MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE GWALIOR

(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV, Bhopal)

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Project Report

on

Smart Fan Controller

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CENTRE FOR ARTIFICIAL INTELLIGENCE

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CERTIFICATE

This is certified that **Priyanshi Garg** (0901AI211054) and **Tanmay Gupta** (0901AI211066) has submitted the project report titled **Smart Fan Controller** under the mentorship of **Dr. Sunil Kumar Shukla** , in partial fulfilment of the requirement for the award of degree of Bachelor of Technology in **Artificial Intelligence and Robotics** from Madhav Institute of Technology and Science, Gwalior.

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DECLARATION

hereby declare that the work being presented in this project report, for the partial fulfilment of equirement for the award of the degree of Bachelor of Technology in **Artificial Intelligence and obotics** at Madhav Institute of Technology & Science, Gwalior is an authenticated and original ecord of my work under the mentorship of **Dr. Sunil Kumar Shukla** , **Assistant Professor** , epartment of Artificial Intelligence

declare that I have not submitted the matter embodied in this report for the award of any degree or iploma anywhere else.

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ABSTRACT

This project introduces a Pulse Width Modulation (PWM) Smart Fan Controller designed for precise thermal regulation. Employing an Arduino Uno microcontroller and a LM35 temperature sensor, the system dynamically adjusts the speed of a PWM-compatible fan based on ambient temperature. The implementation prioritizes energy efficiency and noise reduction. Additionally, the project explores the integration of smart features, such as remote control and IoT capabilities, enhancing user accessibility. Preliminary testing confirms the system's effectiveness in maintaining optimal temperatures while minimizing energy consumption. This research contributes to energy-efficient cooling solutions, showcasing potential applications in various environments.

Keyword: PWM, Smart Fan Controller, Arduino Uno, Temperature Sensor, Energy Efficiency, IoT, Thermal Regulation.

सार:

PWM स्मार्ट फैन नियंत्रक परियोजना का उद्देश्य पल्स विद्युथ मॉड्युलेशन (PWM) का उपयोग करके आसपासी तापमान के आधार पर पंखे की गति को कुशलता से नियंत्रित करना है। इस प्रणाली में एक आर्डुइनो यूनो माइक्रोकंट्रोलर और एक डीएचटी 11 सेंसर का उपयोग किया जाता है ताकि समय-समय पर तापमान की निरंतर निगरानी हो सके, पंखे की गति को बिना किसी लागत के सीधे नियंत्रित किया जा सके। PWM सिग्नल्स द्वारा तय किए जाते हैं जो विशेष रूप से विशेष समय-समय पर घटित होने वाले परिस्थितियों के आधार पर पंखे की गति को सही रूप से नियंत्रित करने के लिए होते हैं। यह प्रकल्प वैकल्पिक रूप से स्मार्ट सुविधाओं की खोज करता है जैसे कि रिमोट नियंत्रण और आईओटी एकीकरण। परीक्षण, अंशांकन, और सुरक्षा मापाओं के माध्यम से प्रणाली सटीक और सुरक्षित संचालन सुनिश्चित करती है। इस परियोजना का विस्तृत दस्तावेजीकरण, भविष्य की सुधार की संभावना, और समस्या सुलझाने के लिए मार्गदर्शन के पूरक हैं।

TABLE OF CONTENTS

ABBREVIATIONS

PWM	Pulse Width Modulation
NPN	Negative-Positive-Negative
RPM	Revolutions per Minute
IDE	Integrated Development Environment
LED	Light Emitting Diode
NTC	Negative Temperature Coefficient
RTD	Resistance Temperature Detectors

LIST OF FIGURES

Chapter 1: Project Overview

1.1 Introduction:

The PWM Smart Fan Controller is designed to provide an intelligent solution for regulating fan speed based on the ambient temperature. Pulse Width Modulation (PWM) is employed to finely control the speed of the fan, optimizing cooling performance and energy efficiency. The software comprises modules for PWM control, temperature reading, and fan speed adjustment algorithms.

