# Temperature Controlled Home Appliances Using Arduino and Thermistor

A Project Report
Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Engineering

in

ELECTRICAL & ELECTRONICS ENGINEERING


By

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# St. Joseph Engineering College

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# CERTIFICATE

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# ABSTRACT

This project gives details about designing and implementing an Automatic room temperature controlled system to control the home appliances, using the Arduino UNO and NTC Thermistor 10k, which acts as the temperature sensor. Here, the user sets the minimum and the maximum reference temperature range using the code uploaded to the Arduino board. The NTC Thermistor sensor senses the surrounding room temperature and gives the result in degrees Celsius. Both the reference and the measured values are displayed on the Liquid Crystal Display (LCD). The Arduino UNO microcontroller, being the processing unit of the system, gets the sensor's measured value and compares it with the set threshold. The results are: when the measured room temperature is more than the threshold value; then, the microcontroller turns on the appliance. If the measured room temperature is less than the threshold value, then the appliance is triggered off. The measured temperature and the appliance status will be displayed on the LCD screen

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# 1. INTRODUCTION

## 1.1 Preface

With the gradual advancement in technology, automation has become part of human life. In this regard, modern technologies have brought several innovations that automatically implement a particular task. Among these discoveries, microcontroller plays a vital role in the smart system of the electronic world. A microcontroller is a control system on a single chip that makes possible for the automation of the designed system and control process and produces precise results. Among all places occupied by a human being, a home is the most important and needs to be maintained in the proper temperature. Nowadays, keeping living and working places at a conducive temperature is not only crucial to be healthy and productive, but also maintaining the room at average temperature helps to prevent spoiling of foods, medicine, and other goods in the room. Usually, there are different way to do this. For example, people use the manually controlled system, air-condition (AC), to regulate the temperature in their living environment. However, this manually operated system has notable limitations. The drawback is that if the user forgets to switch on or adjust the AC when the temperature becomes abnormal, children, disabled persons, and perishable items could be affected. The other problem with the mechanical AC system is, sometimes even if the air condition (AC) is still working, it is difficult to maintain the room temperature. Furthermore, if not appropriately managed, it may result in unnecessary expense and power usage. In general, its operations always require the user to turn it on and off regardless of the room temperature condition. Therefore, to address these drawbacks, the Automatic Room Temperature Control System is proposed. An automatic room temperature control system is a self-automated temperature control system that can control the appliances such as light or fan depending on the current room temperature. This system's main advantages are easy to use, less energy usage, economical, more convenient to control temperature, and user-friendly. It comprises of various components such as Arduino UNO (main microcontroller), NTC Thermistor 10 k (temp. sensor), relay ( 5V) , potentiometer (10 k) and 16*2 LCD Display.

## 1.2 General information about the project

Suppose a person sitting in a room is feeling cold and wants the heater to be automatically turned on, and then off after some time when room temperature is increased, then this project helps the person to control his or her home appliances automatically according to the temperature. Here the home ac appliances such as lights, fans, etc are controlled with the help of Arduino based on the temperature. Here Thermistor is used to read the temperature. The a.c appliance is attached along with a relay to make a temperature-controlled home automation system using Arduino. It also shows the temperature and appliance status on the 16×2 LCD display connected with the circuit.

## 1.3 Literature Survey

Nowadays, technology is advancing and houses are getting smarter. Modern houses are usually shifting from conventional switches to some kind of centralized control system with remote control and switches. As we all know, conventional switches located in different locations of the house makes it difficult in accessing them. Users need to go near them to operate. It is more difficult for elderly folk and handicapped people. In this case, remote control switches are also difficult to operate. Suppose someone among the family members used a remote controller and kept it somewhere else by mistake. Now you need to waste a lot of time searching for it. Furthermore, they need separate batteries to operate, and frequently changing them will decrease your pocket money too. Hence, a temperature-controlled home automation system using Arduino provides the most mod-ern solution. Hence, this concept has been developed with the aim of making it easier and more comfortable for people to control the various appliances and devices used in home in a more convenient way. This project consists of various components like Arduino UNO board, LCD display, relay, and thermistor. The working mainly depends on the relay and thermistor. As the temperature increases above a certain pre-set value, the relay will be turned on and if the temperature is decreased below the pre-set value then the relay will be turned off. The home appliances connected with the relay will also turn on and off accordingly. Here we will use a light bulb, fan, or cooler, etc. as an ac appliance. The whole triggering process and temperature value setting is per-formed by the programmed Arduino

board. It also gives us details about the change in temperature and the appliance status on the LCD screen.

## 1.4 Objective

The main objective of this project is to build Temperature Controlled Home Automation using Arduino. The system will be able to control the ac home appliances like fan, heater, cooler, or even light bulbs. Suppose a person sitting in a room is feeling hot. Now that person wants the cooler or fan to be “ON” automatically, and then “OFF” when room temperature is back to normal. This project will help one to control their home appliances automatically based on the room temperature.

# 2. HARDWARE DETAILS

## 2.1 Components Required: -

- Arduino UNO
- Relay
- 16x2 LCD display
- ac home appliance(light bulb, fan or cooler, etc)
- NTC thermistor 10k
- Connecting wires
- Resistors (1k and 10k ohms)
- Potentiometer (10k)

## 2.2 Brief Description of the Components

### 2.2.1 Arduino UNO

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark a major redesign of the Arduino hardware and software. The Uno board was the successor of the Duemilanove

release and was the 9th version in a series of USB-based Arduino boards. Version 1.0 of the Arduino IDE for the Arduino Uno board has now evolved to newer releases. The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use a FTDI USB-to-UART serial chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter


Fig. 2.1 Arduino UNO board

## 2.2.2 NTC Thermistor 10k

Thermistor is an electronic component used to calculate the temperature. This is a type of resistor whose resistance varies with change in temperature. These NTC thermistors are made up from the combination of metal oxides which passed through sintering process which gives negative electrical resistance versus temperature (R/T) relationship to it. Due to having a large negative slope, a small change in temperature cause a huge change in electrical resistance. Basically, there are two types of thermistor; one is NTC (Negative Temperature Coefficient) and second one is PTC (Positive Temperature Coefficient). If the thermistor is NTC type, then it decreases the resistance as increase in temperature and PTC behavior is just opposite to the NTC. A thermistor is connected with any electrical circuit

to measure the temperature of the body or the substance. This thermistor's operating temperature range is -55 °C to 125 °C, the range of the temperature is depend upon the base resistance.


