Department of Electronic and Telecommunication

University Of Moratuwa

Automatic Temperature Controller

Ranasinghe R.A.R.L

200511V

Abstract

The goal of the Automatic Temperature Controller project is to develop an intelligent and resource-conserving system for regulating room temperature. The system automatically activates the air conditioner when the temperature rises above the user-defined upper limit and shuts it off when the temperature drops below the lower limit using the ATmega328P microcontroller and the DHT22 sensor. As a result, there is less energy wasted and more user comfort because the air conditioner only runs when it is necessary. The hardware and software components, circuit design, and testing outcomes are all covered in the project report. The Automatic Temperature Controller is a useful and environmentally friendly way to maintain desired room temperature in both home and business settings. It has a user-friendly interface and the opportunity for future upgrades.

Content

1. Introduction :-
   This section introduces the project, providing an overview of its purpose and key features.

2. Hardware Description :-
   Here, we present an in-depth analysis of the hardware components utilized in the project, including the ATmega328P microcontroller, DHT22 sensor, and relay.

3. Circuit Design:-
   The circuit design section will illustrate the connections between the microcontroller, sensor, relay, and other peripheral components.

4. Enclosure design :-
   The enclosure houses internal components safely, features an intuitive interface, 20x4 LCD display, and keypad, made of robust plastic.

5. Implementation of prototype

6. Testing and Results :-
   We present the testing methodologies employed to evaluate the project's performance and discuss the obtained results.

7. Conclusion :-
   Finally, we conclude the report, summarizing the project's success and potential for further improvements.

The Automatic Temperature Controller project brings forth a practical and innovative solution for energy-efficient temperature regulation, catering to residential and commercial settings alike. It showcases the capabilities of microcontrollers and sensors in creating smart and sustainable systems.

1. Introduction

The Automatic Temperature Controller project is designed to provide a cost-effective and efficient solution for maintaining a comfortable environment by automatically controlling the air conditioning system. In modern times, with the increasing need for energy conservation and automation, this project offers a practical implementation using the ATmega328P microcontroller and the DHT22 temperature and humidity sensor.

1.1 Project Overview

The primary objective of this project is to regulate room temperature within a specified user-defined range. To achieve this, we employ the ATmega328P microcontroller, a versatile and widely used microcontroller known for its reliability and ease of programming. The DHT22 sensor is utilized to measure real-time temperature and humidity levels, providing crucial data for the controller to make informed decisions.

1.3 Key Features

The key features of the Automatic Temperature Controller project include:

- Temperature Control: The project allows users to set their desired temperature range, within which the air conditioning system will maintain the room temperature.

- Energy Efficiency: By automating the air conditioner based on real-time temperature data, the project significantly reduces energy waste, making it environmentally friendly and cost-effective.

- User-Friendly Interface: The user interface enables simple and intuitive input of temperature settings, ensuring ease of use for individuals of all technical backgrounds.

- Expandability: The modular design of the project allows for easy integration of additional features, such as remote control or data logging.

2. Hardware Description:

Product Specifications:

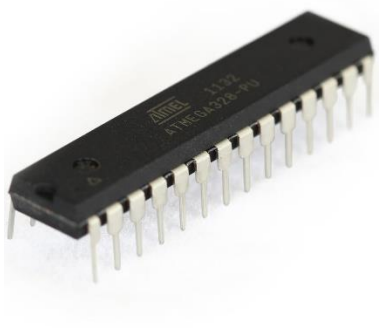
- Input Voltage : 230V AC frequency: 50Hz
- Operating Voltage : 5V
- LCD display : 20 x 4 LCD display (Operating Voltage 5V)
- Temperature Range : - 40°C to +80°C (DHT22)
- Humidity Range :- (0 -100)%
- Accuracy of the Temperature sensor : ±0.5°C
- Key Pad : A standard 4x3 matrix keypad
- Enclosure Material : PLA
- Product Dimensions : 160mm x 80mm x 80mm

Hardware Specification:

- Microcontroller (Atmega328p): This is the main control unit of the system, responsible for reading the temperature sensor data, controlling the fan through the relay module, and displaying the temperature value and the Humidity value on the LCD display. Here use a atmega328p microcontroller.

  Specifications:-

  - Normal operating voltage – 5V
  - Operating Temperature: -40°C to 85°C.
  - Crystal Oscillator Frequency: Supports external crystal oscillators with frequencies from 32kHz to 20MHz; commonly used frequency is 16MHz.
  - Maximum Source/Sink Current: GPIO pins can source or sink up to 20mA individually, with a total combined limit of 200mA in most cases.



- 20 x 4 LCD display: This display is used to show the current temperature and humidity and the user-set temperature range. It has a resolution of 20 x 4 characters. The display is connected to the microcontroller.

Parameter	Symbol	Condition	Stand value			UNIT
			Min.	Typ.	Max.	
Supply Voltage for Logic	V_{DD}-V_{SS}	-	4.5	5.0	5.5	V
Supply Voltage for LCD	V_{DD}-V_o	-	-	4.7	-	V
Input Logic HIGH	V_{IH}	-	2.2	-	V_{DD}	V
Input Logic LOW	V_{IL}	-	-0.3	-	0.6	V
Output Logic HIGH	V_{OH}	$-I_{OH}$=0.2mA	2.4	-	-	V
Output Logic LOW	V_{OL}	I_{OL}=1.2mA	-	-	0.4	V
Power Supply Current without backlight	V_{DD}	V_{DD}=5.0V	-	2.0	5	mA
Power Supply Current with backlight	I_{LED}	V_{LED}=5.0V	-	72	80	mA

- Temperature sensor (DHT22): The system uses a digital temperature sensor to measure the current room temperature. The temperature sensor should have a range of -40°C to +80°C and a temperature accuracy of ±0.5°C.And also this sensor can measure the humidity of the environment.