1.2 Objectives And Scope:

1.2.1 Objectives:

1. Create a PWM-based fan controller for precise speed modulation.
2. Implement temperature-based fan speed control to enhance cooling efficiency.
3. Integrate smart features for user convenience and additional functionality.

1.2.2 Scope:

This project caters to electronics enthusiasts and hobbyists interested in building a versatile and intelligent fan controller. The design is scalable, allowing adaptation for various applications where temperature-sensitive fan control is beneficial.

1.3 Project Features:

Integrate additional features based on user requirements, such as remote control or IoT capabilities.

1.4 Feasibility:

A PWM Smart Fan Controller project appears technically feasible, especially given the availability of components and the support for Arduino development. The economic feasibility is generally favorable, as the components are relatively inexpensive. Operational and schedule feasibility will depend on factors like user-friendliness and the project's time constraints.

1.5 System Requirements:

1.5.1 Hardware Requirements:

1. Microcontroller
2. Temperature Sensor
3. PWM-Compatible Fan
4. NPN Transistor or Motor Driver
5. Wiring and Breadboard

1.5.2 Software Requirements:

1. Arduino IDE
2. Arduino Libraries
3. Programming Skills

Chapter 2: Literature Review

2.1 PWM Control in Fan Systems:

Pulse Width Modulation (PWM) control enables you to externally control the speed of the fan by varying the duty cycles of PWM input signals between control and grounding terminals. It allows fans to operate optimally in response to the device's heat level, lowering the noise and power consumption of the system.

PWM is used to control motors or to power LEDs. The main reason for using PWM is that it allows for controlling the average amount of power delivered to a load or the output. They are also used for voltage regulation and modulation in communications.

2.2 Temperature-Based Fan Control:

The Temperature based fan speed controller system has a wide range of applications in different fields. This system can be used in Store Room, Server Room, Industry, and laboratory, as well as it can be used in our Room and Offices. This system is very useful for that closed places where we need to constant the temperature. For example, in the server room, the machines are continuously running and produce heat which increases the room temperature. In this high temperature Machines can be damaged. But using the temperature based fan speed controller system we can control the room temperature and protect our machines from damage. This system measures the surrounding temperature and controls the fan speed to maintain the temperature. This device controls the fan speed according to the room temperature. Whenever the room temperature is increased, the fan speed is also increasing Automatically. And when the temperature is decreased, the fan speed also decreased automatically. In this way, this system controls the temperature.

2.3 Microcontroller-Based Fan Control:

The microcontroller continuously reads temperature from its surroundings. The temperature sensor acts as a transducer and converts the sensed temperature to electrical value. This is analog value which is applied to the ADC pin of the microcontroller.

Microcontrollers play a very important role in the development of the smart systems as brain is given to the system. Microcontrollers have become the heart of the new technologies that are being introduced daily. A microcontroller is mainly a single chip microprocessor suited for control and automation of machines and processes. Today, microcontrollers are used in many disciplines of life for carrying out automated tasks in a more accurate manner.

2.4 Smart Fan Controllers:

The smart fan controller enables you to adjust the fan 5 speed and time schedule settings. Make your life easier and more convenient.

Fan speed controllers are used to control the speed of various kinds of electric fans, including centrifugal fans, extractor fans, propeller fans and axial fans. They increase or decrease fan speeds to reduce wear and tear on equipment, cut noise levels and save energy. Some models are variable, adjusting speed dynamically according to the situation, while others offer a set number of available speeds. An infinitely variable model can be fully adjusted without limitation between 0 and 100 per cent.

2.5 Sensor Technologies for Temperature Measurement:

Some applications, such as equipment used to create life-saving medications, require temperature sensors to be responsive and accurate for critical quality control; however, some applications, like the thermometer in your car, don't require as accurate or responsive sensors. The four most common types of temperature sensors, ranging in responsiveness and accuracy from high to low are:

- **Negative Temperature Coefficient (NTC) Thermistors:**

  A thermistor is a thermally sensitive resistor that exhibits a continuous, small, incremental change in resistance correlated to variations in temperature.