Fig. 2.2 NTC Thermistor

### 2.2.3 16*2 LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

The 16x2 LCDs are very popular among the DIY community. Not only that, but we can also find them in many laboratories and industrial equipment. It can display up to 32 characters at a time. Each character segment is made up of 40 pixels that are arranged in a

5x8 matrix. We can create alphanumeric characters and custom characters by activating the corresponding pixels. As the name indicates, these character segments are arranged in 2 lines with 16 characters on each line. Even though there are LCDs with different controllers are available, The most widely used ones are based on the famous HD44780 parallel interface LCD controller from Hitachi.


Fig. 2.3 16*2 LCD Display

## 2.2.4 Potentiometer 10k

Potentiometers are very useful in changing the electrical parameters of a system. It is a single turn 10k Potentiometer with a rotating knob. These potentiometers are also commonly called as a rotary potentiometer or just POT in short. These three-terminal devices can be used to vary the resistance between 0 to 10k ohms by simply rotating the knob. A potentiometer knob can also be used along with this POT for aesthetic purposes.

Specifications

- Rotary type shaft potentiometer
- 15mm shaft length
- Total Resistance 10kΩ


Fig 2.4 10k Potentiometer

### 2.2.5 Relay (5V)

A 5V relay module is a single or multi-channel relay module that works with a low-level trigger voltage of 5V DC. The input voltage can be from any microcontroller or logic chip that outputs a digital signal. Like most other relays, the 5V relay module is an electrically operated, electromagnetic switch that can be used to turn on or turn off a circuit. It consists of two parts: the relay itself and the control module.

- The relay contains the coil that creates the magnetic field, the armature that move to complete or disconnect a circuit, and contacts that open and close to operate the load switch.
- The relay control module is the interface or part of the relay module that the user interacts with. It contains the input terminals for connecting to the microcontroller, as well as the output terminals for connecting to the load.

- The control module also contains LED indicators for power and status and other devices such as protection diode, transistor, resistor, and other semiconductor devices necessary for its operation.

# 3. METHODOLOGY

## 3.1 WORKING:-

### 3.1.1 Circuit Diagram:-

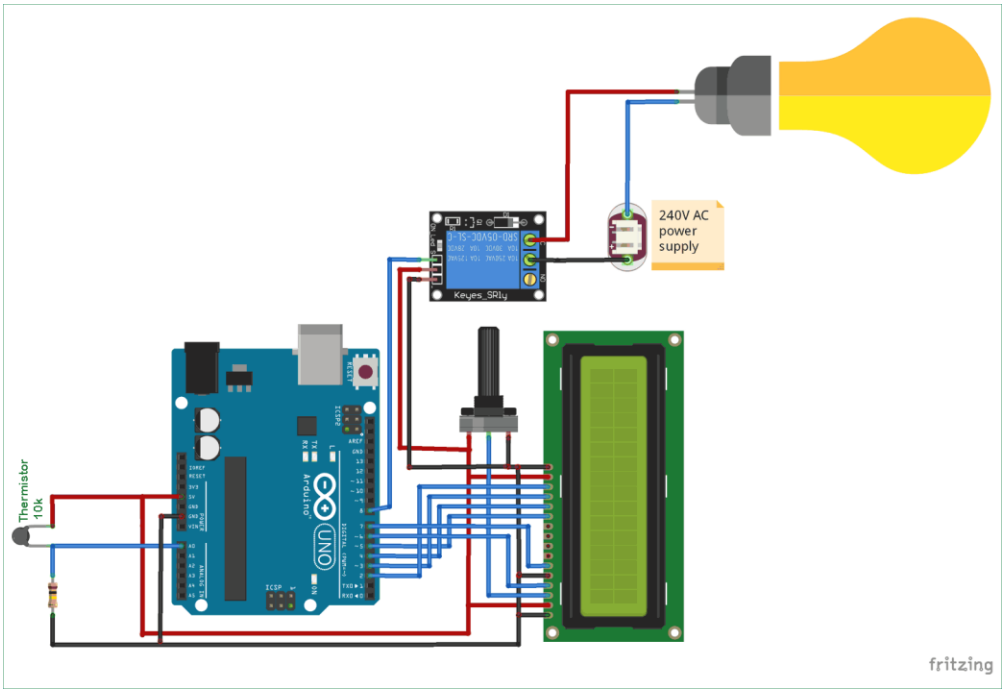


Fig 3.1 Circuit Diagram

This Temperature based Home Automation System consists of various components like Arduino board, LCD display, Relay, and thermistor. The working mainly depends on the relay and thermistor. As the temperature is increased above a pre-set value, the relay will be turned on and if the temperature is decreased below the preset value then the relay will be turned off. The home appliance connected with the relay will also turn on and off accordingly. Here we make use of a light bulb, fan or cooler as an ac appliance. The whole triggering process and temperature value setting is performed by the programmed Arduino board. It also gives us details about the change in temperature in every half second and appliance status on the LCD screen.

### 3.1.2 Measuring Temperature using Thermistor: -

Calculation of temperature can be done with the help of the following formula :- T = 1 / (A + B*ln(Rt) + C*ln (Rt)3 ) where A, B, C are the constants and Rt is the thermistor resistance. These constant values can be taken straight from the datasheet of the Thermistor also.

