Room Safety Monitoring Using a Temperature Sensor Alarm System

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ABSTRACT

This study developed an affordable room safety monitoring system designed to address the critical lack of lowcost tools for detecting hazardous temperature fluctuations in residential and educational environments. Recognizing that commercial safety systems are often cost-prohibitive for average households and local schools, this research aimed to engineer a prototype using accessible, off-the-shelf components. The system utilizes an Arduino UNO microcontroller as its central processing unit, integrated with a high-precision LM35 temperature sensor to provide continuous, real-time environmental monitoring.

The technical architecture is programmed to maintain a specific "safe zone" through a constant feedback loop. When the device detects environmental conditions that deviate from these pre-defined parameters, it triggers a multi-modal alert system designed to ensure immediate human intervention. This includes an auditory alarm via a piezoelectric buzzer, a high-visibility red LED, and a 16×2 LCD screen that displays live temperature data and status updates.

Methodological testing was conducted using controlled heat and cold sources to establish the threshold reliability of the prototype. The results verified that the alarm system consistently and reliably activates when temperatures exceed 41°C or drop below 15°C, maintaining a low margin of error across multiple trials. These findings demonstrate that the prototype is a highly responsive and practical solution for mitigating fire hazards, preventing heat-related illness, and monitoring machinery for potential overheating. Ultimately, this research bridges the gap between high-end industrial safety equipment and community needs, providing a reliable, user-friendly, and cost-effective tool that makes essential safety technology accessible to the general public.

Keywords: Temperature, alarm system, temperature sensor, warning threshold, room safety monitoring

INTRODUCTION

Temperature is a fundamental environmental factor that often goes unnoticed until a room becomes uncomfortably hot or cold. However, in many contexts, a sudden change in temperature serves as a critical warning sign for serious safety risks. These fluctuations may indicate overheating machinery, fire hazards, or unsafe environmental conditions that can compromise both property and personal safety. Furthermore, improper temperature regulation can negatively impact health by weakening the immune system and worsening chronic conditions such as asthma.

Many accidents and system failures result from a lack of consistent monitoring. When early signs of instability are missed, the chance to fix the problem before it escalates is lost. This issue is common in homes and classrooms that lack budget-friendly tools to detect rising heat. Without these early warnings, simple issues can quickly turn into serious electrical hazards or fires.

In response, this research focuses on creating an alarm system that uses a temperature sensor and a microcontroller. The main goal was to build an affordable, user-friendly device for everyday use, making safety technology available to those who cannot afford expensive industrial equipment. The system provides instant alerts using a buzzer and an LED screen that displays the current temperature whenever conditions reach dangerous levels.

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REVIEW OF RELEVANT THEORY, STUDIES, AND LITERATURE

This section presents the theoretical foundations and related studies that support the development of the room safety monitoring system using a temperature sensor alarm. The review is divided into relevant theories and related literature to establish the significance, feasibility, and reliability of the proposed system.