- **Resistance Temperature Detectors (RTDs):**

A resistance temperature detector, or RTD, changes the resistance of the RTD element with temperature. An RTD consists of a film or, for greater accuracy, a wire wrapped around a ceramic or glass core.

- **Thermocouples:**

  A thermocouple consists of two wires of different metals electrically bonded at two points. The varying voltage created between these two dissimilar metals reflects proportional changes in temperature.

- **Semiconductor-Based Sensors:**

  A semiconductor-based temperature sensor is usually incorporated into integrated circuits (ICs). These sensors utilize two identical diodes with temperature-sensitive voltage vs current characteristics that are used to monitor changes in temperature.

2.6 Power Electronics in Fan Systems:

The increasing focus on electrification for a cleaner environment has fueled the need for electric power in different forms. Power electronics is the branch of electrical engineering that deals with the processing of high voltages and currents to deliver power that supports a variety of needs. From household electronics to equipment in space applications, these areas all need stable and reliable electric power with the desired specifications. Power supply in one form is processed using power semiconductor switches and control mechanisms to another form, supplying a regulated and controlled power. While switched-mode power supplies are a common application of power electronics where power density, reliability, and efficiency are of prime importance, motor control is gearing up with more electrification in transportation systems. Precise control and efficiency are key characteristics for power control applications. The study of power electronics is thus multidisciplinary, involving semiconductor physics, electrical motors, mechanical actuators, electromagnetic devices, control systems, and so on.

Chapter 3: Project Architecture and Technologies

3.1 Software Used :

1. **Tinker-Cad :**

   For Ardiuno simulator TinkerCad is used to make circuits as well as working model.

2. **Ardiuno IDE:**

   Ardiuno IDE is used to connect the software components to the hardware components.

3.2 Hardware Used:

This project uses many different hardware components:

1. **NPN-Transistor (BJT):**

   The NPN (Negative-Positive-Negative) transistor is a semiconductor device that lies at the heart of the electronic circuits within the Smart Fan Controller. Specifically, it serves as a key component in the implementation of Pulse Width Modulation (PWM) technology, enabling precise control over the speed and operation of the fan motor.

2. **Temprature Sensor(LM35):**

   We are using LM 35 as temperature sensor. LM 35 is a precision temperature sensor whose output is linearly proportional to Celsius Temperature. The LM35 is rated to operate from -55° Centigrade to 150° Centigrade with a linear scale factor of +10mv/° C.

3. **Resistor**

   Resistors play a crucial role in determining the timing and shaping of the PWM signal. The primary purpose of resistors in this context is to set the reference voltage, control the charging and discharging rates of capacitors, and establish the thresholds that define the duty cycle of the PWM waveform

4. **Diode:**

A diode can serve specific roles within the circuit to enhance the efficiency and reliability of the PWM signal. The exact role of a diode in this context can vary depending on the specific design and requirements of the controller. Here are several potential roles that a diode may play in a smart fan controller's

5. **Dc Motors:**

This is the actuator which is provided with controller voltages for the motor the rotate accordingly.

6. **Arduino Uno:**

Arduino is used as the micro-controller here it is the brain to all this circuit.

7. **Breadboard:**

The breadboard is the connecting interface between the micro controller and the other elements in the circuit.

Chapter 4: Working

Working of Principle:

The working of Pulse Width Modulation (PWM) in a smart fan controller involves the modulation of electrical pulses to control the speed of the fan motor. PWM is a widely used technique for achieving variable control over the speed of motors and other devices. In the context of a smart fan controller, PWM is employed to adjust the power delivered to the fan motor, thereby controlling its rotational speed.