### 3.1.3 Block Diagram:-

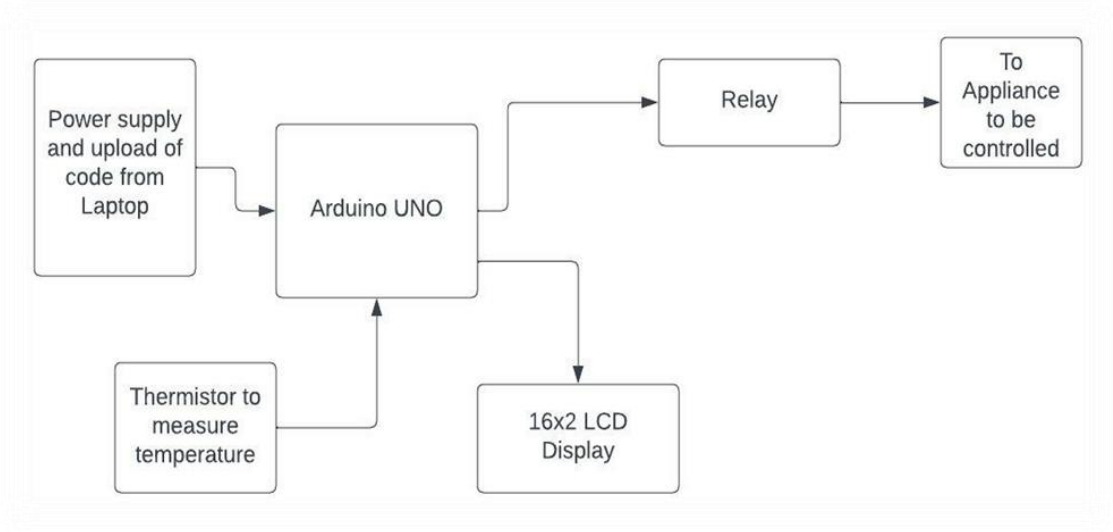


Fig 3.2 Block Diagram

### 3.1.4 Flowchart:-

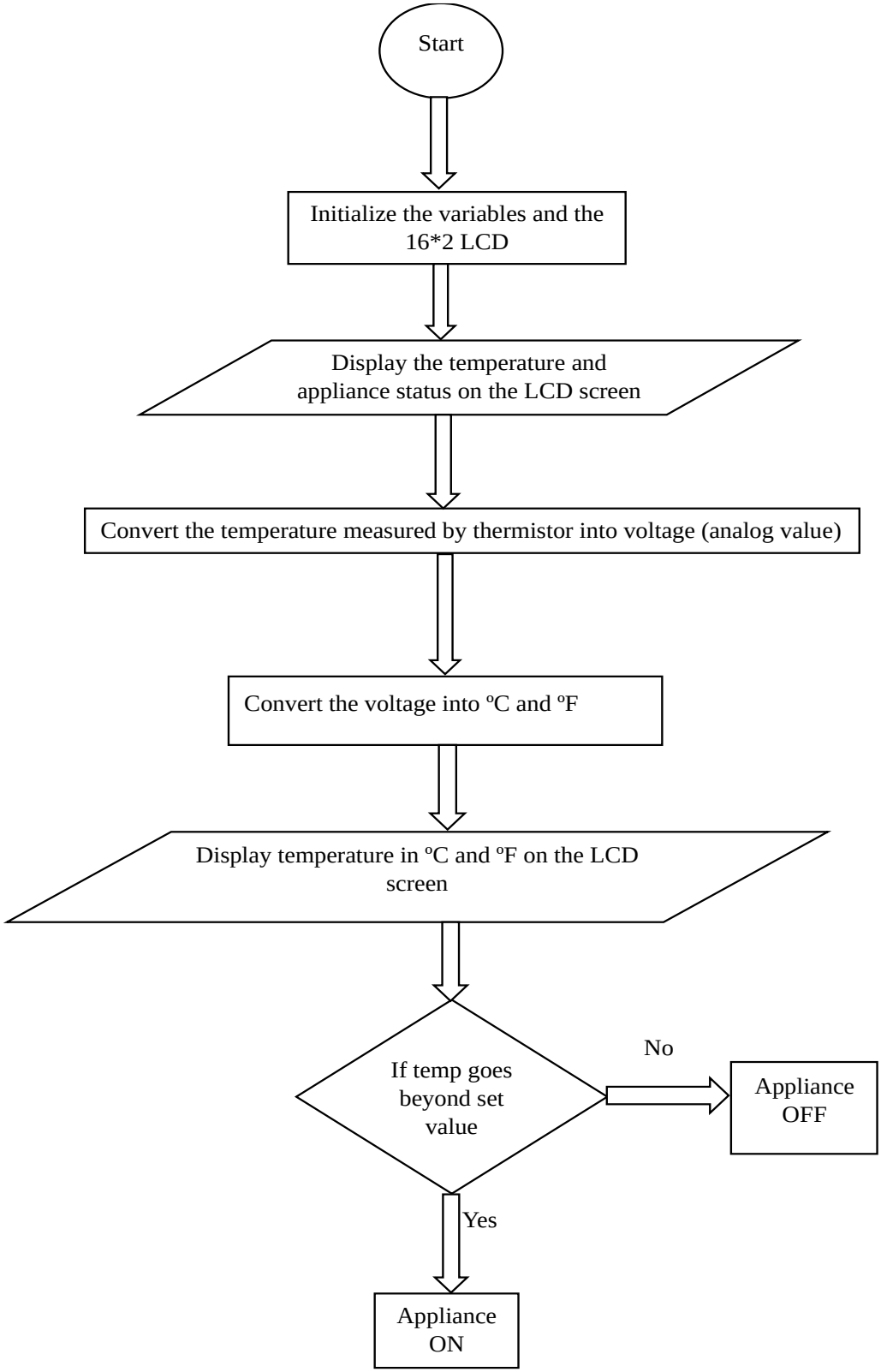


Fig. 3.3 Flowchart

### 3.1.5 Interfacing Arduino with LCD

For that first, connect the VSS to the GND and VDD to the 5V. To use the LCD backlight, connect the backlight Anode to the 5V and connect the backlight cathode to the GND through a 220Ωresistor. Since we are not using the read function connect the LCD R/W pin to the GND too. To adjust the contrast, connect the center pin of a 10KΩ trimmer resistor (or potentiometer) to the VEE pin and connect the side pins to the VCC and GND. Now the registry select pin is connected to D12 and Enable pin is connected to D11.

Next, we connect the data pins. The LCD module can work in two modes, 8-bit and 4-bit. 8-bit mode is faster but it will need 8 pins for data transfer. In 4-bit mode, we only need four pins for data. But it is slower since the data is sent one nibble at a time. 4-bit mode is often used to save I/O pins, while the 8-bit mode is used when speed is necessary. For this tutorial, we will be using the 4-bit mode. For that connect the D4, D5, D6 and D7 pins from the LCD to the D5, D4, D3 and D2 pins of the Arduino.

The circuit is built as per the connection diagram provided. All the connections are made using standard male to male jumper wires. Using the necessary code, we interfaced the Arduino UNO board with the 16*2 LCD display, and found that it works properly, and we can display the characters such as ‘HELLO WORLD’, etc.