Relevant Theories

Figure 1. Temperature Sensing Theory

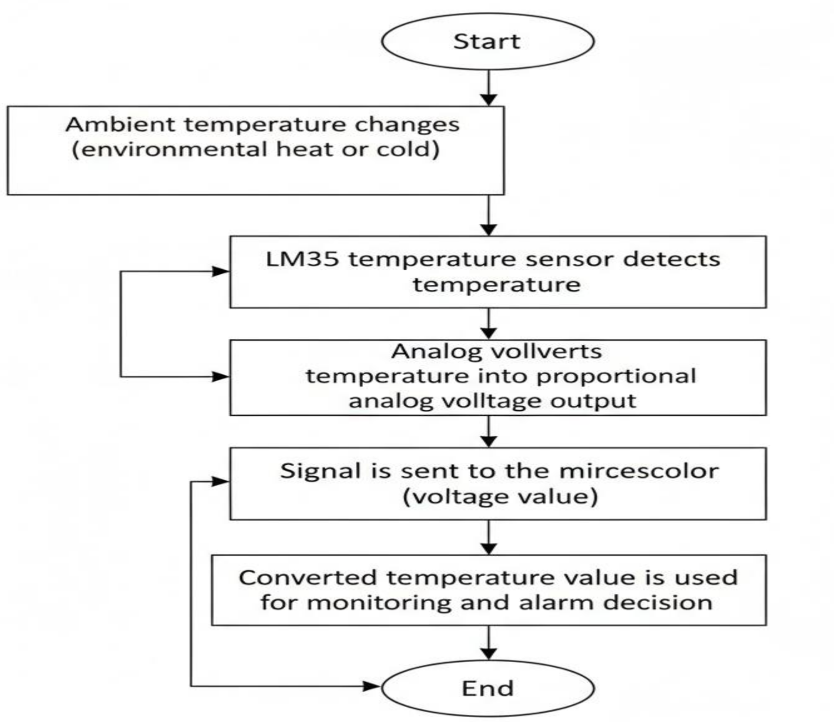

Figure 2. Embedded Systems Theory

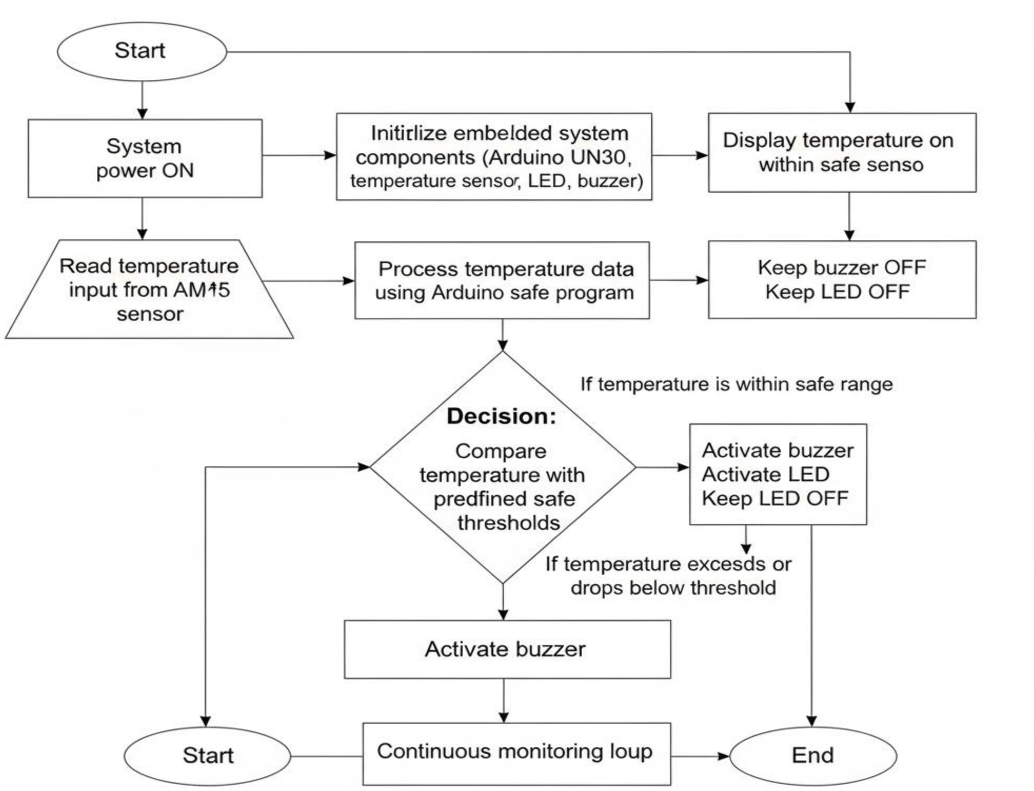

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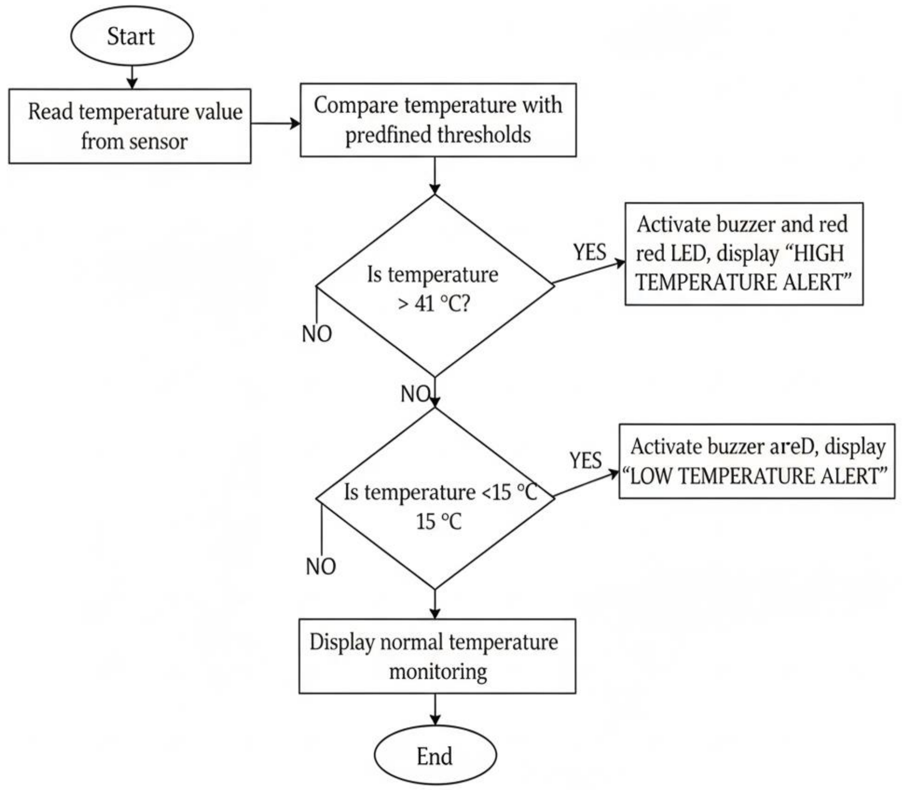
Figure 3. Threshold-Based Alarm Theory



