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Research Article

Accurate Room Temperature Controller Using NodeMCU ESP8266

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Abstract

The "Accurate room temperature controller using NodeMCU ESP8266 "controls the temperature of any device according to its requirement for any industrial/home application. At the heart of the circuit is the NodeMCU controller which controls all its functions. The main purpose of this Digital Temperature Controller is to control the temperature of any device like AC or any other electronic devices whose temperature keeps fluctuating and thus requires a constant watch on the device. A temperature sensor LM35 is used for sensing the temperature of the environment and the system displays the temperature on an LCD in the range of –55°C to +150°C.This temperature is compared with the value stored by the user and if the temperature goes beyond the preset temperature then heater will switch off and if temperature goes below to preset value then heater will switch on. AC bulb is interfaced with the microcontroller which is done with the help of a relay and an npn transistor. The use of this system eliminates constant watching on the device by self controlling the temperature of the system. LCD display is used to display the temperature and when the temperature exceeds the set limit, the lamp is switched off in order to control the temperature. The heater is demonstrated with the help of a lamp. After the heater is switched off, the AC is switched ON. The display consists of LCD display to monitor real time temperature, AC on/off, Bulb On/off etc. By using blynk app, its button allows user to increment and decrement high and low temperatures. After that the system detects temperature and switches the load when it goes beyond set limits. Our proposed project consists of digital temperature sensors for more accurate temperature control in various industries.

Keywords: ***Node MCU ESP8266, LCD Display, DC Cooling Fan, LM35 Temperature Sensor, Embedded C, Arduino IDE***

1. Introduction

The goal of this project is to design an ambient temperature measurement and control circuit. The motivation for the project is the fact that temperature measurement has become an integral part of any control system operating in a temperature sensitive environment and the various learning outcomes associated during the implementation of the project. Temperature control is a procedure to maintain the temperature at a certain level. This method is commonly used in all regions of the world [1]. Recently in the globalization period, this method becomes an important part because there are several applications in daily life includes this procedure especially server room and greenhouse. Every day server room works nonstop in 24 hours. During this procedure, server room needs to be checked frequently in order to confirm its functionality and efficiency, particularly on temperature. Accurate room temperature controller mentioned as the best technique in any application by controlling the temperature automatically.

1.1. Project Working

The principal reason for this Digital Temperature Controller is to control the temperature of any gadget like AC or whatever other electronic gadgets whose temperature continues fluctuating and thus these lines needs a consistent watch on the gadget. The utilization of this framework takes out consistent viewing on the gadget without anyone else controlling the temperature of the framework. The proposed project comprises of digital temperature sensors for more precise temperature control in several industries [2]. The LCD display is used to show the temperature and when the temperature exceeds the fixed limit, the lamp is turned off in order to regulate the temperature. The heater is established with the help of a lamp. After the heater is turned off, the AC is turned ON. Here alternating current is confirmed with the help of a small fan. After the AC is switched ON, it remains ON until the temperature ranges below the surpass limit. Thus, the proposed system keeps on switching ON or OFF the heater (or) the AC for automatically controlling the temperature of the system.

Applications of Room Temperature Controller: Room temperature controller can be used in Industrial Automation as well as home automation.

- This project can be used to conserve the electrical power. These are used in a wide variety of industries to manage the process of manufacturing or operations [3]. Some of the applications of temperature controller are in industries like plastic extrusion,

thermoforming machines, injection molding machines, packaging machines, food storage, food processing, and blood banks

From the above information finally, we can conclude that the proposed system will solve the daily problems where AC's do not work properly due to low voltage, normally in rural areas. In future, this project can be extended for controlling the temperature in many rooms in an apartment.

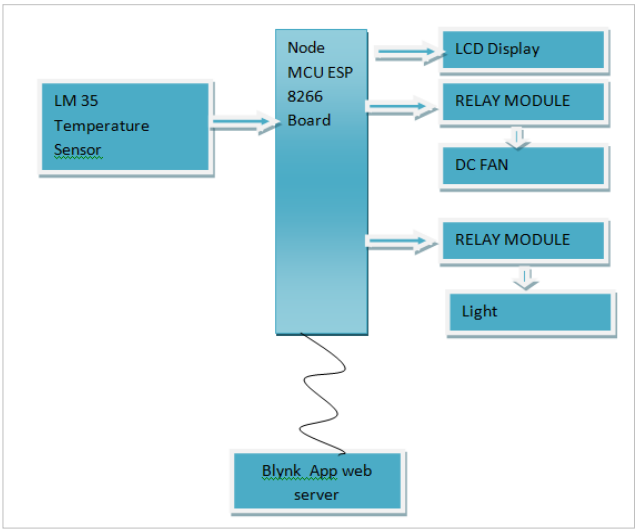


Fig.1. Block diagram of room temperature controller

2. Hardware Description

2.1. NodeMCU Firmware

NodeMCU is an open source IoT platform. It uses the Lua scripting language. It is based on the eLua project, and built on the ESP8266 SDK 0.9.5. It uses many open source projects. It includes firmware which runs on the ESP8266 Wi-Fi SoC, and hardware which is based on the ESP-12 module [4]. The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications. NodeMCU was able to support the MQTT IoT protocol.

