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Shri Bhagwan Mahaveer Jain Educational & Cultural Trust

JAIN COLLEGE OF ENGINEERING, BELAGAVI

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

THIRD YEAR
(2023 – 2024)

MINI PROJECT REPORT

On

"Temperature Based Fan Speed Controller"

PROJECT GUIDE

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that the **Project Work** entitled **"Temperature Based Fan Speed Controller"** carried out by **Mr. Basavaraj B G (2JI21EC030) (4 students name with USN)** are bonafide students of **Department of Electronics and Communication Engineering, Jain College of Engineering, Belagavi,** in partial fulfilment for the award of **Bachelor of Engineering** of the **Visvesvaraya Technological University, Belagavi** during the academic year **2023-2024**. It is certified that all corrections/suggestions indicated for project assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering degree.

Prof. Shivanand Channi	**Prof. V R Bagali**	**Dr. J. Shivakumar**
Project Guide	HOD, Dept. of E&CE	Principal & Director
Dept. of E&CE, JCE BGM	JCE, Belagavi	JCE, Belagavi

Name of the examiners	Signature with date
1. ___________________________	___________________
2. ____________________________	___________________

DECLARATION

We **Mr. Basavaraj B G (2JI21EC030) (4 Students Name with USN)** students of **6th semester B.E. Electronics & Communication Engineering, Jain College of Engineering, Belagavi** hereby declare that the dissertation entitled **"Temperature Based Fan Speed Controller"** has been carried out in a batch and submitted in the partial fulfilment of the requirement for the award of Bachelor's Degree in Electronics & Communication Engineering under Visvesvaraya Technological University, Belagavi during the academic year **2023 – 24.**

Name	**USN**	**Signature**
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Place : Belagavi

Date :

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Program Educational Objectives (PEO's)

1. Graduates will be able to contemplate real-time social problems and deliver efficient solutions.
2. Graduates will be able to lead and succeed in professional careers.
3. Graduates will contribute through research and enterpreneurship.

Program Specific Outcomes (PSO's)

Graduates in the UG program in Electronics and communication engineering will be able to

1. Design, verify and develop analog and digital systems by using state of art technology to contribute to the societal needs..
2. Apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools.

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4. Apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools.

PROGRAM OUTCOME'S (PO'S)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the **engineering and management principles and apply these to one's own work, as a member and** leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

CO-PO/PSO Mapping:

L1: Remembering L2: Understanding L3: Applying L4: Analyzing L5: Evaluating L6: Creating

Course Outcomes	Description	Bloom's Cognitive level
21ECMP67.01	Understand the basic concepts and broad principles of industrial projects.	L3
21ECMP67.02	Apply the theoretical concepts to solve industrial problems with team work and multidisciplinary approach.	L3
21ECMP67.03	Get capable of self education and clearly understand the values of achieving perfection in project implementation and completion.	L3
21ECMP67.04	Demonstrate professionalism with ethics; present effective communication skills relate engineering issues to broader societal context.	L3
21ECMP67.05	Understand concepts of projects and production management.	L3

Strength of CO Mapping to PO/PSOs with Justification:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1		1	1							3
CO2	3	3	3	1					3				3	3
CO3	3	3	3	1	1			2	3	3	2	2	3	3
CO4								2		3				
CO5									3	3	2	2	3	

Avg	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**2**	**3**	**3**

CO-PO-PSO	Justification
CO1 → PO1 (3) CO1 → PO2 (3) CO1 → PO3 (3) CO1 → PO4 (1) CO1 →PO6(1) CO1 →PO7(1) CO1 → PSO3(2)	• Strongly mapped as students apply the electronics and communication engineering skills to understand the principles of industrial projects. • Strongly mapped as students identify, formulate, review research literature and analyse complex engineering problems. • Strongly mapped as students design solutions for complex engineering problems with appropriate consideration for the public health and safety. • Slightly mapped as students can use research-based knowledge and methods including design of experiments, analysis and interpretation to provide valid conclusions. • Slightly mapped as students can able to understand the impact of professional engineering project solutions in societal and environmental contexts. • Slightly mapped as students can be able to apply reasoning of contextual project knowledge to assess societal, health and safety issues. • Strongly mapped as apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools.
CO2 → PO1 (3) CO2 → PO2 (3) CO2 → PO3 (3) CO2 → PO4 (1) CO2 → PO9 (3) CO2 → PSO1(3) CO2 → PSO2(3)	• Strongly mapped as students apply the electronics and communication engineering skills to understand the principles of industrial projects. • Strongly mapped as students identify, formulate, review research literature and analyse complex engineering problems. • Strongly mapped as students design solutions for complex engineering problems with appropriate consideration for the public health and safety. • Slightly mapped as students can use research-based knowledge and methods including design of experiments, analysis and interpretation to provide valid conclusions. • Strongly mapped as students can effectively act as an individual, and as a member or leader and work in a team. • Strongly mapped as students can design, verify and develop analog and digital systems by using state of art technology to contribute to the societal needs and solve industrial problem. • Strongly mapped as students apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools and solve industrial problem.

