
Explanation of the Graph: PWM Waveforms (Left Side)The three plots show PWM signals with different duty cycles:
Top (Blue, 25% Duty Cycle): The signal is ON for 25% of the time and OFF for 75%.
Middle (Orange, 50% Duty Cycle): The signal is ON for 50% and OFF for 50%.
Bottom (Green, 75% Duty Cycle): The signal is ON for 75% and OFF for 25%.
The x-axis represents time, and the y-axis represents amplitude (signal level).Higher duty cycle means the motor gets power for a longer duration in each cycle.

II. PROBLEM STATEMENT

The problem happens when the ac fan is still functioning although in the event of cold weather. The function is uncontrolled and must be manually turned on and off or reduced the speed of the fan. Sometimes it can lead to high usage of electricity which in turn raises the electricity bill when the user forgot to switch it off. To address the problem, the automatic temperature control dc fan that can control the temperature automatically is proposed. The advantages of such a system are less energy usage, and provides more convenient to the consumer.

III. LITERATURE REVIEW

Previous Research and Related Work

1) Microcontroller-Based Temperature Control Systems

Many studies have explored temperature control using microcontrollers like Arduino, PIC, and 8051.Research shows that using LM35, DHT11, or DS18B20 temperature sensors with microcontrollers provides accurate temperature readings.
Works by Kumar et al. (2019) demonstrated an Arduino-based automatic fan speed controller using PWM (Pulse Width Modulation).

2) PWM Control for DC Motors

Research by Gupta and Sharma (2020) discussedthe use of PWM signals to control motor speed efficiently.PWM-based systems reduce power loss and extend motor life compared to traditional voltage control methods.

3) Arduino-Based Motor Speed Control

Studies highlight how Arduino, when paired with a Motor Driver (L298N, L293D), provides smooth and precise motor speed adjustments.Open-source Arduino libraries make implementationsimpler and more flexible.

IV. OBJECTIVES

1) To design and develop a temperature-based speed control system for a DC motor using an Arduino microcontroller.
2) To implement a temperature sensor (e.g., LM35 or DHT11) to continuously monitor the ambient or system temperature.
3) To develop an efficient control algorithm that adjusts the motor speed in response to temperature variations.
4) To integrate pulse width modulation (PWM) techniques for smooth and precise control of motor speed.

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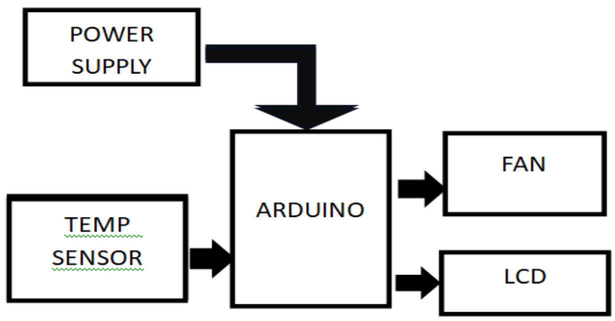
5) To optimize the system for real-time performance by ensuring fast and accurate response to temperature changes.
6) To analyze the efficiency and accuracy of the proposed system through experimental validation and performance testing**.**
7) To explore potential applications of the system in industries like cooling systems, automation, and thermal management**.**

V. METHODOLOGY

The below figure 1 represents the block diagram representation of the proposed concept. The temperature sensor DHT11 is interfaced with Arduino to fetch the data of temperature in the room. The data is processed if the temperature is high fan speed is more relatively if the temperature is low fan speed is low. Moreover if the temperature is below the threshold set then fan will be in off condition. The data related to temperature, fan speed is displayed on the LCD for user interaction. The fan speed is controlled relatively with the temperature using PWM pins available on the Arduino. As duty cycle of PWM signal increases the fan speed increases and the same is true conversely.



VI. HARDWARE IMPLEMENTATION

A. Arduino

Arduino is an open-source platform used for building electronics papers. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the microcontroller into a more accessible package.

The Arduino is a microcontroller board based on the ATmega8. It has 14 digital -input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to getstarted.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision of the board has the following new features:

• 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin that is reserved for future purpose .

• Stronger RESET circuit.

• ATmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

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B. Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction givento LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

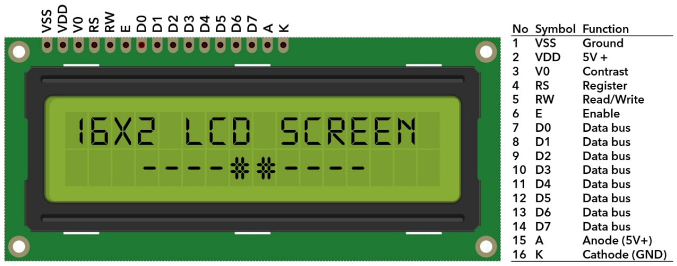

Fig. 3 Pin diagram of 16 x 2 LCD

Fig.4 DHT 11 Temperature and Moisture sensor This DHT11 Temperature and Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensor capability. It is integrated with a high-performance 8-bit.