Threshold-Based Alarm Theory focuses on the activation of alerts when measured values exceed predefined safe limits. This theory is commonly applied in safety systems such as fire alarms, industrial monitoring, and environmental control systems. When a parameter crosses a critical threshold, the system generates an immediate warning to prompt human intervention. In this research, temperature thresholds of above 41 °C and below 15 °C are used to trigger audio and visual alarms, ensuring early detection of potentially hazardous conditions.

Figure 4. Human–Computer Interaction (HCI) Theory

Human–Computer Interaction theory emphasizes designing systems that are easy to understand and use by humans. Safety systems must provide clear and immediate feedback to users to reduce confusion and response time during emergencies. The inclusion of a buzzer, LED indicators, and an LCD display in this study aligns with HCI principles by ensuring that alerts are noticeable, understandable, and accessible to users with minimal technical knowledge.

Review of Related Studies and Literature

Kuzubasoglu and Bahadir (2020) reviewed flexible temperature sensors and highlighted their importance in monitoring environmental conditions for safety and industrial applications. Their study emphasized the role of accurate and responsive temperature sensors in preventing hazards caused by overheating. This supports the use of temperature sensors such as the LM35 in safety monitoring systems.

Li et al. (2024) discussed the application of temperature sensors in human health monitoring systems. Their research demonstrated that continuous temperature monitoring can help detect abnormal environmental conditions that may affect human health. This finding reinforces the relevance of real-time temperature monitoring in indoor environments such as homes and classrooms.

Yahya, Pambudi, and Nugraha (2022) developed a community-based fire and temperature monitoring system aimed at improving safety and fire prevention. Their study showed that temperature-based monitoring systems are effective in providing early warnings before fire incidents occur. This study aligns closely with the present research, as both focus on early detection of temperature anomalies to enhance safety.

Several existing studies emphasize the effectiveness of microcontroller-based alarm systems in detecting abnormal conditions. However, many commercial solutions are expensive and not easily accessible to small households or educational institutions. The present study addresses this gap by developing a low-cost, Arduino-based temperature alarm system that is simple, affordable, and suitable for small indoor environments.

Synthesis of the Review

Based on the reviewed theories and related studies, temperature-based monitoring systems using embedded microcontrollers are effective tools for early hazard detection. The integration of accurate temperature sensors, threshold-based decision logic, and user-friendly alert mechanisms ensures reliable safety monitoring. The reviewed literature supports the design and implementation of the proposed system and highlights its relevance in addressing the lack of affordable room safety monitoring solutions.

Importance and Relevance

This study relies on its ability to provide an early warning when temperatures reach unsafe levels. Many fire hazards and overheating incidents begin with small temperature changes that often go unnoticed. By developing a low-cost temperature-based alarm system, this project helps improve safety in homes, classrooms, and small establishments. It also supports learning in technology and electronics, showing how sensors can be used to address real life problems. This makes the study both practical for community safety and valuable for educational purposes.

Statement of the Problem

Many small indoor areas such as homes, classrooms, and storage rooms lack affordable devices capable of detecting sudden changes in temperature. The absence of early warning systems increases the risk of overheating, electrical hazards, and potential fire accidents. Without timely alerts, minor temperature irregularities may go unnoticed until they develop into serious safety threats. To address this concern, there is a need for a simple and cost-effective alarm system that can continuously monitor temperature and notify occupants when unsafe conditions occur. This study aims to address this problem by developing a microcontroller-based temperature alarm system and evaluating its effectiveness in preventing potential dangers as well as its accuracy in detecting temperature changes.

General Objective

To design and develop a simple alarm system that uses a temperature sensor to detect unsafe temperature levels and provide an early warning to help prevent potential hazards.

Specific Objective

Construct a working prototype of an alarm system using a temperature sensor, microcontroller, and buzzer. Subsequently, test how quickly the alarm activates when the temperature reaches a preset unsafe level. Finally, test the effectiveness of the system in giving early warnings in a controlled environment.