Operating Temperature	-40°C-80°C

Range of temperature measurement	-40°C-80°C
Operating Voltage	+5V
Operating Current	1.5mA

- Relay module (SRD-05VDC-SL-C): This module is used to switch the fan on or off based on the temperature readings. It consists of a relay, which can handle AC or DC load and a transistor driver circuit to interface with the microcontroller.

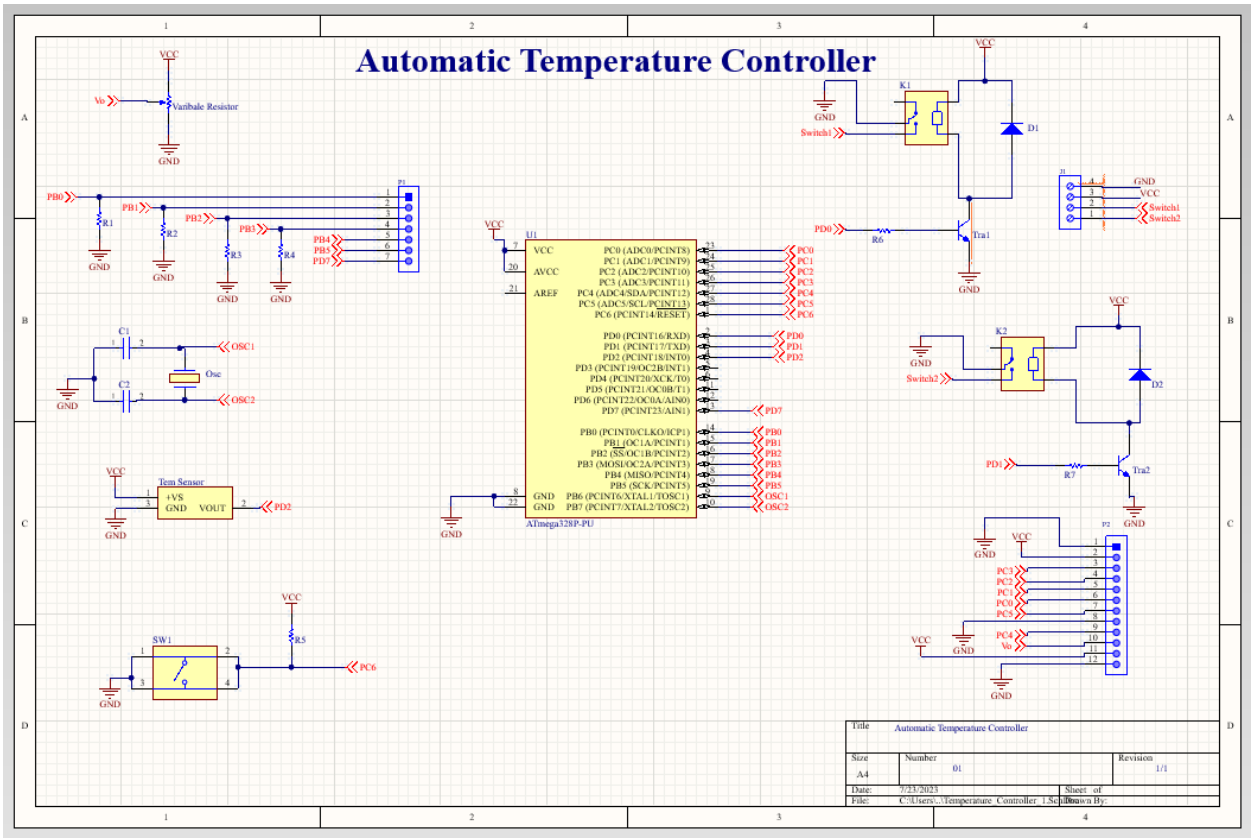
- Keypad: The keypad is used to set the desired temperature value. A standard 4x3 matrix keypad can be used for this purpose