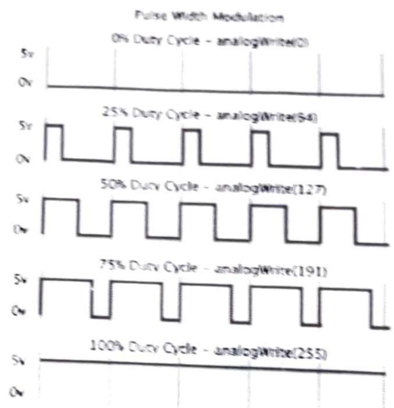


Fig: Pulse Width Modulator

1. Signal Generation :

The PWM process begins with the generation of a square wave signal. This square wave alternates between two voltage levels: a high level (often referred to as "on" or logic 1) and a low level (referred to as "off" or logic 0).

2. Duty Cycle Definition:

The key parameter in PWM is the duty cycle, which is the percentage of time the signal is in the high state (on) within each period of the signal. The duty cycle is expressed as a percentage and determines the average power delivered to the fan motor. It is usually controlled by adjusting the width of the high state relative to the total period of the signal.

3. Modulation for Fan Speed Control:

The duty cycle of the PWM signal directly correlates to the fan speed. A higher duty cycle corresponds to a higher average voltage supplied to the fan motor, resulting in faster rotation. Conversely, a lower duty cycle corresponds to a lower average voltage and slower

4. Integration with Fan Motor:

The PWM signal is fed into the fan motor control circuitry. The motor responds to the changing voltage levels in the PWM signal by adjusting its speed accordingly. This modulation happens rapidly, typically at a frequency measured in kilohertz, making the changes in fan speed imperceptible to the human eye.

5. Fan speed control and regulation:

The smart fan controller continuously adjusts the duty cycle of the PWM signal based on user inputs, environmental conditions, or predefined settings. This dynamic control allows for precise and real-time regulation of the fan speed, ensuring that the fan operates at the optimal level for the current conditions

6. Integration with Smart Features:

In a smart fan controller, PWM is often integrated with additional smart features. Environmental sensors, user preferences, and automation algorithms may influence the PWM signal, allowing the fan to adapt its speed to factors such as room temperature, humidity, and occupancy.

7. Energy Efficiency:

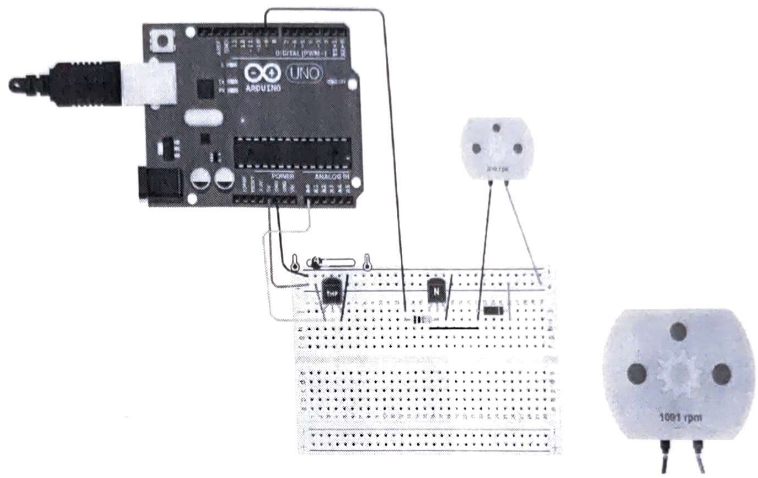
One of the significant advantages of PWM in a smart fan controller is its inherent energy efficiency. By adjusting the duty cycle based on the actual cooling requirements, the controller avoids unnecessary energy consumption, contributing to overall energy savings and a more environmentally friendly operation.

In summary, the working of PWM in a smart fan controller involves generating a variable duty cycle square wave signal to control the average power delivered to the fan motor.

Working of Smart Fan Controller:

1. Implementation:

- For low temperature the motor revolves at an RPM of 1000 which is slower because of the low temperature.



