International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 11 | Nov - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Smart Thermal System Using Lm35 Sensor And 8051 Microcontroller

Padmavati Pise[1], Snehal Shewale[2], Anha Pathan[3] , Maithili Shevale[4]

[1]*Guide, Department Of Electronic & Telecommunication Engineering, D .Y .Patil Collage Of Engineering And Technology Kolhapur, Kolhapur, Maharashtra, India*

[2,3,4] *Student, Department Of Electronic & Telecommunication Engineering, D .Y .Patil Collage Of Engineering And Technology Kolhapur, Kolhapur, Maharashtra, India*

---***---

Abstract - This paper describes the design and development of a Smart Thermal System that automatically adjusts the speed of a cooling fan based on the surrounding temperature. The system uses an LM35 temperature sensor for accurate temperature measurement and an 8051 microcontroller for smart decision-making. As the temperature rises, the microcontroller controls the fan speed through a motor driver circuit (L293D) using Pulse Width Modulation (PWM) signals. This automation reduces manual work, saves energy, and creates a comfortable thermal environment. The system is simple, compact, and can be used in homes, industries, and embedded applications where temperature control is essential.

Keywords:

Temperature Control, LM35 Sensor, 8051 Microcontroller, DC Fan, Automatic System, Embedded Design, PWM Control.

1.INTRODUCTION

Temperature control systems are commonly found in everyday items like air conditioners, computer cooling systems, and refrigerators. Traditionally, these systems rely on manual switches or thermostats, which tend to be less accurate and inefficient. To address these issues, this project introduces a microcontroller-based automatic fan control system. It continuously monitors temperature and adjusts the fan speed as needed.

The 8051 microcontroller acts as the main processing unit, working with an LM35 temperature sensor that provides an analog voltage matching the current temperature. The system changes this analog signal into a digital format and sets fan speed levels based on pre-defined temperature limits.

This system provides:

- Automatic operation (no manual switching)

- Low power consumption

- Low cost and easy setup

- Scalability for larger smart home or industrial configurations

These smart systems are vital in today's world of automation and energy efficiency.

2.LITERATURE REVIEW

Earlier temperature-based systems used thermostats or analog comparators to switch devices ON or OFF at fixed points. These methods lacked precision and consumed more power. With the rise of microcontrollers, digital control has become more accurate and flexible.

Various studies have shown the use of Arduino or PIC microcontrollers for temperature-based systems, but the 8051 microcontroller remains widely used due to its simple architecture, low cost, and wide availability in educational setups. The LM35 sensor provides linear output and high accuracy compared to thermistors, making it ideal for real-time applications.

Hence, this project integrates both — the accuracy of LM35 and the control capability of 8051, resulting in a compact, smart, and efficient thermal management system.

3.SYSTEM DESIGN

The proposed Smart Thermal System automatically controls the fan speed based on the surrounding temperature. The design has four main functional blocks: sensing, processing, driving, and display. Each block serves a specific purpose, and they all work together for effective temperature-based fan control.

3.1 System Architecture

The architecture of the system includes these key units:

1. Sensing Unit – LM35 Sensor

The LM35 is a precise temperature sensor. Its output voltage directly relates to the Celsius temperature, providing 10 mV per °C.

Example: At 25°C, the output voltage equals 250 mV.

This analog signal goes to the ADC (Analog to Digital Converter) input of the 8051 microcontroller or through an external ADC module like ADC0804.

The LM35 gives reliable and stable readings without needing calibration.

2. Signal Conditioning Unit

The LM35 produces a small analog voltage, so a conditioning circuit with resistors and capacitors stabilizes and protects the signal from noise. In some designs, an operational amplifier may be included for scaling or buffering.

3. Processing Unit – 8051 Microcontroller (AT89C51)

The microcontroller acts as the system's brain. It reads the digital temperature value from the ADC, compares it to set temperature limits, and sends control signals to the fan driver circuit.

Port 1 is for ADC data input.

Port 2 controls the LCD display.

Port 3 transmits PWM or control signals to the L293D motor driver.

4. Driving Unit – L293D Motor Driver IC

The L293D is a dual H-bridge motor driver that controls the direction and speed of DC motors. It receives low-current logic signals from the microcontroller and delivers enough current to drive the fan.

The Enable pin of the L293D manages fan speed through PWM signals from the 8051.

5. Output Unit – DC Fan & LCD Display

The DC fan is the final output that adjusts its speed based on temperature.

The 16×2 LCD displays the current temperature and fan status (e.g., “Fan Low,” “Fan Medium,” “Fan High,” “Fan OFF”).

3.2 Working Principle of the System

1. When the system powers ON, the LM35 sensor continually checks the ambient temperature and creates a corresponding voltage.

2. The ADC turns this analog voltage into a digital value that the 8051 can work with.

3. The microcontroller runs the control program, comparing the measured temperature to threshold levels:

Below 25°C → Fan OFF

25°C–30°C → Fan ON (Low Speed)

30°C–35°C → Fan ON (Medium Speed)

Above 35°C → Fan ON (High Speed)

4. Based on these conditions, the controller sends the correct PWM signals to the L293D driver, which adjusts the fan speed.

5. At the same time, the current temperature and fan status appear on the LCD screen.

6. This process repeats continuously, ensuring real-time temperature monitoring and control.

This design makes the system smart, automatic, and energy-efficient. It works in a closed loop: feedback (temperature) is consistently checked, processed, and adjusted.

4.HARDWARE COMPONENTS

1. LM35 Temperature Sensor: Provides output that matches temperature (10 mV/°C).

2. 8051 Microcontroller (AT89C51): Controls system operation and is programmed using Embedded C.

3. Motor Driver IC (L293D): Boosts the control signal to run the DC fan.

4. 16x2 LCD Display: Shows real-time temperature readings.