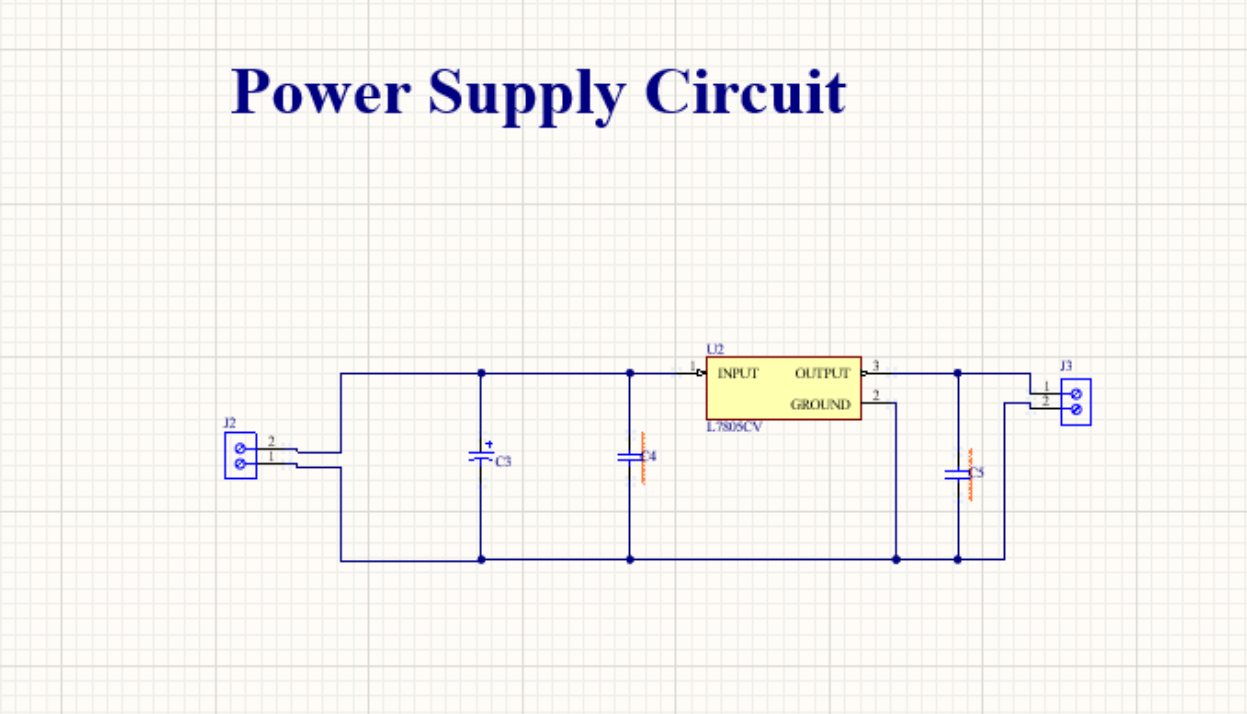
Extra features

Smart Scheduling:

The system can be enhanced with a scheduling feature, which allows the user to set a different temperature for each day of the week or for specific time periods during the day. This feature can be useful in optimizing energy usage and reducing costs. The scheduling can be done through the keypad.