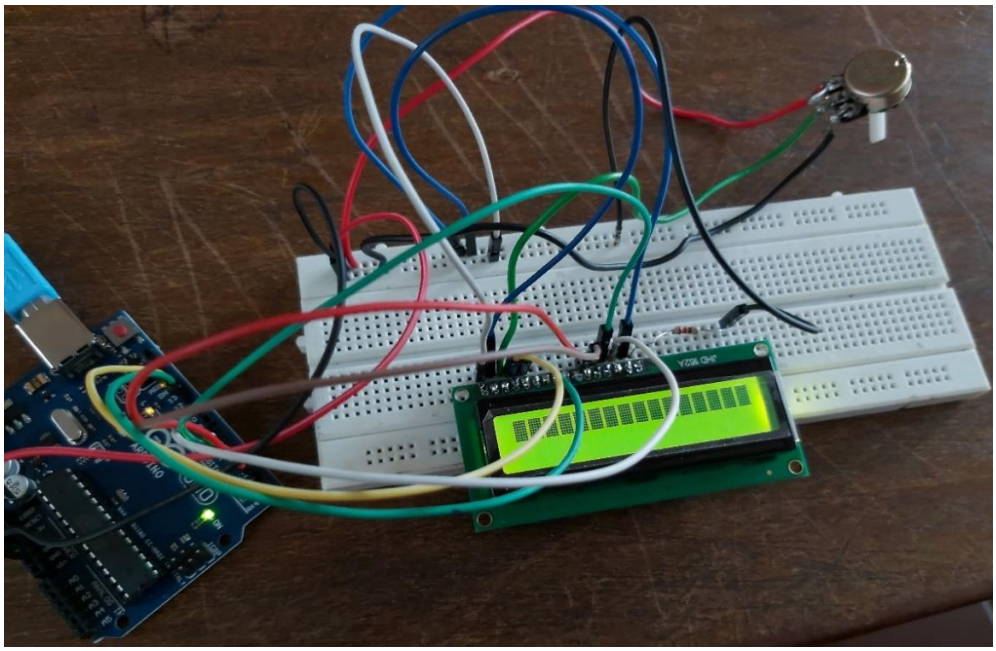

Fig. 3.4 Testing the LCD

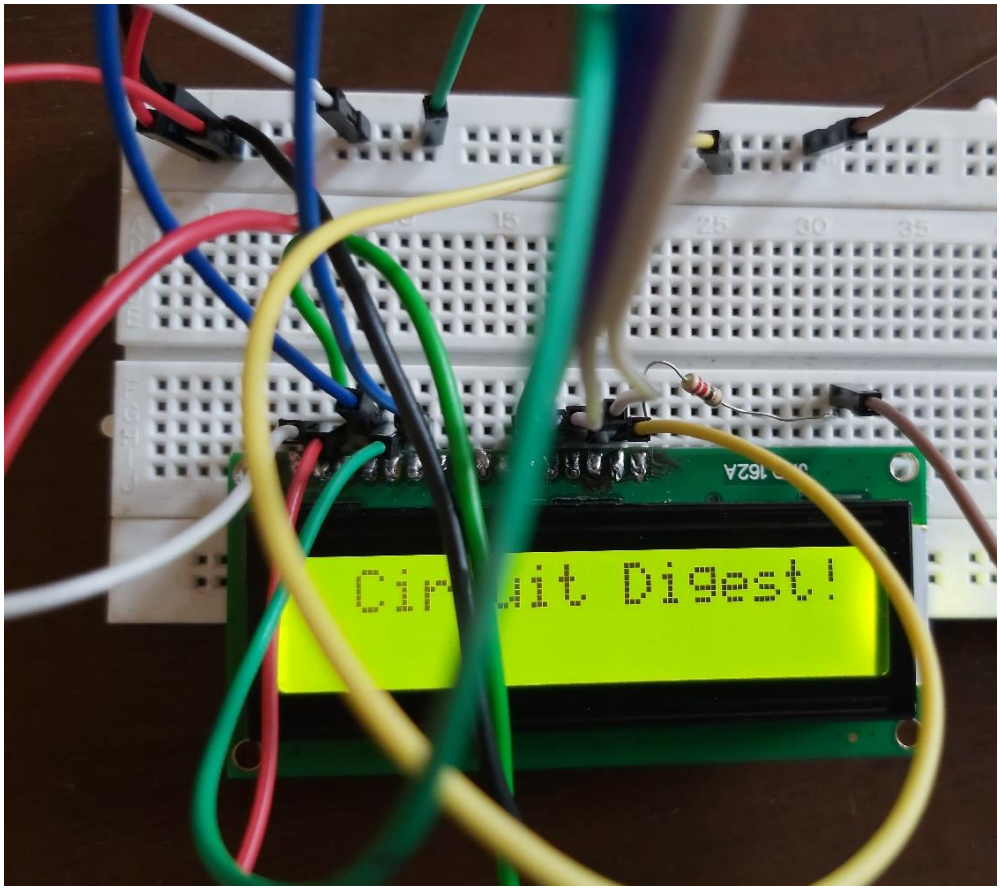


Fig 3.5 Displaying the message ‘Circuit Digest’ on the LCD

### 3.1.6 Running and uploading the code to and powering the Arduino:-

The code for this operation is uploaded to the Arduino UNO board using Arduino IDE software. To upload the code and to give the supply to the Arduino, the connection is made via USB type-B cable to laptop or by connecting 9V adapter (only for power supply in case power supply is not from laptop). A 16x2 LCD is interfaced with Arduino to display temperature values. Thermistor and relay are connected as per the circuit diagram. The analog pin (A0) is used to check the voltage of thermistor pin at every moment and after the calculation using Stein-Hart equation, through the Arduino code we are able to get the temperature and display it on LCD in the Celsius and Fahrenheit scale. As the temperature increases more than a certain value in degree Celsius Arduino makes the relay module turned on by making the Pin 8 HIGH (where the Relay module is connected) when the temperature goes below the same value in degree Celsius, Arduino turns off the relay module by making the pin 8 LOW. The connected ac appliance will also turn on and off according to the commands given to the relay module.