- For High Temperatures the motor revolves at an RPM of 9000 for high temperatures..

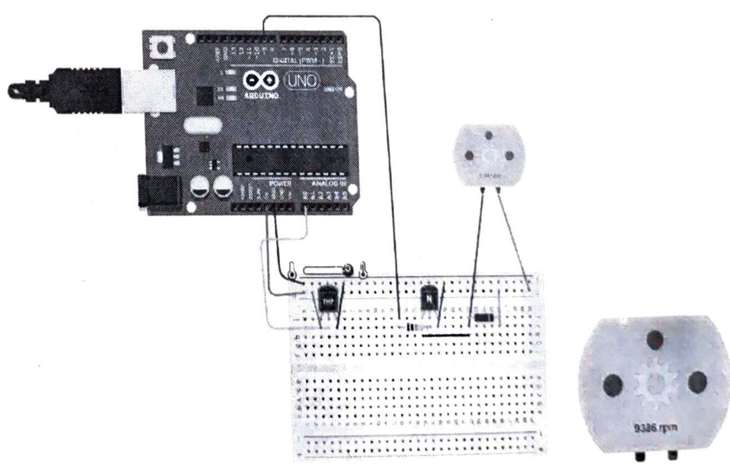


Fig: Circuit Diagram

2. Code:

```
float temp;
int tempPin = A0; //arduino pin used for temperature sensor
int fan = 9;            // the pin where fan is connected

void setup() {
 pinMode(fan, OUTPUT);
 pinMode(tempPin, INPUT);
 Serial.begin(9600);
}
void loop() {
  temp = analogRead(tempPin);
  temp = (temp *3.0*100.0)/1024.0;
  temp = map(temp,100,300,24,70);
  float temprature = map(temp,100,300,24,70);      // delay in between reads for stability
  Serial.println(temprature);
  int motorSpeed = map(temprature, 0, 50, 0,500);
  motorSpeed = constrain(motorSpeed, 0, 1000);
  Serial.print("Temperature: ");
  Serial.print(temprature);
  Serial.print("°C, Motor Speed: ");
  Serial.println(motorSpeed);
  analogWrite(fan,motorSpeed);
   delay(4000);
}
```

Fig: Code

Output :

```
21.00
Temperature: 21.00°C, Motor Speed: 210
15.00
Temperature: 15.00°C, Motor Speed: 150
34.00
Temperature: 34.00°C, Motor Speed: 340
39.00
Temperature: 39.00°C, Motor Speed: 390
25.00
```

Fig: Serial Monitor

Description:

You also need to select the transistor by the type of fan that you use. In my case I used the well-known BD139 transistor and an LM35 temperature sensor and a 3-9 volt motor which are powered with 5V from the Arduino board.

The most important part is to set the variables temp and temperature with your desired values. Temp Min is the temperature at which the fan starts to spin and temp Max is the temperature when the motor stops due to excessive temperature.
For example if you set temp at 30 and temperature at 35 then the fan will start spinning at 30°C and reach its maximum speed at 35°C
We have also mapped the motorspeed with the temperature variable as we don't want to Overload the motor with excessive voltage due to which the motor may become useless
The motorspeed is mapped using the **map** function in the library.
Also the temperature value is calculated using a formula :

- Temp=(temp x 3.0 x 100) /1024

The value is then used to constrain the speed of motor to avoid any wear and tear.

Chapter 5: Applications & Future Enhancement

5.1 Applications :

1. Temperature based fan speed controller is useful for cooling the processor in the laptops and personal computers "more efficiently". Generally fan in laptop comes with only two or three possible speeds. So it results in more power consumption.

2. The fan designed in this project, has different values of speed according to temperature change. This can be also used in small scale industries for cooling the electrical/mechanical equipment. The whole circuit except for motor and fan can be manufactured on a single PCB, and it can be used for temperature based control operations.