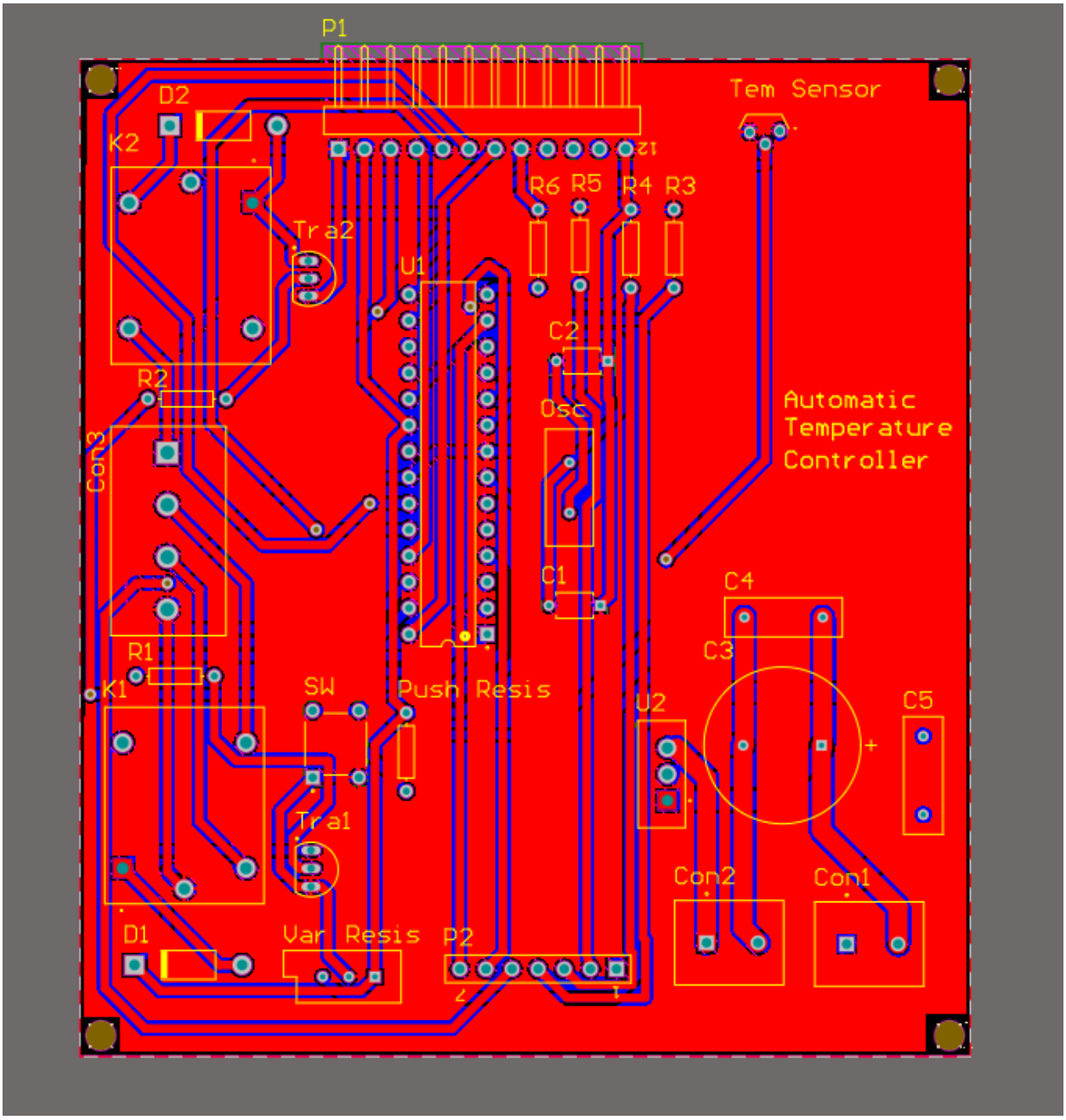
3. Schematic Diagram



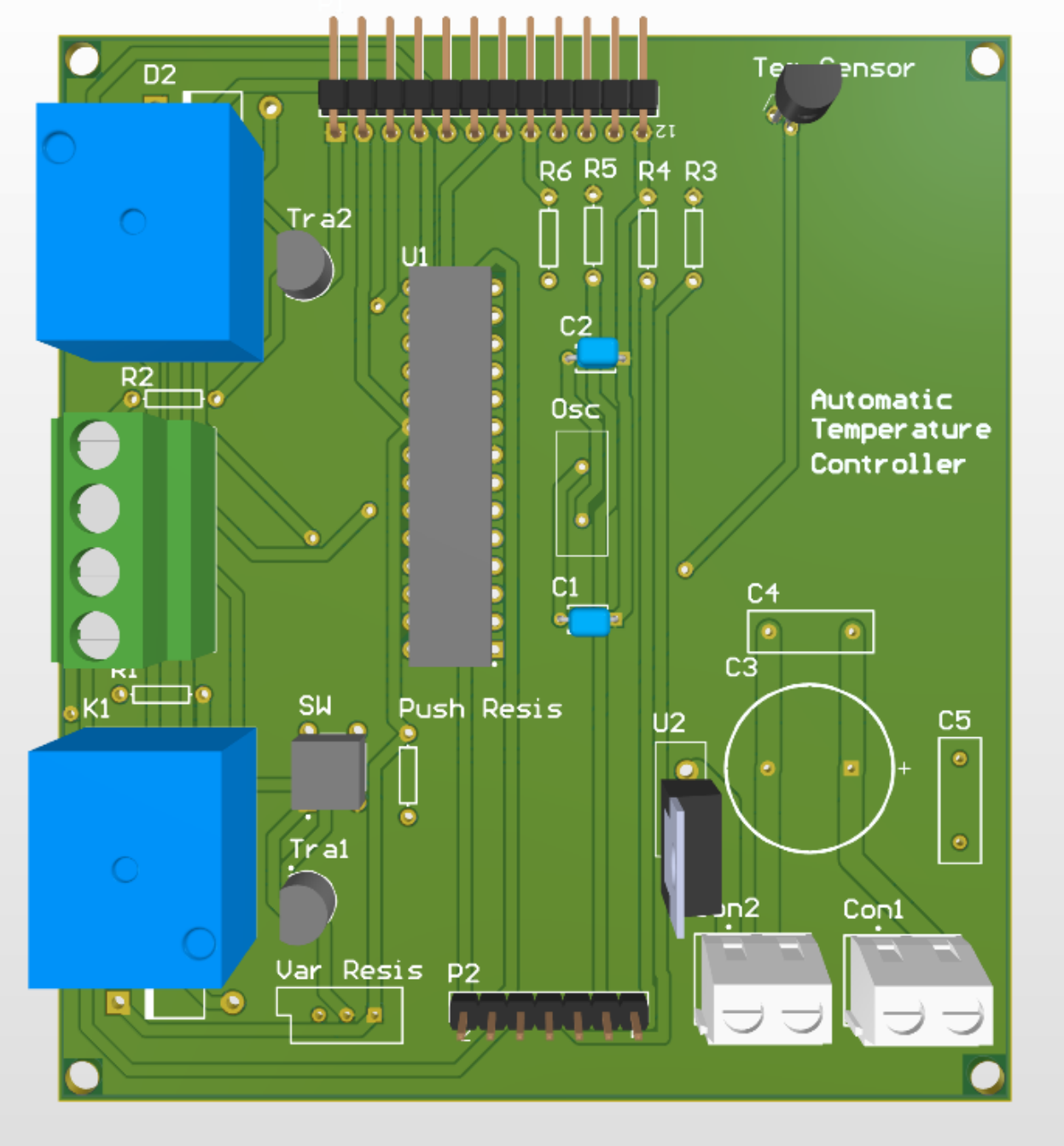


PCB design (Temperature Controller)