Scope and Limitation

This study focuses on the design, development, and testing of a room safety monitoring system using a temperature sensor. The system uses an Arduino UNO and an LM35 temperature sensor to monitor room temperature and provide audio and visual alerts when the temperature goes beyond the preset safe limits. The testing is limited to detecting high and low temperature conditions in small indoor areas such as homes and classrooms.

The study is limited to temperature-based monitoring only and does not include other safety indicators such as smoke, gas, or flame detection. The system was tested only in a controlled environment using artificial heat and cold sources, which may not fully represent real-life fire or extreme weather situations. The temperature thresholds are predefined and fixed, and user adjustment is not included. In addition, the prototype is intended for small-scale use and its long-term durability and performance were not evaluated.

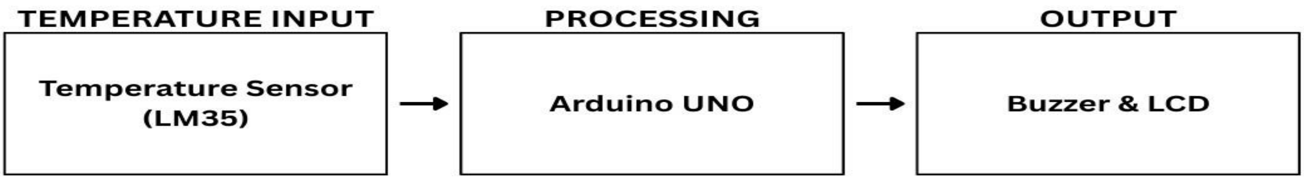
METHODOLOGY

Research Design

This study uses a design focused on building and testing a working safety monitor. The process starts with the assembly of a prototype that uses an Arduino microcontroller as its main controller, connected to a sensitive temperature sensor and a buzzer for loud alerts.

The goal of this design is to check how well the system works when the room temperature moves outside of a "safe zone". The research looks at two specific situations: when the temperature gets too high (signaling a fire or overheating) and when it gets too low (signaling extreme cold). By testing the device in a controlled setting, the study measures how accurately the sensor reads the temperature and how fast the alarm sounds. This design proves if the device is a reliable and low-cost way to keep homes and classrooms safe.

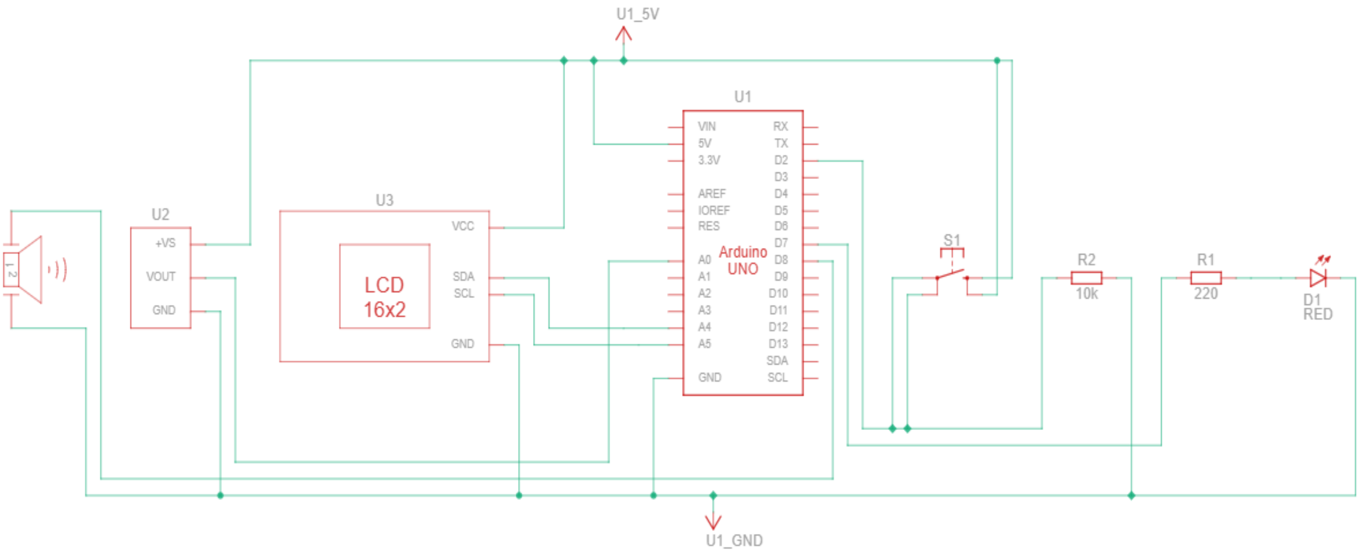
Figure 4. Block Diagram



It's illustrating the functional flow of the room safety monitoring system from sensor input to alarm output.