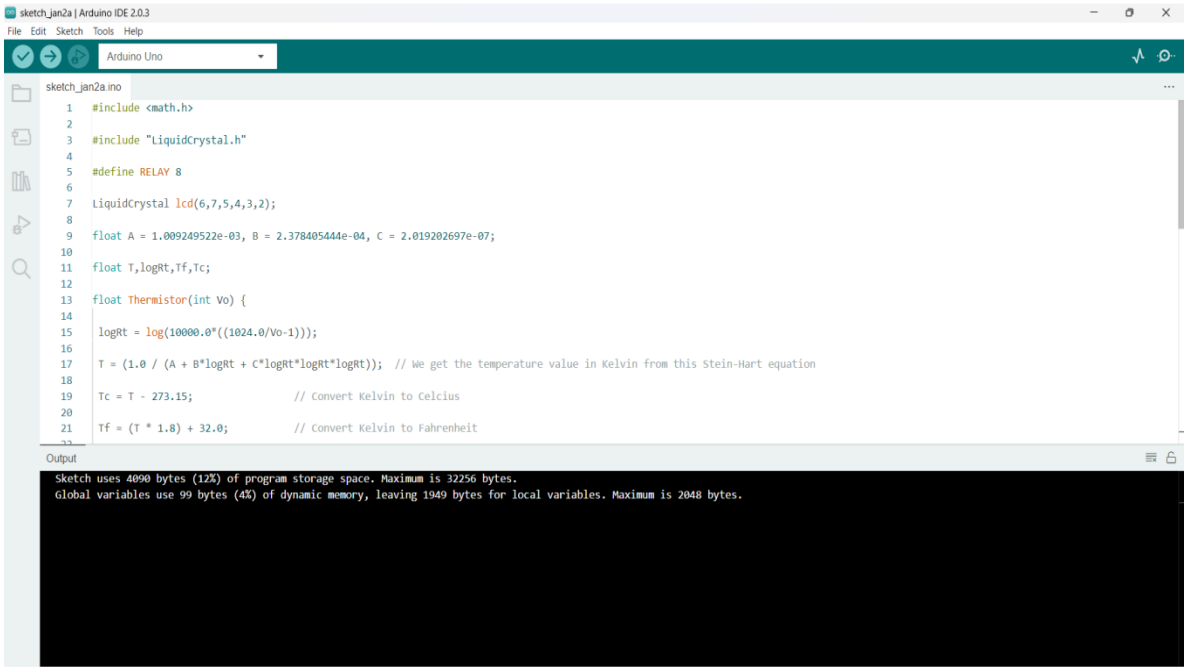


Fig. 3.6 Screenshot of the code in Arduino IDE software

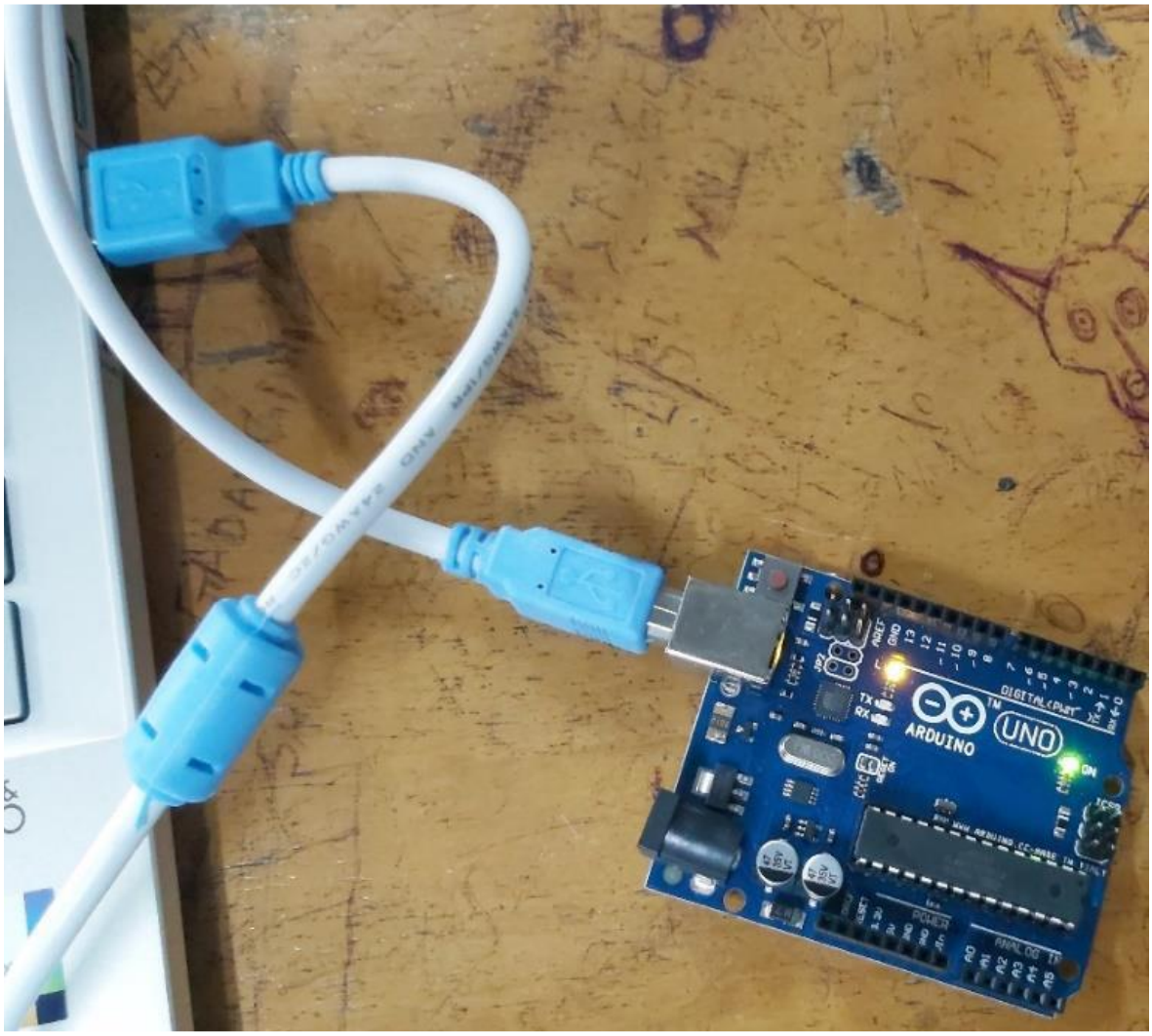


Fig. 3.7 Connection between Arduino and laptop to upload the code

### 3.1.7 Code:-

```
#include <math.h>

#include "LiquidCrystal.h"

#define RELAY 8

LiquidCrystal lcd(6,7,5,4,3,2);
```

```
float A = 1.009249522e-03, B = 2.378405444e-04, C = 2.019202697e-07;

float T,logRt,Tf,Tc;

float Thermistor(int Vo) {

 logRt = log(10000.0*((1024.0/Vo-1)));



T = (1.0 / (A + B*logRt + C*logRt*logRt*logRt));  // We get the temperature value i
n Kelvin from this Stein-Hart equation

 Tc = T - 273.15;                // Convert Kelvin to Celcius

 Tf = (T * 1.8) + 32.0;           // Convert Kelvin to Fahrenheit

 return T;

}

void setup() {

 lcd.begin(16,2);

 lcd.clear();

pinMode(RELAY, OUTPUT);

}

void loop() {



  lcd.setCursor(0,0);

  lcd.print("Temperature:");

  lcd.print(int(Thermistor(analogRead(0))));

  lcd.print("C ");

  delay(500);  // wait 0.5 seconds before sampling temperature again
```

```
if (Tc > 28) digitalWrite(RELAY, HIGH),lcd.setCursor(0,1),lcd.print("Light status:O
N "),delay(500);

else if (Tc < 28) digitalWrite(RELAY, LOW),lcd.setCursor(0,1),lcd.print("Light stat
us:OFF"),delay(500);



}
```

## 3.2 Fabrication and building the circuit

We have built the circuit by soldering the different components onto the copper-clad board, also, known as PCB board. A copper clad board is a circuit board that through lamination has a copper clad material on either a single-sided (one copper layer) or double-sided (two copper layers on both sides of one substrate layer) of the board. The copper clad soak in resin, combined with the glass fiber or other reinforcing material make the board base for printed circuit boards (PCB's).

Copper clad is commonly used within the PCB industry on these clad boards, as is it a great conductor and it can easily transmit signals without losing any electricity. These clad boards are available in numerous mm dimensions, depending upon the requirement.

We also had to solder the pins to the LCD display contacts as it did not have any pins on it to connect, so that we could connect it easily. We also soldered single strand wires to the terminals of the potentiometer to make it easier to connect it to the circuit, and pins called ‘Burg Strips’ onto the copper-clad board to make it easier to connect the wires to it. We made use of single strand wires, and male-male, female-male jumper cables for making the connections.