5.2 Future Options:

1. We can monitor more parameters like humidity, light and at the same time control them.
2. We can send this data to a remote location using mobile or internet.
3. We can draw graphs of variations in these parameters using computer.
4. When temperature exceeds the limit, a call will be dialed to the respective given number by an automatic Dialer system.

Chapter 6: Result and Final Analysis

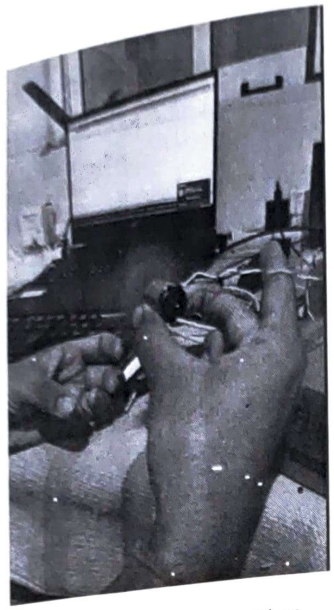


Fig: More RPM high temperature

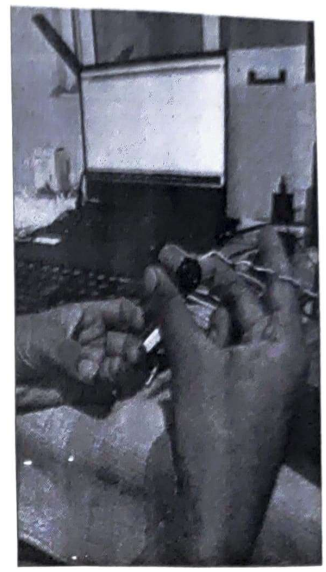


Fig: Less RPM low temperature

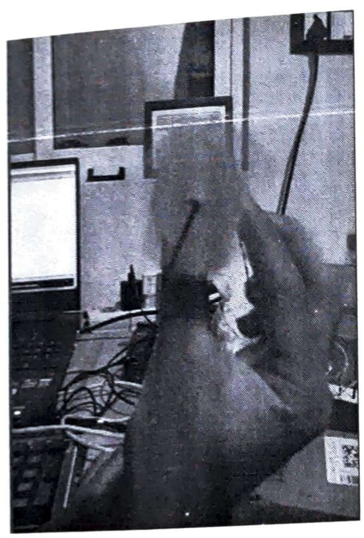


Fig: More RPM high temperature

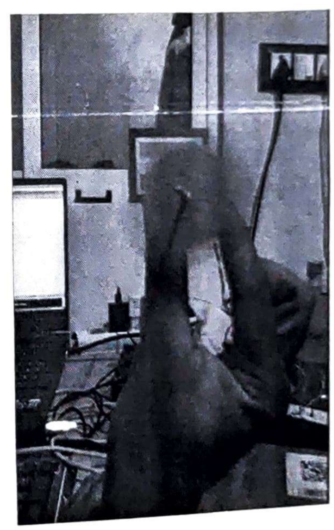


Fig: Less RPM low temperature

Conclusion:

The PWM Smart Fan Controller project successfully demonstrates the effectiveness of dynamic fan speed modulation through Pulse Width Modulation. By utilizing an Arduino Uno microcontroller and a LM35 sensor, the system achieves precise thermal management based on real-time temperature readings. The integration of PWM signals allows for energy-efficient and noise-reduced fan operation.

The project not only accomplishes its primary objectives of temperature-based fan control but also explores the potential for smart features like remote control and IoT integration. Testing and calibration procedures validate the accuracy of temperature readings and the responsiveness of the fan speed adjustments.

The documentation provides comprehensive insights into the hardware setup, software implementation, and safety considerations. The project's adaptability is evident, allowing for future enhancements and modifications to meet evolving needs.

In conclusion, the PWM Smart Fan Controller project presents a viable solution for applications requiring efficient thermal regulation. Its scalable design, energy-saving capabilities, and potential for smart integrations make it a valuable contribution to the field of temperature-controlled fan systems.

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