Node MCU ESP8266:

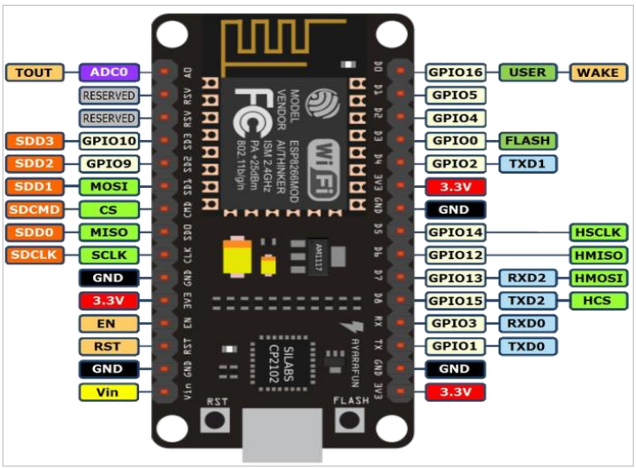


Fig:2 ESP8266

Due to resource constraints users need to select the modules relevant for their project and build a firmware tailored to their needs.

2.2. Relay

Works on 5V 240V Appliances can be controlled from a ARM Processor with a 5V signal High power loads which cannot be directly controlled from ARM Processors can be switched on/off with this relay module. Loads like 12V DC Motors, Solenoids, LEDs, etc can be controlled with this module [5]. Each relay has all three connections - Common, Normally Open, Normally Closed brought out to 3 pin screw terminals which makes it easy to make and remove connections. The board has a power indication and a relay status LED to ease debugging. The board requires a 5V to power supply to power the relay.

The relay operates mechanically, so it cannot operate at high speed.

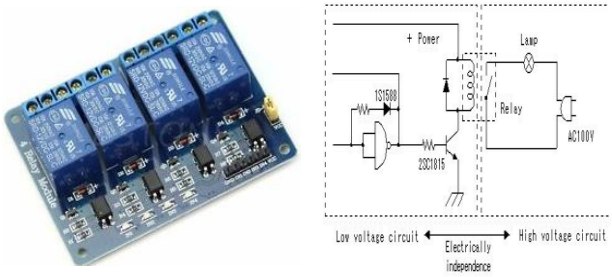


Fig. 3. Internal circuit of Relay

The relay can then be turned on and off with 5V HIGH Signal from a ARM Processor. The relay takes advantage of the fact that when electricity flows through a coil, it becomes an electromagnet. The electromagnetic coil attracts a steel plate, which is attached to a switch. So the switch's motion (ON and OFF) is controlled by the current flowing to the coil, or not, respectively.

2.3. LM35 Temperature Sensor:

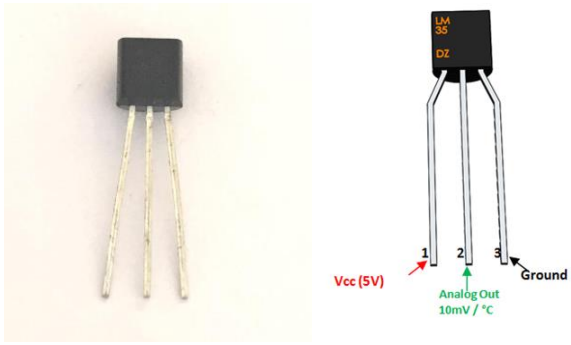


Fig.4. LM35 Temperature sensor pin out

Pin Configuration:

Pin Number	Pin Name	Description
1	Vcc	Input voltage is +5V for typical applications
2	Analog Out	There will be increase in 10mV for raise of every 1°C. Can range from -1V(-55°C) to 6V(150°C)
3	Ground	Connected to ground of circuit

2.3.1. LM35 Regulator Features

- Minimum and Maximum Input Voltage is 35V and -2V respectively. Typically 5V.