Microcontroller. Its technology ensures the high reliability and excellent long-term stability. This sensor includes a resistive element and a sensor for wet NTC temperature measuring devices. It has excellent quality, fast response, anti-interference ability and high performance. Each DHT11 sensors features extremely accurate calibration of humidity calibration chamber. The calibration coefficients stored in the OTP program memory, internal sensors detect signals in the process, we should call these calibration coefficients. The single-wire serial interface system is integrated to become quick and easy. Small size, low power, signal transmission distance up to 20 meters, enabling a variety of applications and even the most demanding ones. The product is 4-pin single row pin package. Convenient connection, special packages can be provided according to users need.

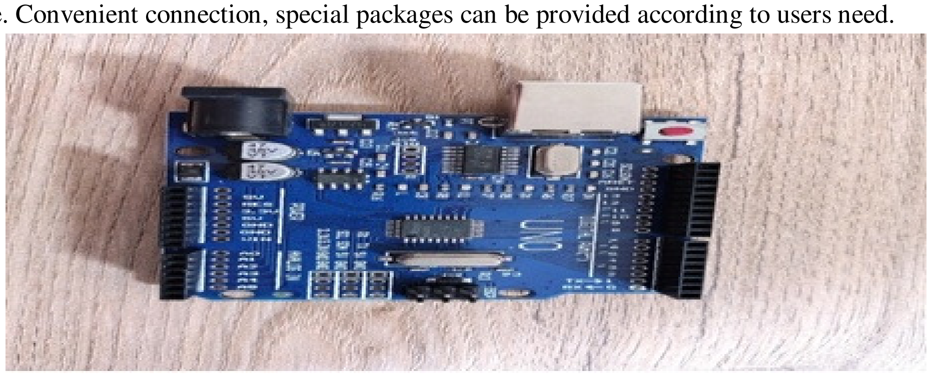

Fig. 2 Arduino UNO

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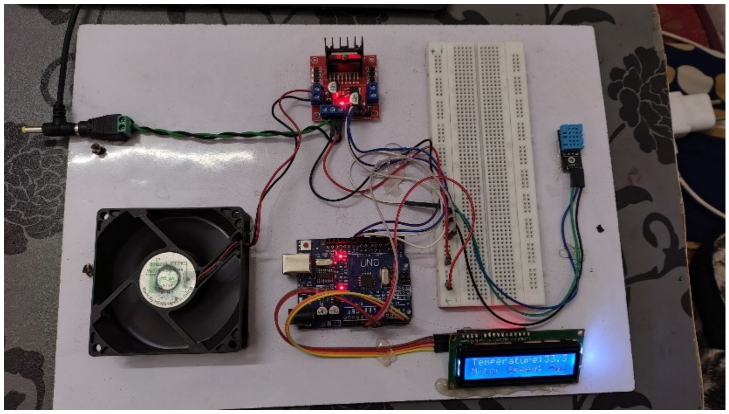
VII. RESULT AND DISCUSSION



The result and discussion of the project "Temperature Based Fan Controller and Monitoring with Arduino" involve the outcomes and findings of the implemented system. Here is a detailed overview of the result and discussion based on the available search results:

1) Temperature Monitoring: The implemented system successfully measures the room temperature using a temperature sensor, such as the LM35. The LM35 sensor provides accurate temperature readings, allowing the system to monitor the temperature effectively.
2) Fan Speed Control: The fan speed is controlled based on the temperature readings. By utilizing pulse width modulation (PWM) technique, the Arduino adjusts the fan speed to maintain the desired temperature range. This ensures efficient cooling while reducing power consumption.
3) Display: The system incorporates an LCD display to show the currenttemperature and fan speed levels. The LCD display provides real-time feedback, allowing users tomonitor thetemperatureand fan speed easily.
4) Power Consumption: One of the objectives of the project is to reduce power consumption by adjusting the fan speed based on temperature. By dynamically controlling the fan speed, the system optimizes energy usage and improves overall efficiency.
5) Hardware Components: The hardware components used in the project include Arduino Uno, LM35 temperature sensor, LCD display, LED 16x2 display, DC motor, battery, resistors, potentiometer, capacitor, transistor, and diode.

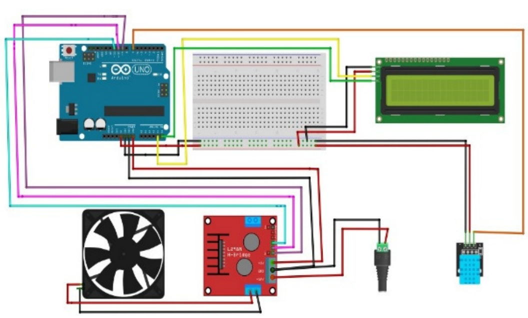


Fig 6. Circuit diagram

VIII. FUTURE SCOPE

1) This project can be used in both the home and Industry. It helps in saving the energy and electricity.
2) To watch the environments that is not comfortable, or possible, for humans to monitor, especially for extended periods of time.
3) Prevents waste of energy when it’s not hot enough for a fan to be needed.
4) To assist people who are disabled to adjust the fan speed automatically.
5) In future case we can monitor more parameters like humidity, light and at the same time control them and also can send this data to a remote location using mobile or internet.