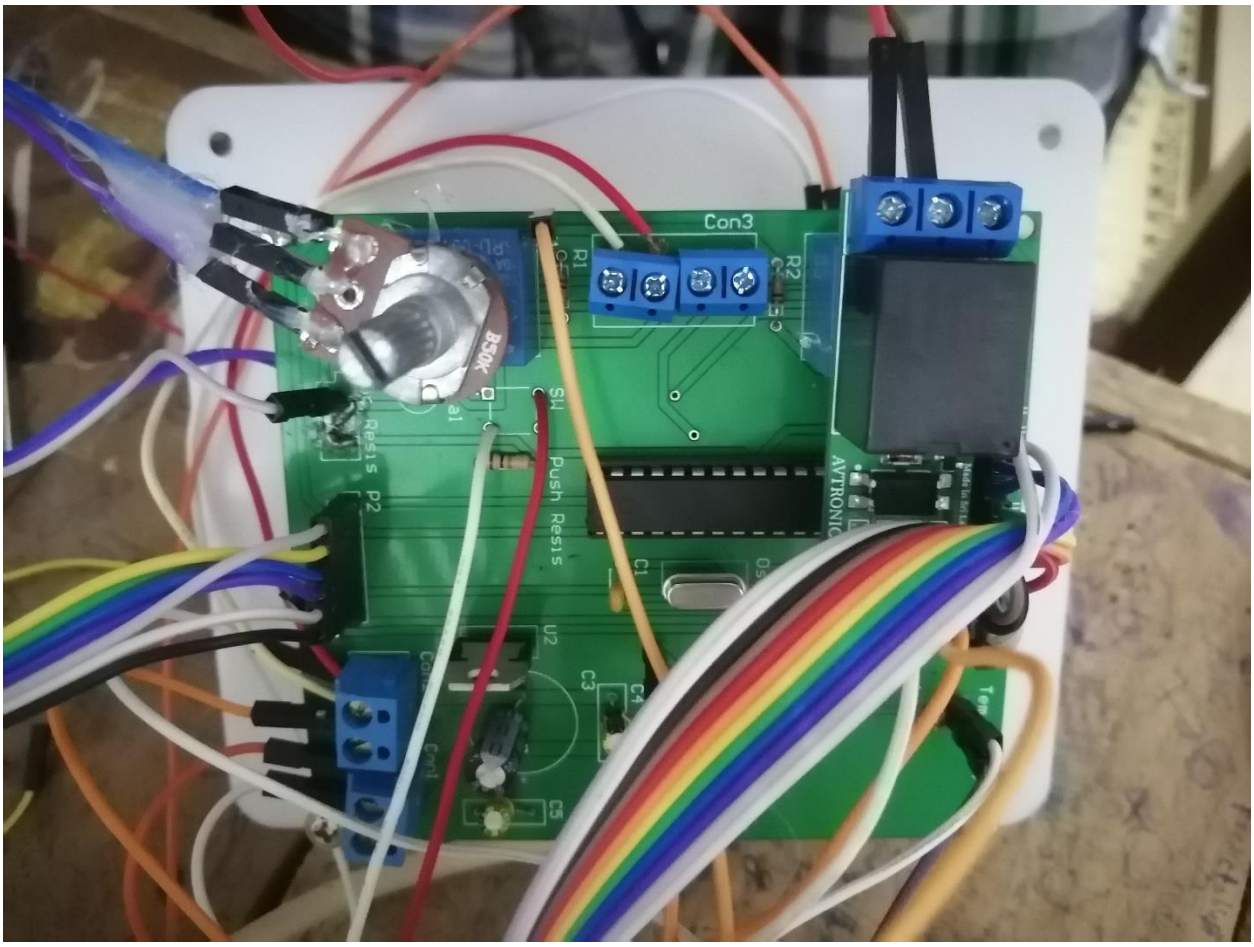
2-D Model of the PCB



3-D Model of the PCB

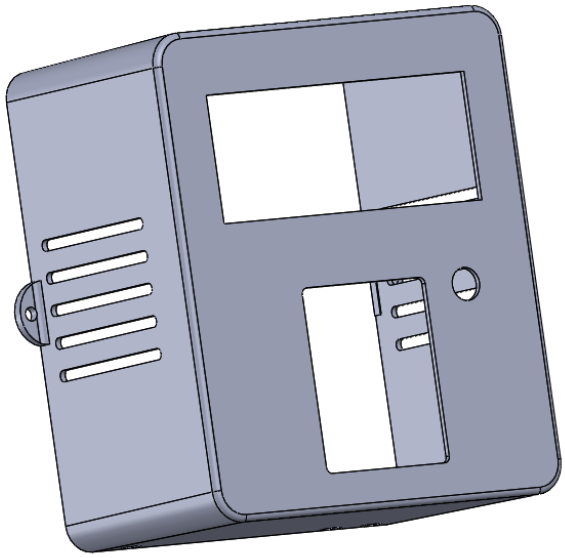


Circuit of the project after assembling components: -

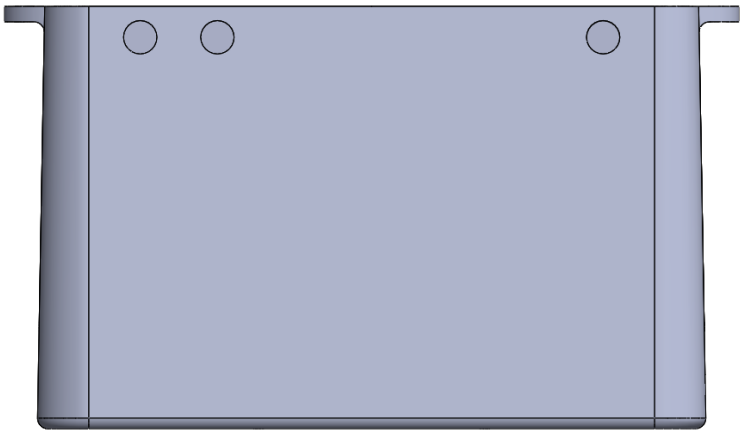


4. Enclosure Design

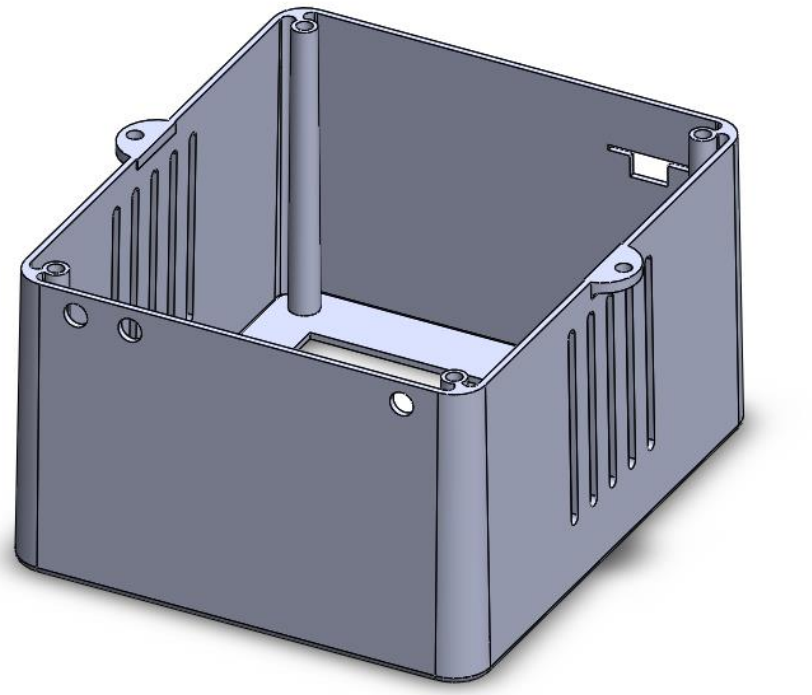
First part of the design:-



Isometric View of the enclosure

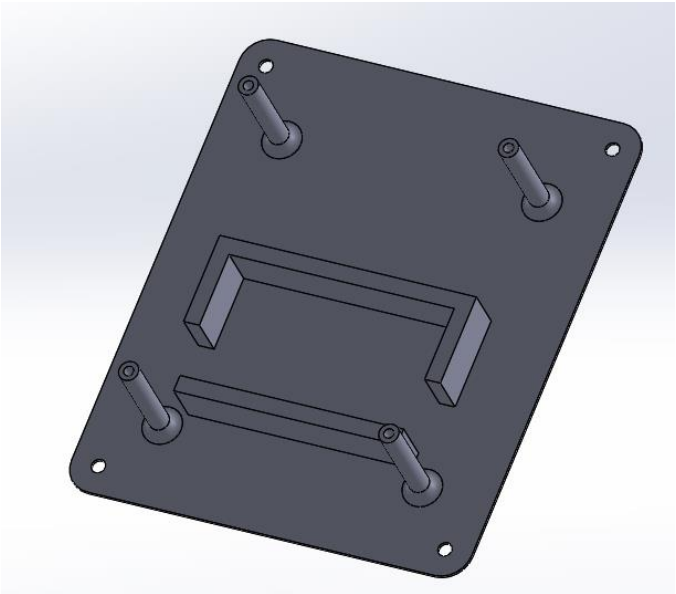