- Can measure temperature ranging from -55°C to 150°C. Output voltage is directly proportional (Linear) to temperature (i.e.) there will be a rise of 10mV (0.01V) for every 1°C rise in temperature. ±0.5°C Accuracy. Drain current is less than 60uA. Low cost temperature sensor. Small and hence suitable for remote applications [6]. The voltage can converted into temperature using the below formulae.

$$V_{OUT} = 10\ mv/°C \times T$$

where

- V_{OUT} is the LM35 output voltage
- T is the temperature in °C

Interface LM35 temperature sensor with any microcontroller that has a built-in analog to digital converter pins. Almost all the microcontrollers today have built-in ADC.

2.3.2. Voltage Divider

The potentiometer can be worked as a voltage divider to obtain a manual adjustable output voltage at the slider from a fixed input voltage applied across the two ends of the potentiometer. Now the load voltage across RL can be measured as

VL= R2RL. VS/(R1RL+R2RL+R1R2)

2.4. BC547 Transistor:

The BC547 transistor is an NPN transistor. A transistor is nothing but the transfer of resistance which is used for amplifying the current. A small current of the base terminal of this transistor will control the large current of emitter and base terminals [7]. The main function of this transistor is to amplify as well as switching purposes. The maximum gain current of this transistor is 800A.

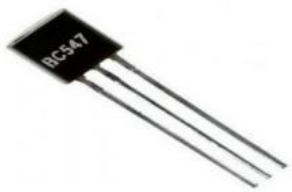


Fig.5. BC 547-transistor

BC547 Transistor Pin Configuration

The BC547 transistor includes three pins which include the following.

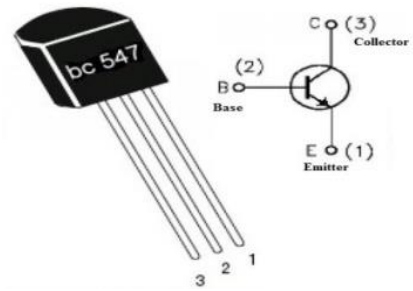


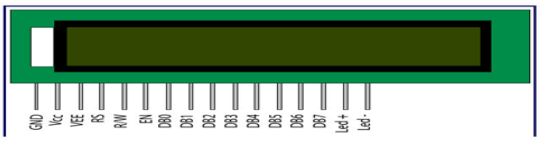
Fig.6.BC 547-transistor-pin-configuration

- Pin1 (Collector): This pin is denoted with symbol ‘C’ and the flow of current will be through the collector terminal.
- Pin2 (Base): This pin controls the transistor biasing.
- Pin3 (Emitter): The current supplies out through emitter terminal

2.5. LCD (Liquid Crystal Display)

A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data [8].

Pin Diagram



Pin Description:

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	VEE
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight VCC (5V)	Led+
16	Backlight Ground (0V)	Led-

Fig.7: LCD display pin configuration

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

2.6. DC Motors

A DC motor is a motor that transforms electrical energy into mechanical energy by drawing in direct current. DC motors induce a rotation movement in the machine by electromagnetism. DC motors have inductors (electromagnet) within them that create a magnetic field that aids the rotation of the motor.

The electromagnet is a piece of iron with wire coil windings around it. This coil has current running through its terminals. This alignment has two stationary magnets on both the sides of the electromagnet. The opposing and attractive forces of these magnets create a torque.

3. Software

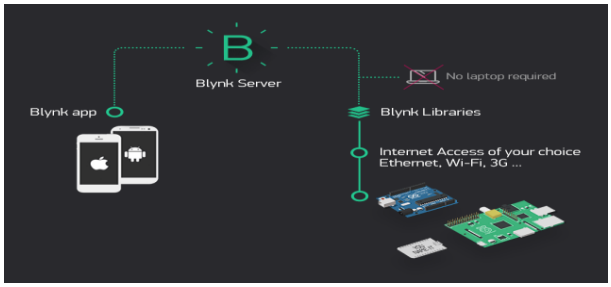
The C computer programming language was used to create a set of instructions for the bidirectional visitor counter to run through a C compiler on a computer in the first place [9]. The instruction set code is converted to into machine language (Hex file) for it to b readable to the microcontroller. The full instruction set code for the bidirectional visitor counter system is given in Appendix.

3.1. Blynk app

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, vizualize it and do many other cool things.