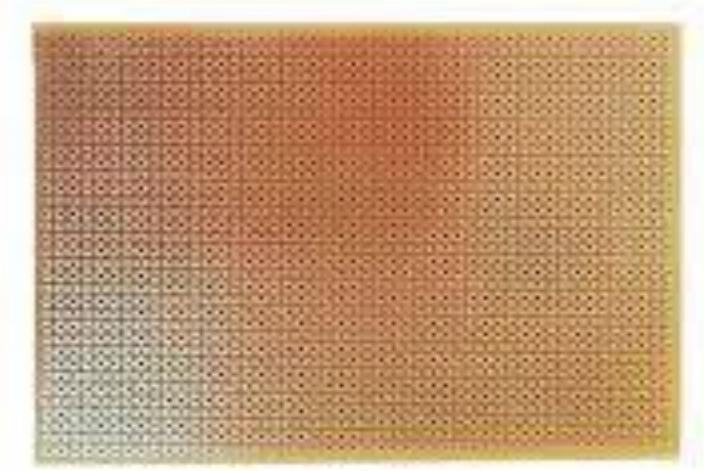

Fig. 3.8 Copper- clad board (or PCB Board)

And then all the components of the circuit, including the a.c appliance( Exhaust Fan) were arranged neatly and fixed on to a 1-inch thick plywood board of dimensions 1.2 feet by 1.2 feet.

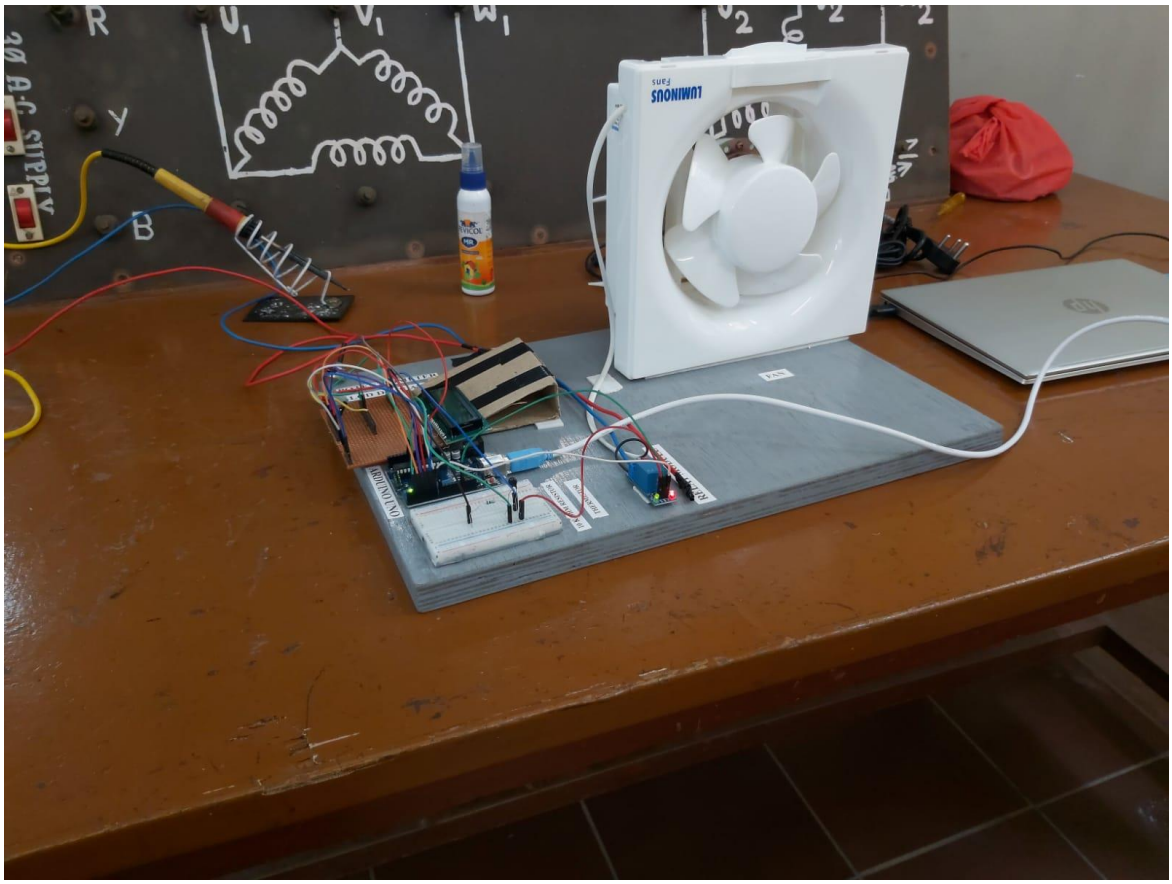


Fig. 3.9 Layout of the components on wooden board

# 4. RESULTS

## 4.1 Result Expected

As the temperature increases more than a pre-set value in degrees Celsius (say 28) Arduino makes the relay module to turn on by making the Pin 8 HIGH (where the Relay module is connected) and when the temperature goes below the same pre-set value in degrees Celsius, Arduino turns off the relay module by making the Pin 8 LOW. The connected ac appliance will also turn on and off according to the commands given to the relay module.

## 4.2 Result Obtained

As the temperature increases more than 23-degree Celsius (room temperature at the time of testing) Arduino makes the Relay Module Turned On by making the Pin 8 HIGH (where the Relay module is connected). And when the temperature goes below 23 Degree Arduino turns off the Relay Module by making the Pin LOW. LED bulb will also turn On and Off according to Relay module