CO3 → PO1 (3) CO3 → PO2 (3) CO3 → PO3 (3) CO3 → PO4 (1) CO3 →PO5(1) CO3 → PO8(2) CO3 → PO9 (3) CO3→ PO10 (3) CO3 → PO11 (2) CO3 → PO12 (2) CO3 → PSO1(3) CO3 → PSO2(3)	• Strongly mapped as students apply the electronics and communication engineering skills to understand the principles of industrial projects. • Strongly mapped as students identify, formulate, review research literature and analyse complex engineering problems. • Strongly mapped as students design solutions for complex engineering problems with appropriate consideration for the public health and safety. • Slightly mapped as students can use research-based knowledge and methods including design of experiments, analysis and interpretation to provide valid conclusions. • Slightly mapped as students can Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. • Moderately mapped as students can work ethically and professionally in the industry. • Strongly mapped as Students can effectively act as an individual, and as a member or leader and work in a team. • Strongly mapped as Students can comprehend and write effective reports and make documentation with effective presentation. • Moderately mapped as students can learn to management and financial skills required for the execution of project. • Moderately mapped as students can be engaged in life long learning in the broadest context of technological change through project implementation and completion. • Strongly mapped as students can design, verify and develop analog and digital systems by using state of art technology to contribute to the societal needs and solve industrial problem. • Strongly mapped as students apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools and solve industrial problem.
CO4 → PO8 (3) CO4→ PO10 (3)	• Moderately mapped as students can work ethically and professionally in the industry. • Strongly mapped as Students can comprehend and write effective reports and make documentation with effective presentation.
CO5→ PO9 (3) CO5→ PO10 (3) CO5 → PO11 (2) CO5 → PO12 (2) CO5 → PSO1(3)	• Strongly mapped as Students can effectively act as an individual, and as a member or leader and work in a team. • Strongly mapped as Students can comprehend and write effective reports and make documentation with effective presentation. • Moderately mapped as students can learn to management and financial skills required for the execution of project.

	• Moderately mapped as students can be engaged in life long learning in the broadest context of technological change through project implementation and completion. • Strongly mapped as students can design, verify and develop analog and digital systems by using state of art technology to contribute to the societal needs and solve industrial problem.

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We would like to extend our gratitude to all staff of **Department of Electronics and Communication Engineering** for the help and support rendered to us.

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ABSTRACT

This project is a standalone automatic fan speed controller that controls the speed of an electric fan according to our requirement. Use of embedded technology makes this closed loop feedback control system efficient and reliable. Microcontroller (ATMega8 / 168 / 328) allows dynamic and faster control. Liquid crystal display (LCD) makes the system user-friendly. The sensed temperature and fan speed level values are simultaneously displayed on the LCD panel. It is very compact using few components and can be implemented for several applications including air-conditioners, waterheaters, snow-melters, ovens, heat-exchangers, mixers, furnaces, incubators, thermal baths and veterinary operating tables. ARDUINO micro controller is the heart of the circuit as it controls all the functions. The temperature sensor LM35 senses the temperature and converts it into an electrical (analog) signal, which is applied to the microcontroller. The sensed and set values of the temperature are displayed on the 16x2-line LCD. The micro controller drives Transistor to control the fan speed. This project uses regulated 12V, 2A power supply. This project is useful in process industries for maintenance and controlling of Boilers temperature.

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INTRODUCTION

1.1 Motivation

The motivation for developing the Temperature based fan speed controller is with the increasing emphasis on energy efficiency and automation in modern technology, the need for smart systems that adapt to environmental conditions is more crucial than ever. Traditional fan systems operate at a constant speed, wasting energy and failing to provide optimal cooling based on the current temperature. By creating a temperature-based fan speed controller using Arduino UNO, we aim to enhance energy efficiency, improve user comfort, and extend the lifespan of electronic components by maintaining optimal thermal conditions. This project is driven by the desire to reduce energy consumption, lower electricity costs, and minimize environmental impact while delivering a practical solution for temperature regulation in various applications, such as computer cooling systems, home appliances, and industrial machinery.

1.2 Problem Statement

Conventional fans operate at fixed speeds, regardless of the ambient temperature, leading to unnecessary energy consumption and inadequate cooling or overheating. This lack of adaptability not only wastes energy but also reduces the efficiency and lifespan of electronic devices and machinery. The challenge is to develop an intelligent system that automatically adjusts fan speed based on real-time temperature readings. The project "Temperature-Based Fan Speed Controller Using Arduino UNO" seeks to address these issues by designing a system that monitors ambient temperature and dynamically controls fan speed, ensuring efficient cooling and energy usage. The proposed solution should be cost-effective, easy to implement, and suitable for various environments, ultimately contributing to energy conservation and improved operational efficiency.

