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DESIGN AND IMPLEMENTATION OF A DIGITAL THERMOMETER USING ARDUINO AND LM35 SENSOR

Ch Prashant kumar Dora, Dept of ECE, 22ece118.chprashantkumardora@giet.edu
Aditya kumar Madhav, Dept. Of ECE, 22ece112.adityakumarmadhav@giet.edu
Sourav Naik, Dept, of ECE, 22ece115.souravnaik@giet.edu
Devashish kumar, Dept. of ECE, 22ece113.devashishkumar@giet.edu
Tusharkant Panda, Asst. Prof. Dept. of ECE, tkpanda@giet.edu

Abstract: The design and implementation of a digital thermometer using an Arduino microcontroller and LM35 sensor are shown in this work. An output voltage that is linearly proportional to the Celsius temperature is provided by the precision integrated-circuit LM35 sensor. An open-source platform called the Arduino board may be configured to read the analog input from the LM35 sensor and show the temperature on a 16x2 LCD screen. The project's components and circuit diagram are described in detail, together with the project's operating principles and source code, and the project's outcomes and analysis are presented. The paper provides examples of how to utilize the Arduino IDE, the LM35 library, the LCD library, and fundamental programming ideas. The report ends with several recommendations for potential future advancements.

Keywords— Digital Thermometer, LM35 Sensor, Arduino Microcontroller, LCD Display(16x2), Variable Resistor, Connecting wires.

1. Introduction:

A digital thermometer is a device that can measure and display the temperature of an object or environment using electronic components. Digital thermometers have many advantages over traditional thermometers, such as higher accuracy, faster response, and easier readability. One of the common sensors used in digital thermometers is the LM35, which is a precision integrated-circuit temperature sensor that produces an output voltage linearly proportional to the Celsius temperature. The LM35 sensor has many advantages, such as: It is calibrated directly in Celsius, so no conversion is required. It has a low output impedance, which makes it easy to interface with readout or control circuits. It has a low self-heating effect, which minimizes the error due to temperature changes in the sensor itself. It operates from a wide range of power supply voltages, from 4V to 30V. As fever is one of the most common diseases happen to human, an appropriate recording of fever consoles the health care providers in avoiding inappropriate medical consultations and investigations [11]. It has a high accuracy of ±0.5°C at 25°C and ±0.75°C over the full -55°C to 150°C temperature range. Though mercury thermometers are very accurate, still its alternative is required because of its toxic nature as mentioned in an article [5] in “Hindustan Times” says

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that, at the time of breakage of mercury thermometer, the mercury spilled out and started vaporizing immediately in temperatures of 22-24 degrees Celsius. Furthermore, research has shown that body temperature is a nonlinear function of several variables such as age, state of health, gender, environmental temperature, time of the diurnal cycle, among many others [3]. In this paper, we will discuss how to design and implement a digital thermometer using an Arduino microcontroller and an LM35 sensor. We will also demonstrate how to display the measured temperature on a 16x2 LCD screen and how to calibrate the sensor for better accuracy. We will compare the performance of our digital thermometer with other types of thermometers and discuss the limitations and challenges of using the LM35 sensor.

2. LITERATURE REVIEW:

A digital thermometer is a tool that uses a sensor to measure temperature and displays the results on a screen or computer. It can be applied in a number of different contexts, including medicinal, industrial, and environmental ones. The LM35, a precision integrated-circuit temperature sensor that produces an output voltage linearly proportional to the Celsius temperature, is one of the most used sensors for digital thermometers. A low-cost digital thermometer with an LM35 temperature sensor, a PIC16F77A microcontroller, and a 16*2 LCD display was designed for everyday use by the general public and published in Design of Digital Thermometer Based on PIC16F77A Single Chip Microcontroller by K. Mahmud et al. [4]. This system's drawback is that it cannot be used to monitor temperatures below zero, and the thermometer's accuracy was only ± 2.0 C with a 0.5–2.5% error rate. The extended operating range of LM35 sensors is the rationale behind their selection. In 2018[6], a voice-activated digital thermometer is created for use in medical settings. The purpose of this study is to design a portable thermometer and to determine a patient's condition. This is accomplished by utilizing an LM35 sensor, an RF 343 wireless transmitter, and a receiver to send data over long distances. However, this paper presents a contradiction in that it is exclusively intended for use by physicians in remote patient monitoring, and the transmission range is limited to approximately 50 feet. [1] implemented an automatic temperature detection system for the LM35-based digital room temperature meter. The goal of the study is to design a digital thermometer based on a microcontroller and achieve automatic room temperature detection. The LM35 is superior than other temperature sensors in several ways, including affordability, low power consumption, ease of interface, high accuracy, broad range, and lack of calibration. The LM35 can be used to build and implement a variety of digital thermometer projects by interfacing with various microcontrollers, including Arduino, PIC, Raspberry Pi, and others. The LM35 can easily be integrated with additional parts, like LCDs.