Bottom View of the enclosure

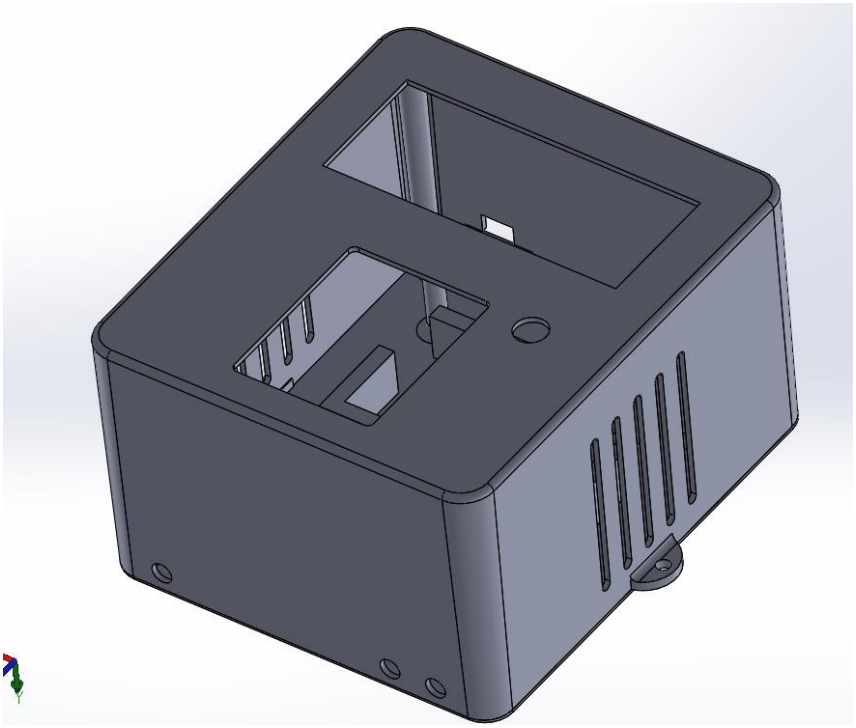


Isometric view of the enclosure

Second part of the design: -



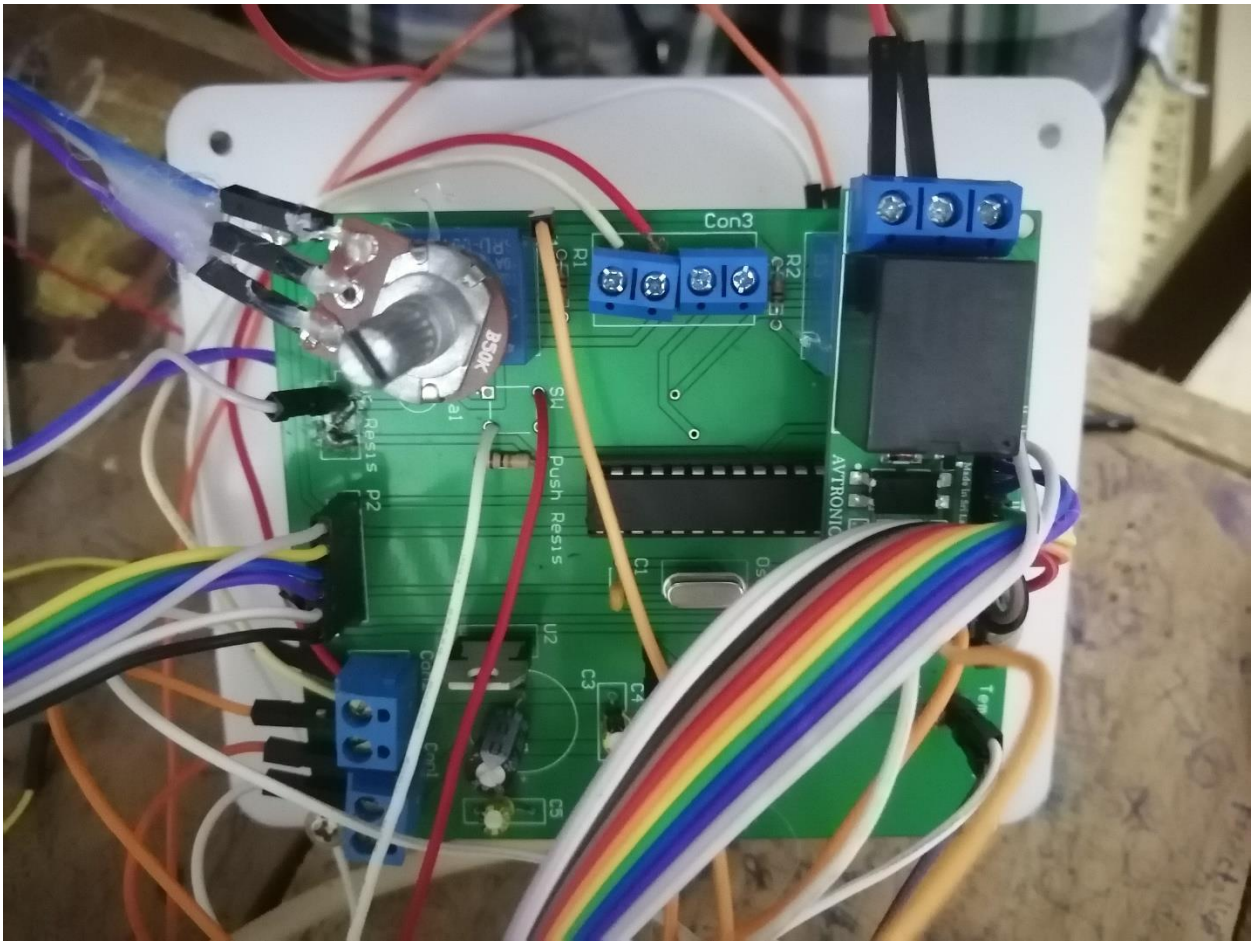
Assembled Design: -



Isometric View of the Assembled Enclosure

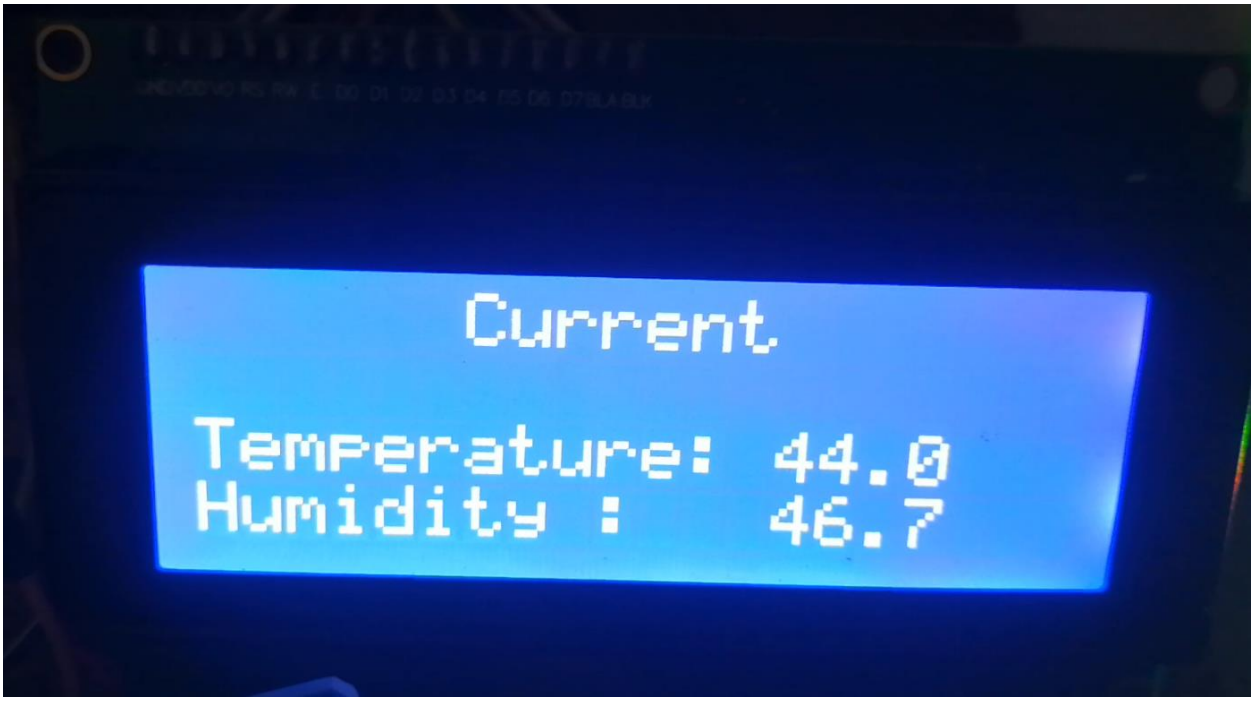
5. Implementation results of the first prototype

Circuit of this project:-