1.3 Objective of the report :

The objective of this project is to design and implement an automated fan speed control system using an Arduino UNO microcontroller that adjusts the fan speed based on real-time temperature readings. This system aims to optimize energy consumption, enhance user comfort, and improve the efficiency and lifespan of electronic devices by ensuring they operate within optimal temperature ranges. The solution will:

1. Accurately Monitor Temperature : Utilize a temperature sensor to continuously measure the ambient temperature and provide real-time data to the Arduino UNO.
2. Adjust Fan Speed Dynamically: Implement a control algorithm that adjusts the fan speed according to the detected temperature changes, providing adequate cooling while minimizing energy usage.
3. Improve Energy Efficiency: Reduce unnecessary energy consumption by running the fan at lower speeds when the temperature is low and increasing the speed only when necessary.
4. Enhance User Comfort and Device Lifespan: Maintain a comfortable temperature environment for users and prevent overheating of electronic components, thereby extending their operational lifespan.
5. Cost-Effective and Scalable Design: Develop a solution that is affordable, easy to assemble, and scalable for various applications, from household appliances to industrial systems.
6. User-Friendly Interface: Incorporate a user interface that allows for manual adjustments, overrides, and status monitoring, ensuring the system is easy to use and understand.

By achieving these objectives, the project will demonstrate a practical approach to smart temperature control systems, contributing to energy savings and improved thermal management in electronic devices and environments.

1.4 Literature survey

A temperature-based fan speed control system is crucial in applications where maintaining optimal temperature is vital for device performance and longevity, such as electronics cooling and environmental management. The Arduino UNO microcontroller is widely used in these systems due to its ease of use, flexibility, and extensive community support.Several studies have investigated the implementation of temperature-based fan speed control systems using Arduino. Ali et al. (2020) described a system that uses a thermistor to detect temperature changes and control a DC fan's speed via Pulse Width Modulation (PWM), enabling precise fan speed control for enhanced energy efficiency and reduced noise [1]. Singh and Kumar (2019) employed the DHT11 temperature sensor with Arduino UNO to dynamically adjust fan speed in response to ambient temperature changes, underscoring the system's ability to maintain a stable environment [2]. Sharma et al. (2021) developed a similar system with an LCD display to provide real-time feedback on temperature readings and fan speed, improving user interaction and system transparency [3].Additionally, Gupta and Verma (2018) highlighted the use of the LM35 temperature sensor with Arduino to implement a fan speed control system, emphasizing its effectiveness in maintaining the desired temperature range in residential and industrial applications [4]. Rana and Ahmed (2020) focused on using the Arduino IDE and PWM for fan speed control, demonstrating the system's simplicity and efficiency [5]. Mishra et al. (2019) explored the integration of wireless communication modules with Arduino-based fan control systems to enable remote monitoring and control, which enhances convenience and accessibility [6]. Finally, Patel et al. (2021) investigated the use of machine learning algorithms to predict temperature changes and optimize fan speed control, showcasing the potential for advanced control techniques to further improve system performance [7].These studies collectively highlight the Arduino UNO's capabilities in implementing effective temperature-based fan speed control systems, utilizing a variety of sensors and control methods to achieve efficient and user-friendly solutions.

1.5 System Overview

- Hardware: The physical 12v Fan connected to the Arduino uno.
- Control Unit: Arduino uno

1. Hardware Components

- Arduino Uno
- 16*2 LCD Display
- LM35 Temperature senser
- Power Supply
- 12 V fan

- LED
-1K resistor
- 2N2222 Transistor
- 1N4007 Diode

2. Software Components
   - Arduino Uno Firmware
3. Features and Functionality
   - Automatic fan speed control
   - Adjustable temperature thresholds
   - LCD display
   - PWM fan control
   -Reads temperature
   - Adjusts fan speed based on temperature
   - Displays temperature and fan speed
   - Allows manual threshold adjustment
4. Implementation Steps
   - Hardware Setup
   - Firmware Development
   - Testing and Deployment

CHAPTER-2

HARDWARE DESIGN

2.1 Block diagram :

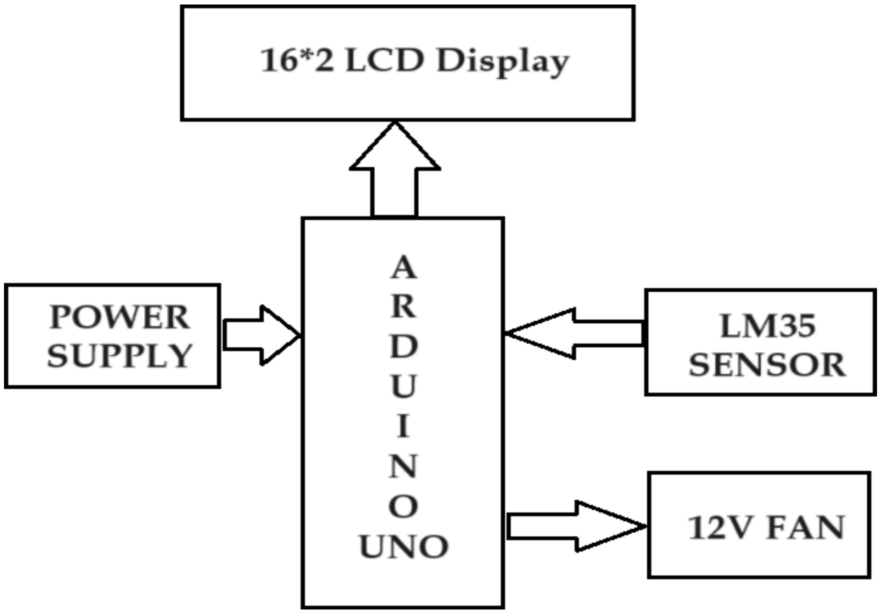

Figure 2.1.1: Block Diagram

As shown in the fig 2.1.1., Power Supply: This is the source of electrical power for the entire system. It ensures that all components receive the necessary voltage and current to operate correctly.