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3. DESIGN AND SIMULATIONS:

Digital thermometer is device which senses the surrounding temperature and display it in a LCD or any computer screen. This device has various application in the world and in day-to-day life. Using these single devices, we can design various automatic system that requires the information about the temperature. The various components used in this design are:

3.1 **ARDUINO (SIMULINO NANO):** It is a simulation software that allows you to program and test Arduino Nano boards on your computer without using any physical hardware.

3.2 **LM35:** The LM35 temperature sensor is a versatile and precise tool for measuring temperature in a variety of applications.

3.3 **VARIABLE RESISTOR:** Variable resistors, also known as potentiometers, are electrical components that allow you to adjust the resistance in a circuit, making them ideal for volume controls and many other applications.

3.4 **LCD SCREEN:** An LCD screen 16x2 is a liquid crystal display with 16 characters per line and 2 lines, commonly used for text and simple graphical information displays in various electronic devices.

3.5 **CONNECTING WIRES:** These are wires used to connect components.

3.6 **CIRCUIT DIAGRAM:**

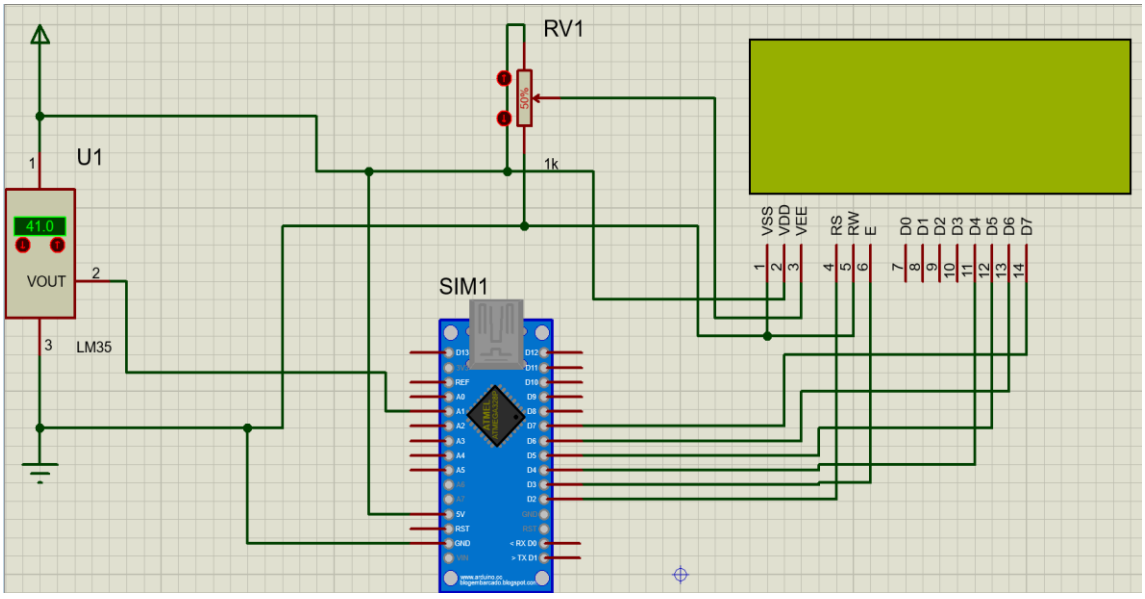

Figure 1: Diagram of circuit

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Design specification for a digital thermometer can vary depending on the specific requirements and use cases, but here are some specifications to consider: -

1. Temperature range – It can measure the temperature between -55°C to 150°C.
2. Accuracy – It has a desired value of accuracy ±0.5°C at room temperature and ±1°C over a full −55°C to 150°C temperature range.
3. Resolution – The smallest difference the thermometer can display is ±1°C.
4. Display – 16x2 LCD display is been used with size: -

Table 1: Specification of display

Sl. No	Parameters	Size
1.	MODULE DIMENSION	80.0 x 36.0 x 13.2 (mm)
2.	VIEWING AREA	66.0 x 16.0 (mm)
3.	DOT SIZE	0.55 x 0.65 (mm)
4.	DOT PITCH	0.60 x 0.70 (mm)
5.	CHARACTER SIZE	2.95 x 5.55 (mm)

4. Result Analysis

This is a Device which measures the temperature and display it on the screen using LM35 sensors within few seconds. It even displays how the temperature feels like and it is as follows:

Table 2: Result analysis

S NO.	TEMPERATURE RANGE(DISPLAYS)	FEELING (DISPLAYS IN OUTPUT)
1.	>=32°C	VERY HOT
2.	26°C-31°C	MODERATE TEMPERATURE
3.	20°C-25°C	NORMAL TEMPERATURE
4.	15°C-19°C	QUITE COLD
5.	<15°C	VERY COLD

5. Conclusion

The LM35 Digital Thermometer is a versatile, precise temperature sensor. Its linear temperature sensing system offers high accuracy and ease of use. This article explores its design, simulation, source code and how it outshines other sensors. We provide a circuit

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diagram, component list, and a step-by-step guide for assembly. Programming it with an Arduino and interfacing with display devices are explained. Its simplicity, precision, and ease of integration make it a top choice for temperature monitoring and control. The LM35 contributes to home automation. In conclusion, the LM35 is a valuable tool for temperature measurement.

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