5. DC Fan: Works at different speeds based on temperature.

6. Power Supply (5V & 12V): Gives stable power to all components.

7. Crystal Oscillator (12 MHz): Supplies clock pulses to the microcontroller.

8. Resistors, Capacitors, and Connecting Wires: Ensure stable operation and complete the circuit.

5.SOFTWARE DESIGN

The software program reads temperature data, processes it, controls fan speed, and displays information. It is written in Embedded C language and compiled with Keil µVision IDE. The microcontroller periodically reads the sensor value and converts it into a temperature using a formula. Based on this reading, the controller adjusts the fan speed using PWM.

5.1 Algorithm Steps

1. Initialize LCD, ports, and ADC.

2. Continuously read temperature from LM35.

3. Convert analog value to temperature (°C).

4. Compare the temperature with preset thresholds.

5. Based on the range, generate PWM for the motor driver.

6. Display temperature and fan status on LCD.

7. Repeat the process continuously for real-time control.

5.2 Flowchart Description

Start → Initialize peripherals.

Read Sensor Value → Get analog data from LM35.

Convert and Calculate Temperature.

Decision Block:

If $T < 25°C$ → Fan OFF

If 25°C ≤ T < 30°C → Fan Low

If 30°C ≤ T < 35°C → Fan Medium

If T ≥ 35°C → Fan High

Display Temperature on LCD.

Return to reading loop for continuous monitoring.

This logic ensures smooth fan speed changes instead of abrupt ON/OFF switching. It improves both performance and component life.

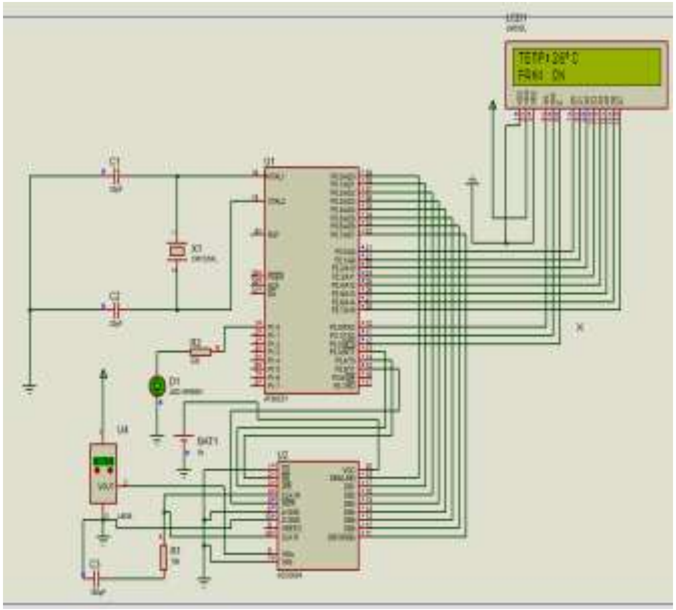

Fig 1: Schematic Diagram

6.RESULTS AND DISCUSSION

The proposed system was successfully tested under different temperature conditions. The output shows a clear link between temperature and fan speed.

At 25°C, the fan stays OFF.

From 26°C to 30°C, the fan runs at low speed.

From 31°C to 35°C, the fan runs at medium speed.

Above 35°C, the fan runs at maximum speed.

The LCD displays real-time temperature readings. The system showed stable performance, low response delay, and high reliability even after continuous use. Power consumption was much lower compared to manual fan control systems.

7.FUTURE TRENDS AND CHALLENGES

1. Automatic Room Temperature Control:

The system can be set up in homes or offices to automatically adjust fan speed and keep a comfortable temperature without any manual changes.

2. Industrial Equipment Cooling:

In factories and workshops, machines often produce heat during operations. This system can turn on cooling fans automatically to stop overheating and keep equipment running well.

3. Server Rooms and Data Centers:

This system monitors and controls the temperature of server racks or computer rooms, where stable conditions are crucial to prevent system failure.

4. Refrigeration and HVAC Systems:

The system can be modified for smart temperature control in air conditioners, refrigerators, and HVAC systems, which helps save energy and improve efficiency.

5. Automobile Climate Management:

This feature is built into car dashboards for automatic fan control based on engine or cabin temperature, enhancing passenger comfort and reducing manual adjustments.

6. Greenhouse and Agricultural Applications:

It keeps the ideal environment for plant growth by controlling temperature and air circulation inside greenhouses.

7. Medical and Laboratory Equipment:

This system is used in incubators, sterilizers, and other lab devices that need accurate temperature monitoring and control.

8. Smart IoT-Based Home Automation:

When linked to IoT modules like Wi-Fi (ESP8266/ESP32), it can send real-time temperature data to a mobile app or cloud dashboard, allowing for remote monitoring and control.

CONCLUSION

The Smart Thermal System uses an LM35 sensor and an 8051 microcontroller. It provides a cost-effective and efficient way to regulate temperature automatically. This project shows how embedded systems can create smart and energy-saving applications.

The system's modular design allows for easy upgrades by adding IoT (Internet of Things) features. This means you can monitor and control it remotely using mobile devices. In the future, the project can be enhanced by including humidity sensors, Bluetooth or Wi-Fi modules, or cloud data logging to improve automation and analysis.

REFERENCES

1.Muhammad Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education.
2. Datasheet: LM35 Precision Centigrade Temperature Sensor, Texas Instruments.
3.Datasheet:AT89C51 Microcontroller, Microchip Technology.
4. Raj Kamal, Embedded Systems: Architecture,

Programming and Design, Tata McGraw-Hill.
5. Kunal Ghosh et al., "Microcontroller-based Temperature Controlled Fan," IJERT, Vol. 8, Issue 5, 2023.