Arduino UNO Microcontroller: The Arduino uno is a powerful microcontroller. It serves as the brain of the system, executing the programmed instructions and managing communication between components. It can be programmed using various development environments like Arduino IDE.

16*2 LCD display: It is connected to Arduino UNO and it shows the output of Arduino Uno

LM35 temperature sensor : It is a temperature sensor which detects temperature of senser and give as input for Arduino Uno

12V Fan : it takes input from the Arduino and operates a given instruction

2.2 ARDUINO UNO

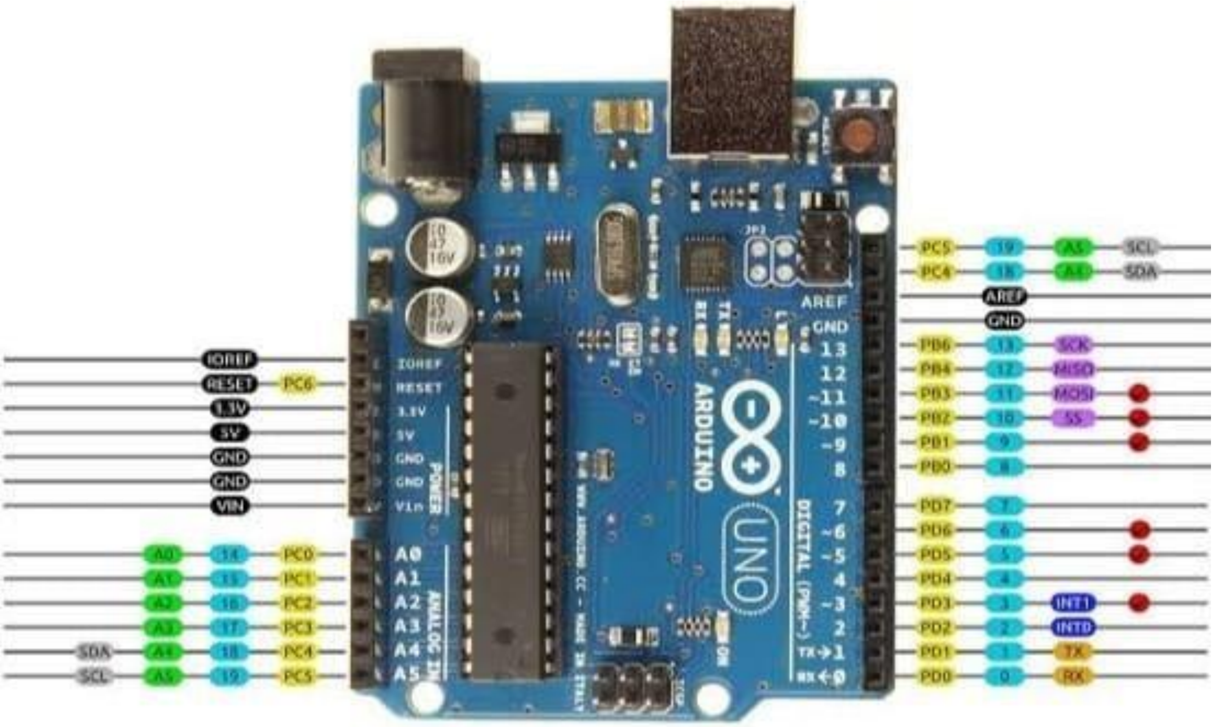

Figure 2.1.2: Arduino Uno

The Arduino Uno is a widely-used microcontroller board based on the ATmega328P chip, popular in electronics and DIY projects due to its simplicity, versatility, and affordability. It features 14 digital input/output pins (6 of which can be used for PWM output), 6 analog inputs, and operates at a 16 MHz clock speed. The board is powered via a USB connection or an external power source, making it suitable for both portable and stationary projects.

The Arduino Uno is programmed using the Arduino IDE, which is designed to be user-friendly and supports a simplified version of C/C++. This makes it accessible for beginners while being powerful enough for experienced developers. The board is compatible with a wide range of shields and modules that can expand its functionality, enabling projects involving sensors, motors, displays, and wireless communication.

Thanks to its open-source nature, there is a vast community of users who share projects, resources, and support, making it easy for anyone to get started and find help. The Arduino Uno is ideal for educational purposes, rapid prototyping, and personal projects in areas such as home automation, robotics, and IoT applications.

This concise summary captures the essential aspects of the Arduino Uno, highlighting its features and widespread use in various applications.