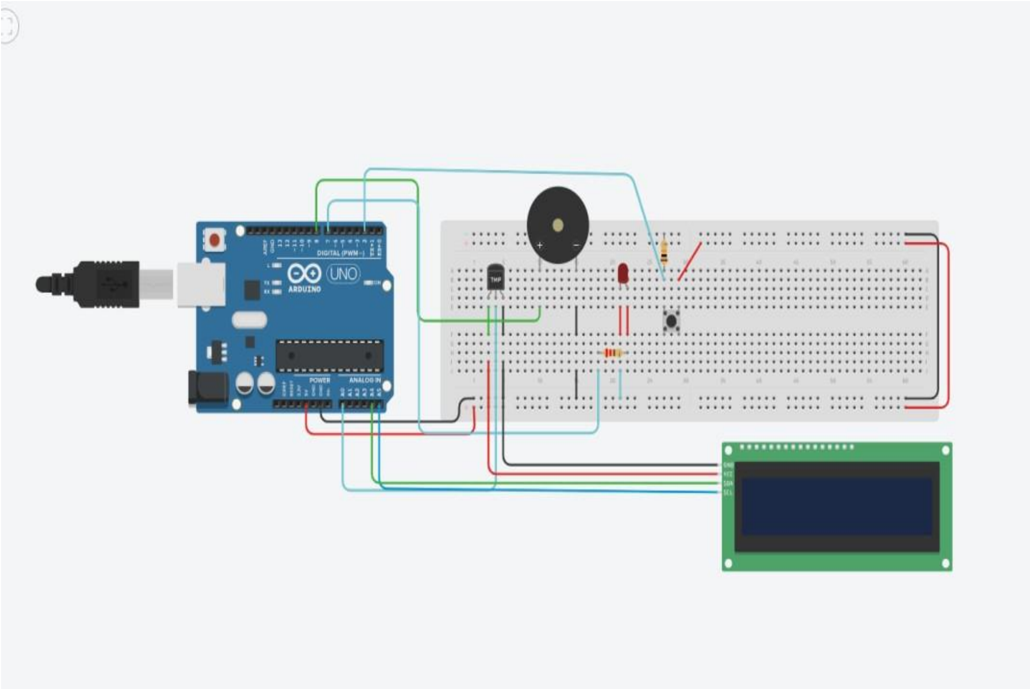
The block diagram shows how the system works step by step. The temperature sensor (LM35) acts as the input and continuously measures the surrounding temperature. The measured temperature is sent to the Arduino UNO, which processes the data and checks if the temperature is too hot or too cold based on the set limits. When an abnormal temperature is detected, the Arduino sends a signal to the buzzer, which produces a sound as an alert to warn the user. The LCD then returns the digital reading of the temperature of the surroundings.

Figure 5. Schematic Diagram



Schematic circuit diagram showing the electrical connections between the microcontroller and peripheral components.