6) Using this technology we can able to draw graphs of variations in these parameters using computer. And the temperature exceeds the limit; a call will be dialed to the respective given number by an automatic Dialer system.

IX. CONCLUSION

The conclusion of the project "Temperature Based Fan Controller And Monitoring With Arduino" is that the system successfully controls the fan speed based on temperature readings and monitors the temperature in real-time. It effectively measures the room temperature using a temperature sensor like the LM35 and adjusts the fan speed using PWM. The system optimizes energy usage, improves cooling efficiency, and provides real-time feedback through an LCD display. Overall, the temperature-based fan controller and monitoring system using Arduino offer an efficient solution for temperature control and fan speed adjustment in various applications.

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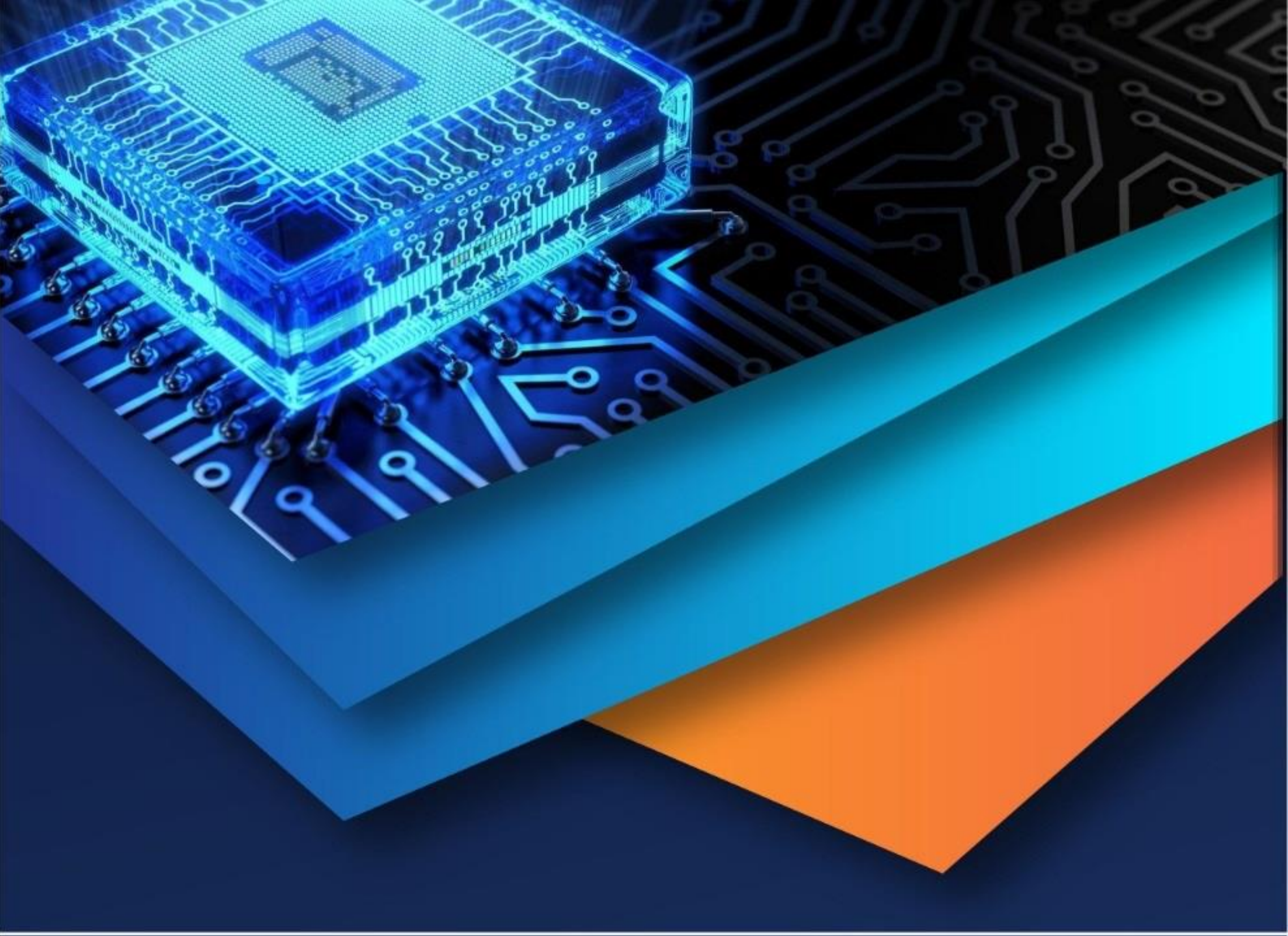

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