2.3 LM35 Temperature sensor

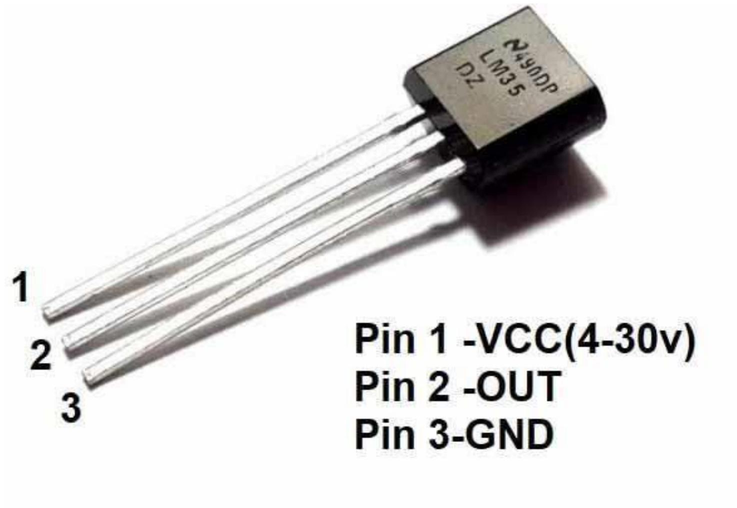

Figure 2.3.1: LM35 Temperature sensor

The LM35 is a precision analog temperature sensor that provides a voltage output linearly proportional to the temperature in Celsius. It's a popular choice for temperature measurement in electronic projects due to its simplicity, accuracy, and ease of use. With an accuracy of ±0.5°C at room temperature and a typical range of -55°C to +150°C, it delivers reliable performance without requiring any calibration. The LM35 outputs 10 mV per degree Celsius, meaning the output voltage increases by 10 mV for every degree rise in temperature. This sensor operates on a wide supply voltage range from 4V to 30V, making it compatible with various microcontrollers like Arduino. Its low self-heating of less than 0.1°C ensures accurate readings. The LM35 is widely used in applications like home automation, industrial monitoring, and consumer electronics, where precise temperature measurement is essential. Its simple 3-pin design (VCC, GND, VOUT) makes it easy to integrate into circuits, offering a straightforward way to measure temperature without complex circuitry.

Pin Connections by looking upto the table 2.3.1:
VCC : 5V power supply from Arduino Uno
Vout : Output for the Arduino uno
GND : Ground connection

Table 2.3.1: Pin description of LM35 Temperature sensor

Pin name	Description
VCC	5V power supply from Arduino Uno
Vout	Output for the Arduino uno
GND	Ground connection

2.4 12 v DC Fan

Figure 2.4.1: 12v DC Fan

A 12V DC fan is a small, electrically powered fan designed to operate on a 12-volt direct current (DC) power supply. It is commonly used in electronic devices and systems for cooling and ventilation purposes. The fan typically consists of a motor-driven rotor with blades encased in a protective housing, which helps to draw in and expel air, effectively dissipating heat from components like CPUs, GPUs, power supplies, and other electronic equipment.

The 12V DC fan is known for its efficiency and relatively low power consumption, making it suitable for applications where energy conservation is important. It is widely used in computers, home appliances, automotive systems, and industrial equipment to prevent overheating and maintain optimal operating temperatures.

The fan's size can vary, with common sizes being 80mm, 92mm, and 120mm, and it may feature different types of bearings, such as sleeve or ball bearings, which influence its noise level and durability. While 12V DC fans are generally quiet, higher-speed models may produce more noise. They are favored for their affordability, ease of installation, and ability to provide effective cooling in compact spaces.

Table 2.4.1: Pin Description of 12V DC fan

Pin Number	Pin Name	Description
1	Positive (+)	12V Power Supply (Positive)
2	Negative (-)	12V Power Supply (Ground)

2.5 Power supply requirements

Figure 2.5.1: 12VDC – 1.5A Power Adaptor

A 5V power supply provides a constant 5 volts of direct current (DC) to electronic devices. It's commonly used for powering microcontrollers, sensors, and other small electronics. The 5V power supply can come in various forms, including wall adapters, USB ports, and batteries as in fig 2.6.1. It ensures that devices receive a stable voltage necessary for their operation, preventing damage from power fluctuations. When designing circuits or projects, it's important to match the voltage and current requirements of your components with the power supply's specifications to ensure safe and efficient operation.

Specifications:

- Input Voltage : 100~240V
- Output Power : 12W
- Output Voltage : DC 5V ±5%
- Output Current : DC 1.5A
- Frequency : 50/60 Hz
- AC Inlet Mode : 2 Pins AC Cord

CHAPTER 3

SOFTWARE DESIGN

3.1 Hardware Resource allocation

Table 1: Hard ware Resource Allocation

Arduino UNO	Description
A0	Reads analog temperature data from the sensor
D9	Sends PWM signal to control the fan speed through the transistor
D12	Connects to LCD RS (Register Select) pin.
D11	Connects to LCD E (Enable) pin.
D5	Connects to LCD D4 pin.
D4	Connects to LCD D5 pin.
D3	Connects to LCD D6 pin.
D2	Connects to LCD D7 pin.
GND	Common ground for all components.
5V	Powers the LM35 sensor and LCD display.