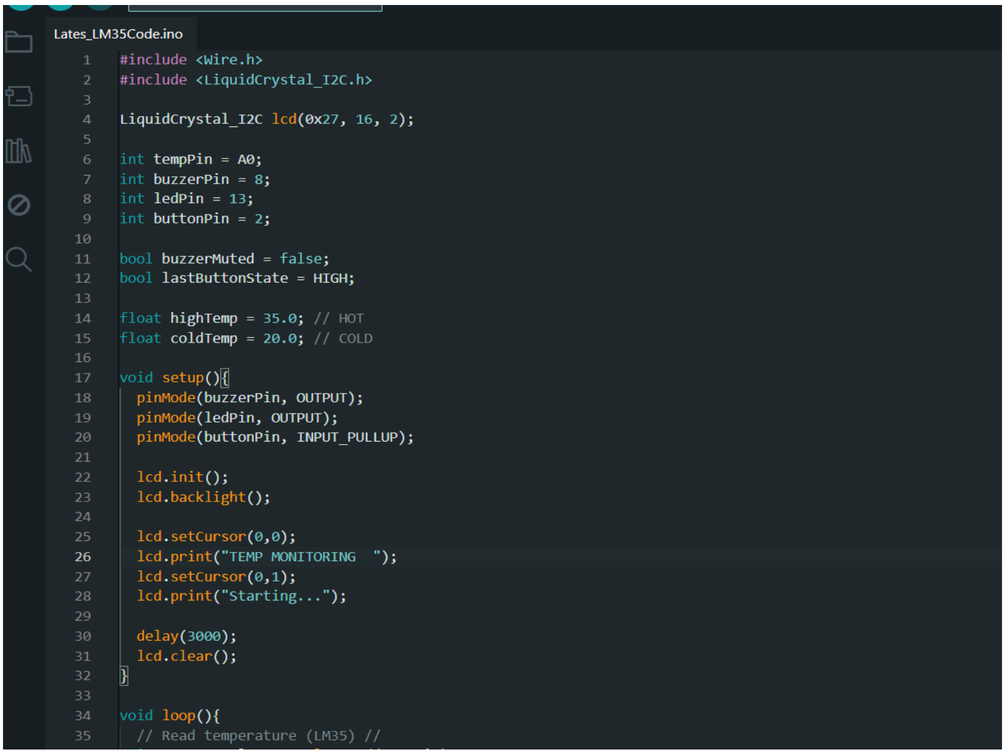
Figure 5. Breadboard Prototype



Breadboard Prototype of the Arduino-Based Temperature Monitoring and Alarm System

This circuit uses the Arduino UNO as the main controller and the LM35 temperature sensor (U2) to monitor temperature. The LM35 continuously senses the surrounding temperature and sends an analog signal to the Arduino. When the Arduino detects that the temperature becomes too hot or too cold based on the programmed limits, it automatically activates the buzzer as an alert and can also indicate the status using the LED and LCD. The push button is not used to start the alarm; instead, it is used to stop or silence the buzzer when pressed, with the 10 kΩ resistor ensuring a stable button signal.

Figure 6. Arduino Code



Lates_LM35Code.ino

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27, 16, 2);

int tempPin = A0;
int buzzerPin = 8;
int ledPin = 13;
int buttonPin = 2;

bool buzzerMuted = false;
bool lastButtonState = HIGH;

float highTemp = 35.0; // HOT
float coldTemp = 20.0; // COLD

void setup(){
  pinMode(buzzerPin, OUTPUT);
  pinMode(ledPin, OUTPUT);
  pinMode(buttonPin, INPUT_PULLUP);

  lcd.init();
  lcd.backlight();

  lcd.setCursor(0,0);
  lcd.print("TEMP MONITORING  ");
  lcd.setCursor(0,1);
  lcd.print("Starting...");

  delay(3000);
  lcd.clear();
}

void loop(){
  // Read temperature (LM35) //
```

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```
void loop(){
  // Read temperature (LM35) //
  int sensorValue = analogRead(tempPin);
  float voltage = sensorValue * (5.0 / 1023.0);
  float temperature = voltage * 100.0; // LM35 formula

  // LCD display //
  lcd.setCursor(0,0);
  lcd.print("Temp: ");
  lcd.print(temperature);
  lcd.print((char)223);
  lcd.print("C ");

  // Pushbutton  //
  bool buttonState = digitalRead(buttonPin);

  if (buttonState = LOW && lastButtonState == HIGH) {
    buzzerMuted = !buzzerMuted;
    delay(300);
  }
  lastButtonState = buttonState;

  // TEMPERATURE STATUS
  if (temperature >= highTemp) {
    // -------- HOT --------
    digitalWrite(ledPin, HIGH);

    if (!buzzerMuted) {
      digitalWrite(buzzerPin, HIGH); // alarm
    } else {
      digitalWrite(buzzerPin, LOW);  // muted
    }
```

```
Lates_LM35Code.ino
    // -------- HOT --------
    digitalWrite(ledPin, HIGH);

    if (!buzzerMuted) {
      digitalWrite(buzzerPin, HIGH); // alarm
    } else {
      digitalWrite(buzzerPin, LOW);  // muted
    }

    lcd.setCursor(0,1);
    lcd.print("Status: HOT    ");
  }

  else if (temperature <= coldTemp) {
    // -------- COLD --------
    digitalWrite(ledPin, LOW);
    digitalWrite(buzzerPin, LOW);

    lcd.setCursor(0,1);
    lcd.print("Status: COLD   ");
  }

  else {
    // -------- NORMAL --------
    digitalWrite(ledPin, LOW);
    digitalWrite(buzzerPin, LOW);

    lcd.setCursor(0,1);
    lcd.print("Status: NORMAL ");
  }

  delay(500);
}
```

The code is written using the Arduino programming language (C/C++). It contains the necessary libraries and variables to operate a temperature monitoring system. The program assigns pins for the LM35 temperature sensor, LCD, LED, buzzer, and push button. During operation, the code reads the analog value from the temperature sensor and converts it into a temperature reading in degrees Celsius, which is shown on a 16×2 I2C LCD.

The code uses simple conditions to check if the temperature is high, low, or normal based on preset values. When the temperature is high, the LED and buzzer are activated as alerts, while the LCD displays the corresponding status. A push button included in the code allows the buzzer to be muted when pressed. The program runs continuously using the loop function to ensure constant temperature monitoring.