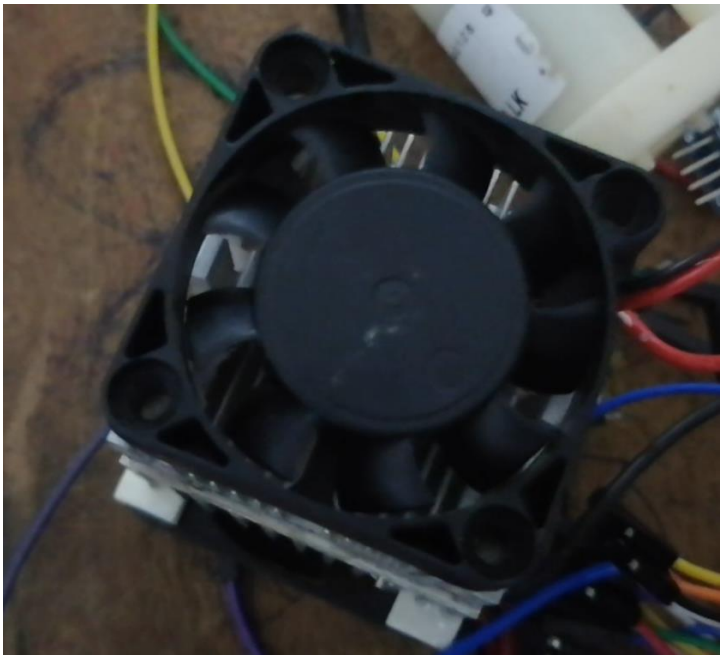
Now the current temperature is 44.0. We get this current temperature value by using DHT22 temperature and humidity sensor.

In here first use has to input the temperature range that they want to maintain. Here user has to input Low temperature value and the High temperature value. In here user input 45 Celsius as the high temperature value.