3.2 Programming language

C++

3.3 Development Tool

Arduino SDK 1.6.9

3.4 Arduino IDE

Arduino software is needed to program Arduino boards and must be downloaded from the Arduino website and installed on a computer. This software is known as the Arduino IDE (Integrated Development Environment). Drivers must be installed in order to be able to program an Arduino from the Arduino IDE.

3.5 Design

3.5.1 Main Flow Diagram

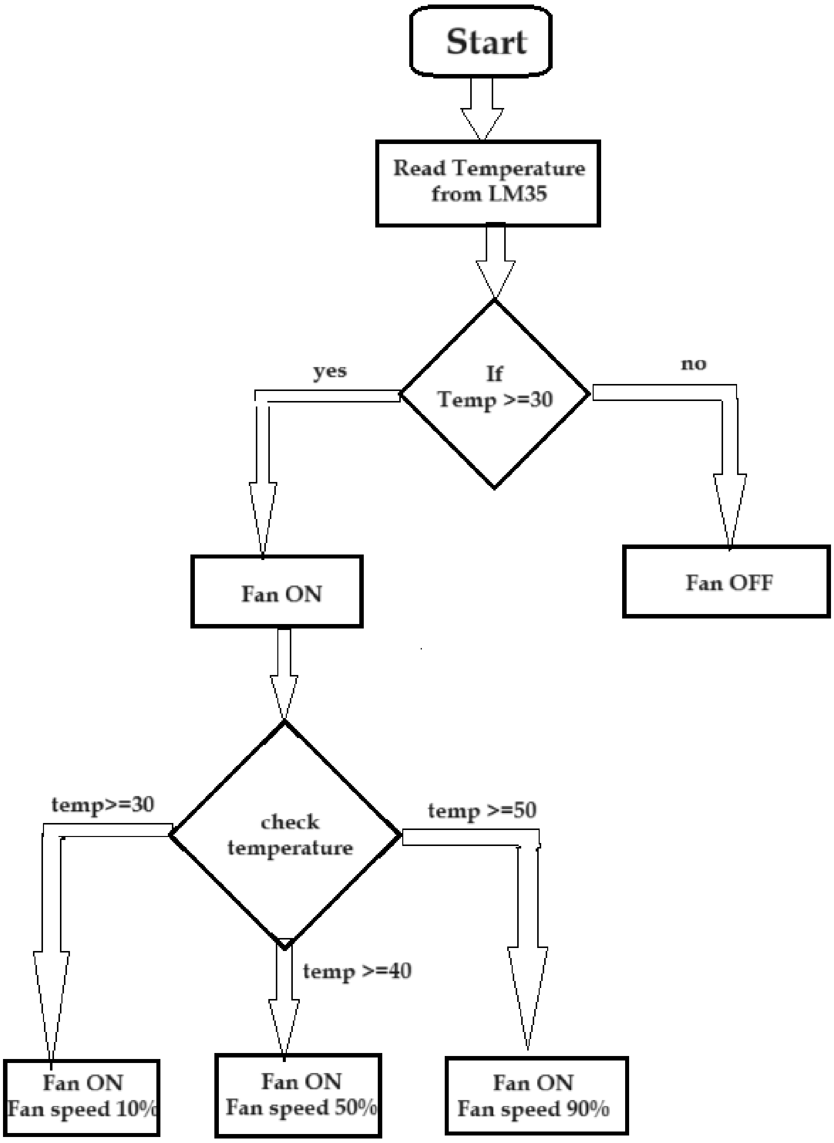

Figure 3.5.1.1 Control flow chart of Temperature based fan speed controller

In above figure 3.5.1.1 ,the flowchart for a temperature-based fan speed controller begins with initializing the Arduino, LM35 temperature sensor, and the fan. The system then reads the ambient temperature from the LM35 sensor, converting the analog voltage to a Celsius value. Based on the measured temperature, the system determines the appropriate fan speed by comparing it to predefined thresholds: low, medium, or high. For low temperatures, the fan speed is set to a minimum or turned off; for medium temperatures, the fan runs at a moderate speed; and for high temperatures, the fan operates at maximum speed. This is achieved by sending a corresponding PWM signal to control the fan's speed. Optionally, the system can display the current temperature and fan speed on an LCD for monitoring. The process loops continuously, allowing the fan to adjust its speed dynamically based on the temperature, ensuring efficient cooling.

CHAPTER 4

APPLICATIONS

4.1 Applications of Temperature based fan speed controller :

- CPUs and GPUs: Adjust fan speed to prevent overheating.
- Air conditioners and refrigerators: Optimize cooling efficiency.
- Smart thermostats: Regulate HVAC system fans.
- Automotive engines: Maintain optimal engine temperature.
- Automotive climate control systems: Ensure cabin comfort.
- Industrial machinery : Keep machines at safe temperatures.
- Industrial HVAC systems: Regulate airflow in large-scale systems.
- Data centers : Prevent server overheating.
- Laptops, tablets, and gaming consoles: Balance cooling and noise levels.
- Solar inverters: Maintain efficiency and longevity.
- Medical imaging devices (MRI, CT scanners): Ensure safe operating temperatures.