There are three major components in the platform:

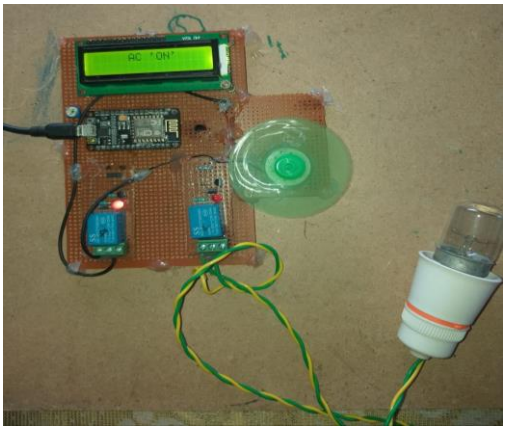
- **Blynk App** - allows to you create amazing interfaces for your projects using various widgets we provide.
- **Blynk Server** - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- **Blynk Libraries** - for all the popular hardware platforms - enable communication with the server and process all the incoming and out coming commands.



System Testing

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product [10]. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

4. Screen Shots



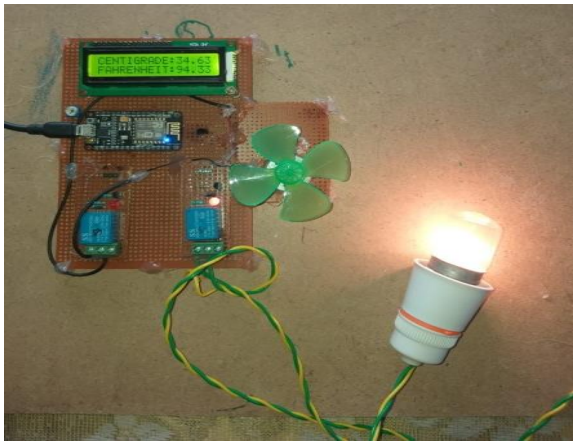


Fig.8.Images of accurate room temperature controller using ESP8266

6. Conclusion

This will start the AC depending upon the temperature label in a room by sharing the load also this project can be extended for controlling the temperature in more rooms in an apartment in future. IoT based AC control system is monitored and controlled by using Blynk app. IoT based AC control system using IOT is an innovative application of internet of things developed to monitor and control temperature levels remotely over the cloud from anywhere in the world. In the proposed project Temperature sensor is used to sense the temperaure and display it on internet using IoT. The system updates the information in every 1 to 2 seconds on the internet using public cloud Blynk application. Also using cloud analytics we can predict future energy consumptions.

7. References

1. J.E. Johnson, P.F. Maccarini, D. Neuman, P.R. Stauffer, Automatic temperature controller for multi element array hyperthermia systems, IEEE Trans. Biomed. Eng. 53 (6) (2006) 1006e1015.
2. S. Ludwig, J. Pritchard, 10 principles of sustainable, cost-effective design: building a safer, more efficient machine, in: Control Engineering Magazine, October 2010 [Online]. Available: https://www.plantengineering.com/singlearticle/10-principles-of-sustainable-cost-effective-design-building-a-safer-moreefficient- machine/. (Accessed 5 May 2018).
3. "Service Champion.Net," Service Champions Heating and Air Conditioning, [Online]. Available:

https://servicechampions.net/different-types-of-thermostatsavailable-today/. (Accessed 17 March 2017).

4. B. Ian, Self-programmable temperature control system for a heating and cooling system. United States of America Patent US5088645 A, 24 June 1992. https://patents.google.com/patent/US20100211224A1/en.
5. R.E. Hedges, Automatic temperature control for transport airplanes, IEEE Trans. Am. Inst. Electr. Eng. 66 (1) (1947) 1197e1202.
6. M. R. Levine, Automatic temperature adjusting system for air conditioner room. China Patent CN103335385 A, 6 June 2013.
7. B. G. Tate and R. P. Ries, Wireless thermostat and room environment control system. Unites States of America Patent US4969508 A, 13 November 1990. https://patents.google.com/patent/US4969508A/en.
8. S.B Poll, Automatic heater controller. United States of America Patent US4086466 A, 21 June 2006. https://patents.google.com/patent/US4086466A/en?oq¼US4086466þA.
9. T. Agarwal, EL PRO CUS, 17 October 2006 [Online]. Available: https://wwwelprocus.com/arduino-basics-and-design/. (Accessed 16 March 2017).
10. E.C. Ogu, S. Ogunlere, C. Ogu, A control and security system for internal temperature breaches using the ATMEL AT89C52 microcontroller, Int. J. Adv. Stud. Comput. Sci. Eng. 5 (1) (2016) 1e7. http://publication.babcock.edu.ng/asset/docs/publications/COSC/9475/2149.pdf.