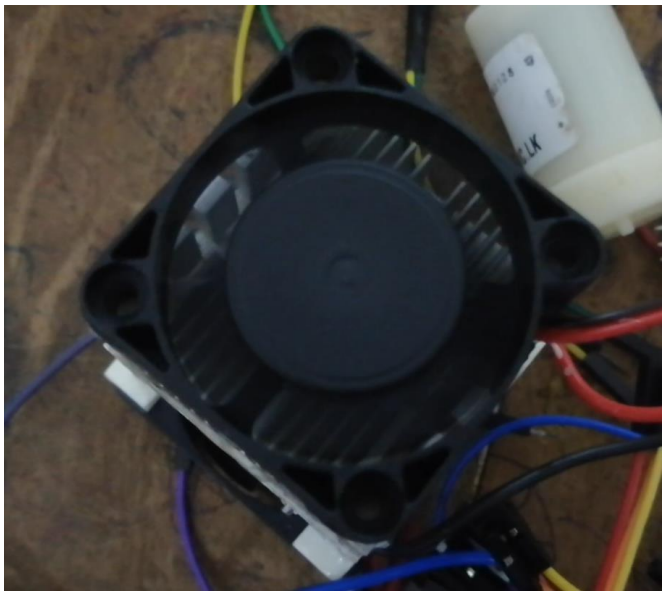
Here then current temperature is smaller than the user input high value then it will turn OFF the AC. Here I use fan to demonstrate the AC. Here the relay is in the turn OFF mode.

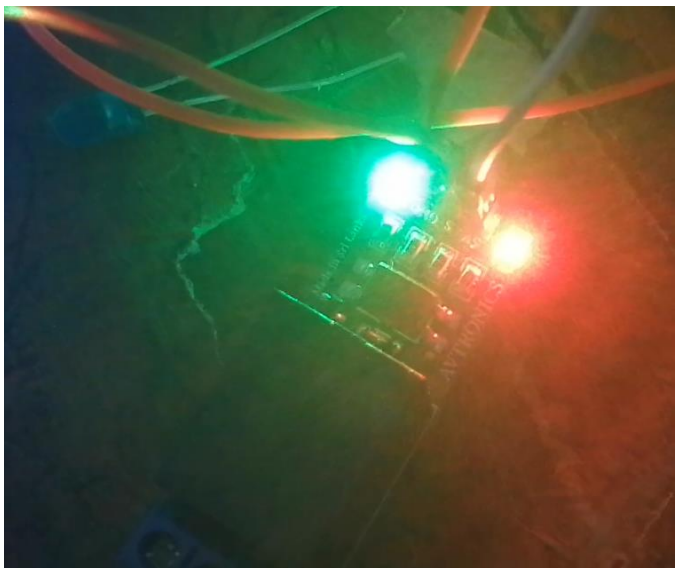
AC. Here I use fan to demonstrate the AC. Here the relay is in the turn OFF mode.



Now when the current temperature is greater than the user input high value then it will automatically turn ON the AC.

Here the Fan is turn On and the relay is in the ON condition.





6. Testing and Results

In order to evaluate the Automatic Temperature Controller project's performance, accuracy, and user interaction capabilities, thorough testing was conducted. The 3x4 keypad input technique was validated during testing, and the output shown on the 20x4 LCD screen was assessed.

5.1 Test Setup

The test setup remained consistent with the components used in the project:

- ATmega328P microcontroller board
- DHT22 temperature and humidity sensor
- 5V relay module
- Air conditioning unit
- 3x4 keypad for temperature input
- 20x4 LCD display for output

5.2 Input Testing: Using the 3x4 Keypad

Users were asked to enter the preferred temperature range using the 3x4 keypad during the input testing. An easy-to-use interface was provided by the keypad for entering the higher and lower temperature criteria. The goal of the test was to check that the system accurately read and interpreted the keypad input without any mistakes or discrepancies.

5.3 Output Testing: 20x4 LCD Display

The objective of the output testing was to confirm the veracity of the data displayed on the 20x4 LCD panel. The LCD showed current temperature information, humidity readings.

5.4 Integrated Testing

The entire system was put through integrated testing after individual component testing. The system replied by managing the air conditioner and showing the results on the 20x4 LCD based on the temperature ranges that users entered using the 3x4 keypad. The goal was to make sure that the LCD display, input interface, microcontroller logic, sensor data, and relay control all worked together seamlessly.

5.5 Results

Input Testing: Using the 3x4 Keypad

The input testing results were positive, showing that the 3x4 keypad was effective in accepting user input for defining the temperature range. Users could enter the desired upper and lower temperature values easily and accurately.

Output Testing: 20x4 LCD Display

The output testing revealed that the 20x4 LCD accurately displayed real-time temperature and humidity data, as well as the status of the air conditioner. The LCD provided clear and consistent information, making it easy for users to monitor the room conditions and the system's response.

Integrated Testing

The integrated testing demonstrated that the Automatic Temperature Controller operated seamlessly as a cohesive system. Users could input temperature values through the 3x4 keypad, and the system accurately controlled the air conditioner based on the defined temperature range. The 20x4 LCD effectively conveyed the system status and real-time data, ensuring a user-friendly and informative experience.

7.Conclusion

The Automatic Temperature Controller project is an intelligent solution for maintaining room temperature within a user-defined range. Utilizing an ATmega328P microcontroller and DHT22 temperature and humidity sensor, the system achieves accurate temperature control, prompt responsiveness, and substantial energy savings. The 3x4 keypad for user input and 20x4 LCD for output display enhance the user experience. The project aims for energy conservation and user comfort, reducing energy waste and utility costs. The system's user-friendly interface and easy input of desired temperature ranges make it accessible to users of all technical backgrounds. The project's modular design allows for future enhancements, such as remote control or data logging features. Overall, the Automatic Temperature Controller project showcases the practical application of microcontrollers, sensors, and human-machine interfaces in creating a smart and eco-friendly temperature regulation system.