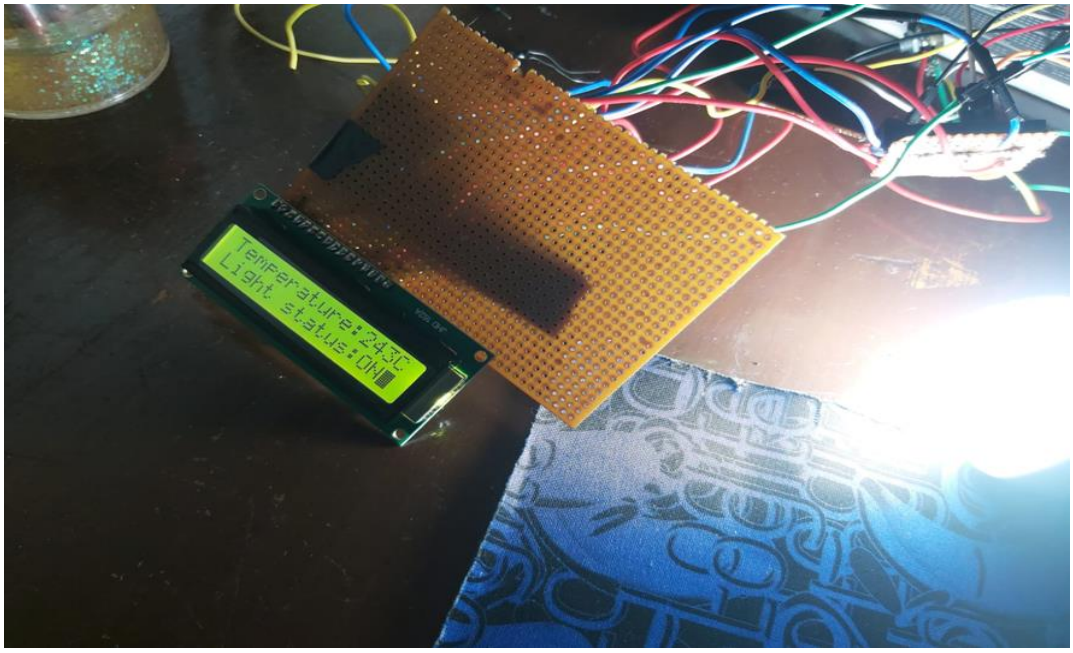


Fig. 4.1 Appliance (LED bulb) is on

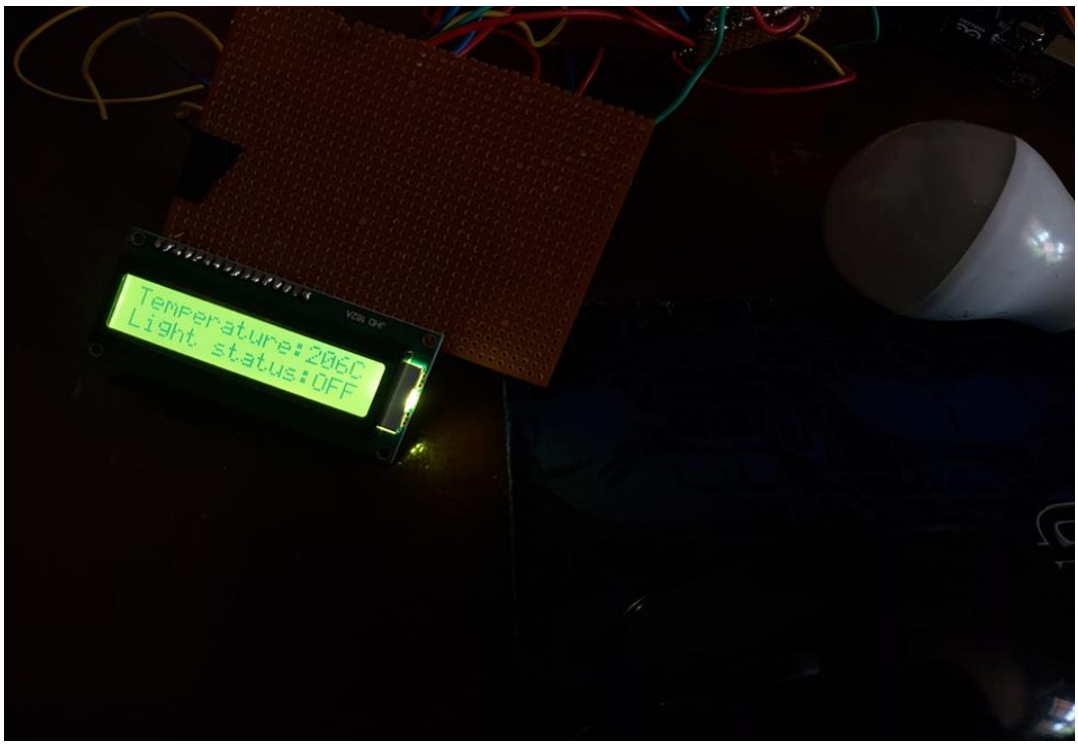


Fig. 4.2 Appliance (LED bulb) is off

# 5. CONCLUSION AND FUTURE SCOPE

## 5.1 Conclusion

In this paper, an automatic room temperature control system using Arduino UNO nad NTC Thermistor 10k to sense the temperature has been designed and constructed. The system uses an Arduino microcontroller, and thermistor to control and monitor both the heater and the fan simultaneously. The home appliance is on when the room temperature is higher than the reference temperature. When the room temperature is lower than the minimum of the reference temperature, the appliance is triggered off. When the room temperature is within the reference range, all the loads are automatically off. The main advantages of this system are its low cost, ease of installation, simplicity, low power consumption, small size, and user-friendly. This project efficiently optimizes energy consumption in a room while keeping the room at a comfortable temperature.

## 5.2 Future Scope

It is applicable in areas such as manufacturing industry, computer server room, classroom, conference room, automobile to adjust the temperature automatically. This system's disadvantage is that it depends on the microcontroller, Thermistor, and LCD display to control and monitor the room temperature. If any of them got damaged, this system is interrupted. So, it is dependent on individual preferences. For this system to function correctly, we should make sure that the fundamental components are connected correctly and work properly. In future also this system can be improved by adding more features like timer, and other sensors, just like the ones in use nowadays in Air-Conditioners (ACs). We can set the timers in such a way that the appliance is on only for a particular duration of time as desired by the user. This system is helpful for disabled persons and infants. There is room for improvement, as more features can be added, and the system can be made the error-free, and at a reasonable price, affordable by all.

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