4.2 Advantages of Temperature based fan speed controller :

- Improved efficiency: Adjusts cooling based on need, reducing energy consumption.
- Enhanced equipment lifespan: Prevents overheating, extending component life.
- Noise reduction: Lowers fan speed when cooling demand is low.
- Cost savings: Reduces energy bills by optimizing fan usage.
- Automatic operation: Eliminates the need for manual fan speed adjustments.
- Better performance: Maintains optimal temperatures for electronic devices.
- Environmental benefits: Decreases overall energy usage and carbon footprint.
- System reliability: Prevents thermal-related failures in sensitive equipment.
- Comfort: Provides consistent climate control in automotive and home applications.
- Scalability: Applicable to various systems from small electronics to large industrial machines.

4.3 Disadvantages of Temperature based fan speed controller:

- Higher Initial Cost: Temperature-based controllers can be more expensive to install.
- Complex Maintenance: Requires specialized knowledge for troubleshooting and re-pairs.
- Potential Sensor Failure: Inaccurate readings can lead to improper cooling.
- Incompatibility Issues: May not be compatible with all existing systems.
- Noise Variations: Frequent speed changes can cause variable noise levels.

- Power Consumption: Continuous monitoring and adjustments can increase energy use.
- Limited by Sensor Accuracy: Effectiveness is dependent on the precision of temperature sensors.
- Firmware Updates: May require periodic updates to maintain performance.
- Response Time: There can be a delay in adjusting fan speeds to temperature changes.
- Wear and Tear: Frequent speed adjustments can lead to faster wear on fan components.
- Complex Installation: Setup can be more complicated than traditional systems.

CHAPTER 5

RESULT

5.1 Hardware Connection

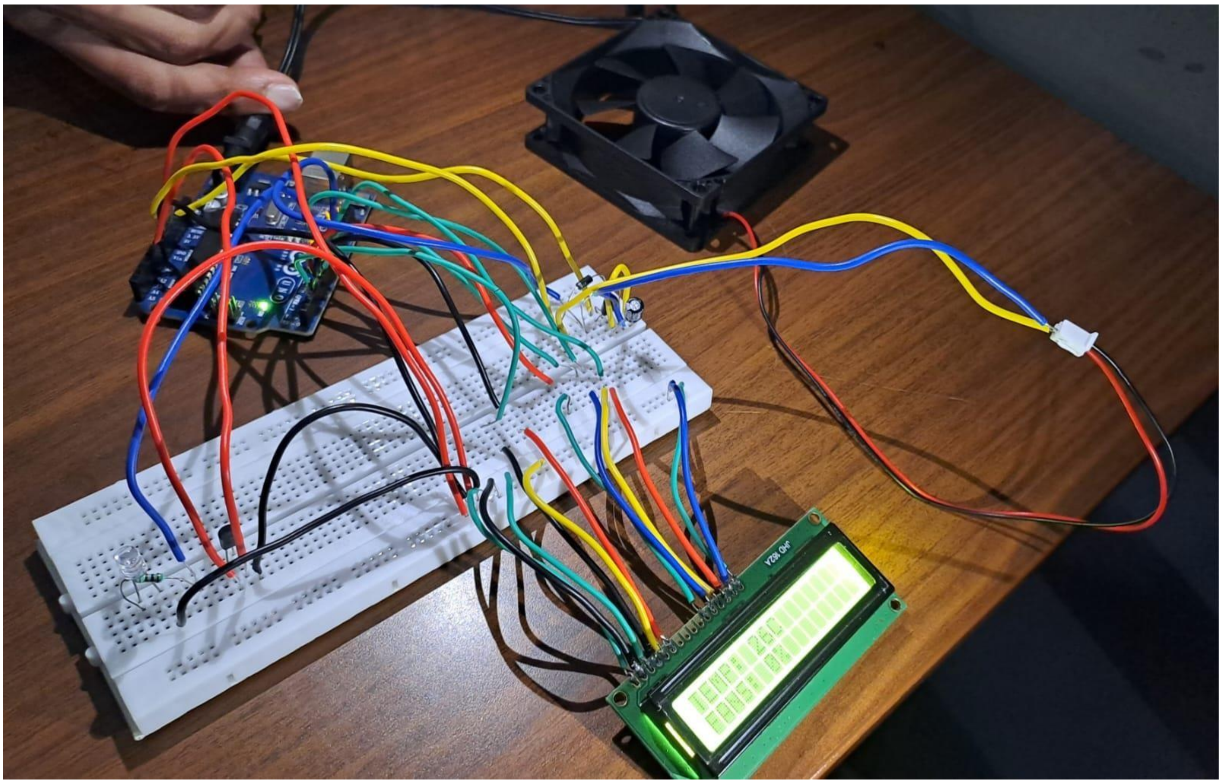

Fig :- 5.1.1 Hardware connection

In above figure 5.1.1 The temperature-based fan speed controller system consists of an Arduino Uno, an LM35 temperature sensor, and a 12V DC fan. The LM35 sensor is used to measure the ambient temperature and outputs an analog voltage that is linearly proportional to the temperature in Celsius. It is connected to one of the analog input pins of the Arduino