In the initial stage of the development process, the researchers used the **Tinkercad online simulation platform** to design and simulate the prototype of the temperature sensor alarm system. This approach allowed the circuit connections and system behavior to be tested and verified virtually before constructing the physical prototype, reducing errors and improving design efficiency.

Materials and Components

This study utilizes several electronic components to design and test a temperature-based safety monitoring system. The following components were used to build the temperature monitoring system, and each part has a specific role to ensure the system works properly.

Table 1.

COMPONENT	FUNCTION
Arduino UNO	Acts as the main controller of the system. It reads the temperature data from the sensor, processes it based on programmed limits, and controls the buzzer, LED, and LCD.

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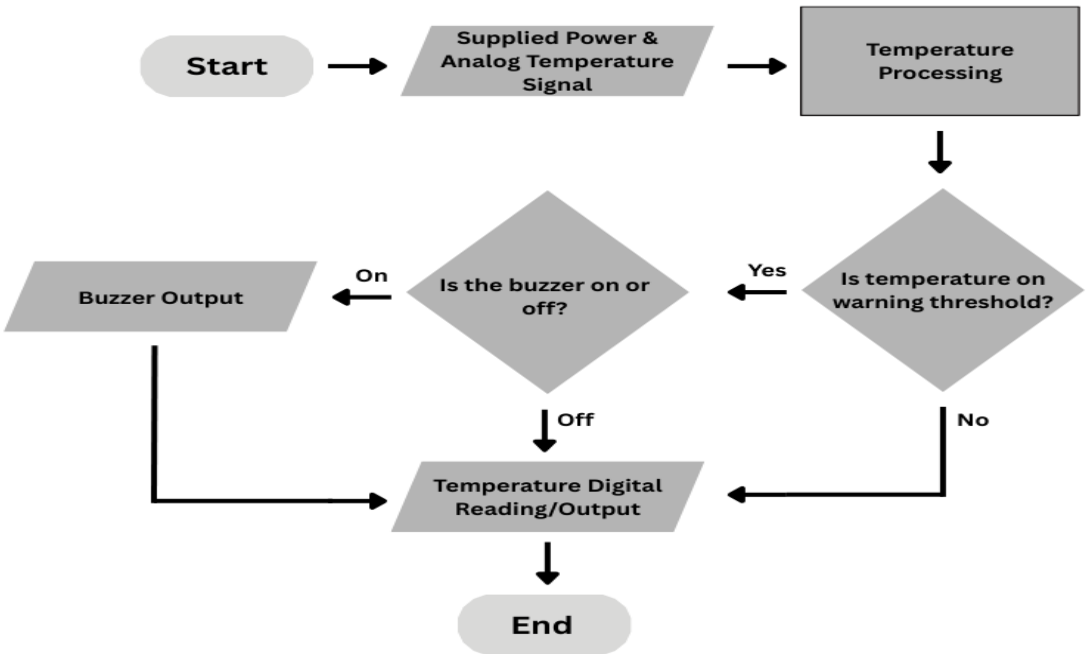
Temperature Sensor (LM35)	Measures the surrounding temperature and converts it into an analog voltage signal that is sent to the Arduino for processing.
16×2 LCD (I²C)	Displays the current temperature and system status such as normal, hot, or cold conditions.
10 kΩ Resistor	Acts as a pull-up or pull-down resistor for the push button to ensure stable and reliable input signals.
220 Ω Resistor	Limits the current flowing through the LED to prevent damage.
LED (Red)	Provides a visual indicator when an alert condition occurs.
Push Button	Used to manually stop or silence the buzzer when the alarm is active.
Buzzer	Produces an audible alarm when the detected temperature becomes too hot or too cold.

Figure 7. Flowchart



Flowchart represents the logic and decision-making process of the temperature monitoring software.

The flowchart illustrates the overall operation of the temperature monitoring system. The process begins when power is supplied to the system, allowing the temperature sensor to generate an analog temperature signal. This signal is sent to the Arduino UNO for temperature processing, where the measured value is compared with the preset warning thresholds. If the temperature reaches or exceeds the warning limit, the system checks the buzzer status. When the buzzer is turned on, an audible alert is produced to warn the user. If the buzzer is off or the temperature is within the normal range, the system proceeds to display the temperature as a digital output. The process then ends, ensuring that the system only activates the buzzer during abnormal temperature conditions while continuously providing temperature readings.

RESULTS & DISCUSSION

The testing procedure utilized a lighter as the heat source and an ice pack as the cold source to evaluate the system's response under varying temperature conditions. Additionally, a thermometer was used to measure and verify the temperatures produced by the lighter and the ice pack, ensuring the reliability and accuracy of the testing results. To clearly present the results of the experiment, the collected data are organized and shown in Table below.