Uno, typically A0, for reading temperature data. The Arduino Uno processes this data to determine the required speed of the fan. The 12V DC fan is powered separately through an external power supply to provide adequate voltage and current for operation. To control the fan speed, a transistor (such as a TIP120) is used as a switch, driven by a PWM signal from one of the digital pins of the Arduino (e.g., pin 9). The transistor is connected to the ground and one terminal of the fan, allowing the Arduino to modulate the fan's speed by adjusting the PWM signal based on the temperature readings from the LM35. Additionally, a diode is placed parallel to the fan terminals to prevent back EMF from damaging the circuit. This setup enables the fan to adjust its speed automatically according to the surrounding temperature, providing efficient cooling.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

A temperature-based fan speed controller using Arduino provides an efficient and automated solution for regulating cooling systems. By leveraging the LM35 temperature sensor, the Arduino can accurately measure ambient temperature and adjust the fan speed accordingly. This dynamic control ensures that the fan operates at an optimal speed, minimizing energy consumption and noise while maintaining the desired environmental conditions. The system's flexibility allows for easy customization and scalability, making it suitable for various applications, from personal computer cooling to industrial environments. Furthermore, implementing such a system can significantly improve the longevity and performance of electronic devices by preventing overheating. Overall, this project demonstrates the power of microcontroller-based automation in creating responsive and intelligent systems that adapt to real-time environmental changes.

6.2 Future Scope

The future scope of temperature-based fan speed controllers is promising, with advancements likely to enhance their efficiency, integration, and functionality. Key areas of development include:

1. Smart and IoT Integration: Future controllers will increasingly integrate with smart home systems and IoT platforms, enabling more precise and automated climate control based on real-time data and user preferences.

2. Enhanced Sensor Technology: Improved sensor accuracy and reliability will minimize errors in temperature readings, leading to better performance and energy efficiency.

3. AI and Machine Learning: The incorporation of AI and machine learning algorithms will enable predictive maintenance and adaptive control, optimizing fan speeds based on usage patterns and environmental conditions.

4. Energy Efficiency Innovations: Advances in energy-efficient designs and materials will reduce power consumption further, making these controllers more environmentally friendly.

5. Wider Application Range: Expanding applications in emerging technologies such as electric vehicles, renewable energy systems, and advanced medical devices will drive demand and innovation.

6. Wireless and Remote Control: Enhanced wireless capabilities and remote monitoring will allow for easier installation, control, and troubleshooting of fan speed controllers.

7. Miniaturization: Smaller and more compact designs will facilitate integration into a broader range of devices, including portable and wearable technology.

8. Regulatory and Standardization Improvements: As regulations and standards for energy efficiency and electronic waste evolve, temperature-based fan speed controllers will adapt to meet new requirements, promoting sustainability.

Overall, the future of temperature-based fan speed controllers is set to benefit from technological advancements that will improve their effectiveness, reduce their environmental impact, and broaden their applicability across various industries.

CHAPTER 7

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APPENDIX – A

CODE :

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(2,3,4,5,6,7);
int tempPin = A0; // the output pin of LM35
int fan = 11; // the pin where fan is
int led = 8; // led pin
int temp;
int tempMin = 30; // the temperature to start the fan 0%
int tempMax = 60; // the maximum temperature when fan is at 100%
int fanSpeed;
int fanLCD;

void setup() {
pinMode(fan, OUTPUT);
pinMode(led, OUTPUT);
pinMode(tempPin, INPUT);
lcd.begin(16,2);
Serial.begin(9600);
}

void loop()
{
temp = readTemp(); // get the temperature
Serial.print( temp );
if(temp < tempMin) // if temp is lower than minimum temp
{
fanSpeed = 0; // fan is not spinning
analogWrite(fan, fanSpeed);
fanLCD=0;
```

```
digitalWrite(fan, LOW);

}

if((temp >= tempMin) && (temp <= tempMax)) // if temperature is higher than minimum
temp

{

fanSpeed = temp;//map(temp, tempMin, tempMax, 0, 100); // the actual speed of
fan//map(temp, tempMin, tempMax, 32, 255);

fanSpeed=1.5*fanSpeed;

fanLCD = map(temp, tempMin, tempMax, 0, 100); // speed of fan to display on LCD100

analogWrite(fan, fanSpeed); // spin the fan at the fanSpeed speed

}


if(temp > tempMax) // if temp is higher than tempMax

{

digitalWrite(led, HIGH); // turn on led

}

else // else turn of led

{

digitalWrite(led, LOW);

}


lcd.print("TEMP: ");

lcd.print(temp); // display the temperature

lcd.print("C ");

lcd.setCursor(0,1); // move cursor to next line

lcd.print("FANS: ");

lcd.print(fanLCD); // display the fan speed

lcd.print("%");

delay(200);

lcd.clear();

}
```

```
int readTemp() { // get the temperature and convert it to celsius
temp = analogRead(tempPin);
return temp * 0.48828125;
}
```