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TABLE 2: Temperature Test Using Lighter (Heat Source)

TRIAL	INITIAL TEMPERATURE (°C)	TEMPERATURE AFTER HEATING(°C)	WARNING THRESHOLD (°C)	BUZZER STATUS
1	29.8	43.7	TEMP > 41	ACTIVE
2	28.7	42.5	TEMP > 41	ACTIVE
3	29.4	44.2	TEMP > 41	ACTIVE
4	30.3	41.5	TEMP > 41	ACTIVE
5	30.2	40.3	TEMP > 41	INACTIVE
6	30.3	42.4	TEMP > 41	ACTIVE
7	29.8	41.6	TEMP > 41	ACTIVE
8	28.9	43.5	TEMP > 41	ACTIVE
9	29.6	41.6	TEMP > 41	ACTIVE
10	29.4	40.8	TEMP > 41	INACTIVE

TABLE 3: Temperature Test Using Ice Pack (Cold Source)

TRIAL	INITIAL TEMPERATURE (°C)	TEMPERATURE AFTER COOLING(°C)	WARNING THRESHOLD (°C)	BUZZER STATUS
1	28.8	15.3	TEMP < 15	INACTIVE
2	28.1	14.6	TEMP < 15	ACTIVE
3	29.5	15.4	TEMP < 15	INACTIVE
4	30.1	15.7	TEMP < 15	INACTIVE
5	29.6	14.2	TEMP < 15	ACTIVE
6	28.7	13.5	TEMP < 15	ACTIVE

7	29.2	14.9	TEMP < 15	ACTIVE
8	28.4	14.8	TEMP < 15	ACTIVE
9	28.2	14.6	TEMP < 15	ACTIVE
10	28.9	14.8	TEMP < 15	ACTIVE

Based on the results of the temperature tests using both a lighter (heat source) and an ice pack (cold source), the prototype successfully detected abnormal temperature conditions and responded as intended. During the heat tests, the buzzer was activated when the temperature exceeded the warning threshold of 41 °C, while it remained off when the temperature stayed below this limit. Similarly, in the cold tests, the buzzer was activated when the temperature dropped below the set threshold of 15 °C and remained inactive when the temperature was within the normal range. These results show that the system can accurately monitor temperature changes and provide timely audio alerts for both high and low temperature conditions, proving that the prototype is effective and reliable for temperature monitoring and warning applications.

During the development and testing of the system, the researchers encountered an issue wherein the buzzer continued to sound and could not be stopped unless the power was turned off. To address this problem, a stop button was installed in the circuit, allowing the user to manually silence the buzzer without shutting down the entire system. This improvement enhanced the usability and practicality of the prototype.

CONCLUSION

This research successfully designed and tested a room safety monitoring system using a temperature sensor alarm that can detect both high and low temperature conditions and provide early warnings. Based on the testing results using a lighter as a heat source and an ice pack as a cold source, the system accurately identified temperatures that exceeded the preset thresholds and activated the buzzer accordingly, while remaining inactive under normal conditions. The Arduino UNO effectively processed the analog temperature data from the LM35 sensor and converted it into reliable digital outputs displayed on the LCD. Therefore, the prototype proved to be effective, responsive, and reliable in monitoring temperature changes and alerting users to potentially unsafe conditions, making it a practical and low-cost solution for improving safety in homes, classrooms, and small establishments.

RECOMMENDATIONS

To improve the practical utility of the room safety monitoring system, several recommendations are suggested for future development. First, the system should be housed in a durable, heat-resistant enclosure to protect the Arduino UNO and LM35 sensor from the extreme temperatures they are designed to monitor. Second, the software could be updated to include a menu system using the LCD and push button, allowing users to manually adjust safety thresholds without needing to rewrite the computer code. Finally, the buzzer could be programmed with distinct sound patterns to help users quickly distinguish between a high-temperature fire risk and a lowtemperature warning. These enhancements would make the device more versatile and resilient for everyday use in homes and classrooms.

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Mariel Keith T. Olfindo is a third-year Bachelor of Science in Computer Engineering student at the Eulogio "Amang" Rodriguez Institute of Science and Technology (EARIST). She is driven by a deep curiosity for creative problem-solving and is dedicated to designing original and inventive technological solutions that blend engineering precision with artistic vision.

Engr. Meshelle N. Fabro is a Professional Computer Engineer with extensive academic and industry experience. She has worked with leading technology companies such as Hewlett-Packard (HP) and IBM, where she specialized in systems and enterprise solutions. She currently serves as a Part-time Instructor in the Computer Engineering Department of the Eulogio "Amang" Rodriguez Institute of Science and Technology (EARIST), where she is actively involved in training and mentoring future engineers. Her professional interests include computer systems, VLSI design, artificial intelligence, and emerging technologies in computing.