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Automatic Temperature Controller with Cooling System

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ABSTRACT: The Automatic Temperature Controller (ATC) is a locally designed Arduino nano borne electronic circuit system capable of monitoring and controlling the temperature of a thermally isolated enclosure or chamber, provided the heating or cooling source is powered electrically. Monitoring and automation are achieved with the aid of Temperature sensor, Arduino nano, Analogue-to-Digital Converter (ADC), Liquid Crystal Display (LCD) unit, Switching circuit and other essential components. The Arduino nano has been programmed to monitor and control instantaneous temperature values received from a temperature sensor. The preset values determine whether a relay is energized or de-energized. The switching terminal of the relay has been connected in series to the live terminal of the mains that powers an electrical heating or cooling by peltier plate. Thermoelectric cooling (peltier cooler) is the cooling element in our system it can reduce the use of electricity to produce cooling effect and also meet today's energy challenges. Therefore, the need for thermoelectric cooler in developing countries is very high where long life and low maintenance are needed. The circuit can be employed in managing the temperature of drying compartments such as House warmer, heating furnace, incubators, and others. The temperature range of the system is between - 4°C and 130°C with a resolution of 0.5°C.

1. INTRODUCTION

1.1 Introduction:

Temperature is a fundamental quantity that expresses the level of hotness or coldness of matter. Everybody is interested in knowing his/ her body temperature and if possible the ambient temperature as well. This is because temperature reveals microscopic information about matter at any given time. Temperature is an ever changing parameter because of exposition to huge array of stimuli from their environment (Deepika, 2006). When measuring temperature of a system or a confinement, it is paramount to ensure that the measuring instrument does not generate heat. Under some conditions heat from the measuring instrument can cause a temperature gradient, so the measured temperature is different from the actual temperature of the system. In such a case the measured temperature will vary not only with the temperature of the system, but also with the heat transfer properties of the system (Temperature Measurement, 2010). Temperature is generally measured with instrument called thermometer. Although the most commonly used and readily available type of thermometer is the Analogue Liquid-in-glass.

1.2 OBJECTIVE: 1] To design Automatic cooling system in such a way that it intelligently controls temperature of component and thus increase efficiency and lifespan of component.

2] To design and construct automatic temperature controller system so that It is of less cost, portable, very low power consumption.

3] To design and construct thermoelectric cooler to minimize the vibration.

II. LITERATURE SURVEY & REVIEW

2.1.Literature survey & review:- We have designed a simple method of temperature control system automatically. Utilizing the concept cooling after certain temperature, Arduino-based hardware along with display was realized in hardware. Few samples are shown in result, but any value of temperature can be generalized in this work. The work is focused mainly on temperature control, and no other parameter is involved. This seems to be robust way of handling only temperature control on automatic basis. This can be extremely useful for persons of physical disability. Soft computing method could be used to make it more robust and fuzzy controlled. [1]

III. METHODOLOGY

3.1.WORKING COMPONENTS:

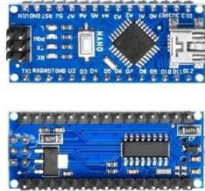
1. Switched-mode power supply :



A switched-mode power supply (SMPS) is an electronic circuit that converts power using switching devices that are turned on and off at high frequencies, and storage components such as inductors or capacitors to supply power when the switching device is in its non-conduction state.

- * Input Voltage: AC 90 - 264V 50 / 60Hz
- * Output Voltage: 12V DC, 10A, and 120W
- * Output voltage: Adjustment Eange: $\pm 20\%$
- * Protections: Overload / Over Voltage / Short Circuit
- * Auto-Recovery After Protection
- * Short Circuit Protection: The power supply will be auto recovered when short circuit faults remove.
- * The power supply will be auto recovered when over current faults remove.
- * The power supply will not be auto recovered when faults remove.
- * Universal AC input / Full range
- * Shell Material: Metal Case / Aluminum Base
- * Color: Sliver
- * Weight: Around 500g
- * Dimension: (199 x 98 x 42) mm / (7.80 x 3.85 x 1.57) inch (L x W x H)

2. Arduino Nano :



Support for external 5V ~ 12V DC power supply .

Operating Voltage(logic level):5V

8 analog inputs ports:A0 ~ A7

14 Digital input / output ports:TX,RX,D2 ~ D13

6 PWM ports:D3, D5, D6, D9, D10, D11

Support power supply by 9V battery

The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments.

Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smartphone or your TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a huge variety of Arduino-based projects.

3. Relay circuit :



- 12V 2channel relay board module can control various appliances and other equipment that draws large current.

It can be controlled directly by microcontroller (raspberry pi, Arduino, 8051, avr, pic, dsp, arm, arm, msp430, ttl logic)

Optically isolated relays protect your microcontroller from damage if the equipment being controlled fails 12v 2 channel relay interface board, each one needs 15 20ma Relays work taking an electrical current through them. In response to this current, the coil of the relay produces a magnetic field. This magnetic field then attracts the mechanical switch, closing it. This is why a relay is an electrical actuator. It uses an electric current to actuate the closing of a switch, and this is through the use of a magnetic field.

4.Peltier :



Thermoelectric peltier cooler or generator tec1-12706.

Create a temperature differential on each side

One side gets hot and the other side gets cool

Designed for cooling and heating up to 90 degree celsius applications

weight: 20 gms

5. LCD display module :



SIZE : 20x4 (2 Rows and 16 Characters Per Row)

Built-in industry standard HD44780 equivalent LCD controller

Commonly Used in: Student Project, Collage, copiers, fax machines, laser printers, industrial test equipment, networking equipment such as routers and storage devices

Operate with 5V DC LCD type: Characters

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.

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 LCDS .

6. Radiator fan and heat sink Module :



A30 comes with 92mm blue LED fan for ultra-quiet and efficient operations.

The Straight Touch copper heatpipes paired with aluminium fins offer a large surface area for heat dissipation and efficient functioning.

A heat sink is designed to maximize its surface area in contact with the cooling medium surrounding it, such as the air. Air velocity, choice of material, protrusion design and surface treatment are factors that affect the performance of a heat sink. Heat sink attachment methods and thermal interface materials also affect the die temperature of the integrated circuit. Thermal adhesive or thermal paste improve the heat sink's performance by filling air gaps between the heat sink and the heat spreader on the device. A heat sink is usually made out of aluminium or copper.

7. Water Cooling Block :



- Internal flow channel extrusion forming,Brazing parts into a whole,Leak rate of less than 5×10^{-6} mbar.l/s parts

Internal fin thickness 0.5MM Processing: vacuum aluminum brazing Surface treatment: silver oxidation

- Applicable to computer CPU water, industrial inverter driver, laser-head cooling, industrial control cabinet cooling.

8. Water pump :



- This is a small size submersible pump Motor which can be operated from a 3 ~ 6V power supply.
- It can take up to 120 liters per hour with very low current consumption of 220mA.
- Just connect tube pipe to the motor outlet, submerge it in water and power it.
- Make sure that the water level is always higher than the motor.
- Dry run may damage the motor due to heating and it will also produce noise.



9. Temperature sensor:



The DS18B20 is a 1-wire programmable Temperature sensor from maxim integrated. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. ... It can measure a wide range of temperature from -55°C to +125° with a decent accuracy of ±5°C.

Because, this sensor follows the single wire protocol, and the controlling of this can be done through an only pin of Microcontroller. This is an advanced level protocol, where each sensor can be set with a 64-bit serial code which aids to control numerous sensors using a single pin of the microcontroller. This article discusses an overview of a DS18B20 temperature sensor.

10. Voltage regulator:

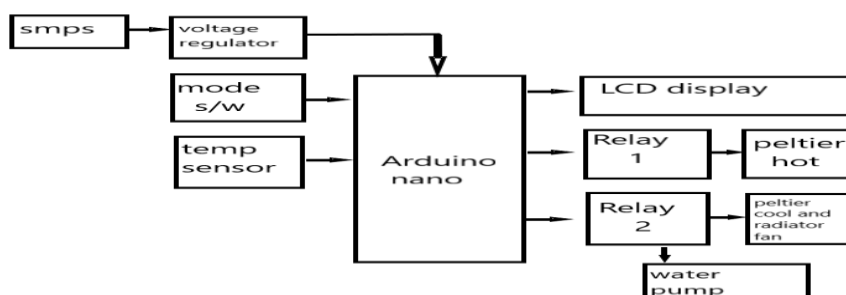


7809 IC is a simple voltage regulator IC which regulates the voltage to 9v, which means it gives a fixed 9V regulated voltage. It is a monolithic 3 terminal regulator IC. Its 9v output voltage makes is most convenient to use in TTL devices or circuits.

It is a member of 78xx series fixed linear voltage IC. it finds application where the 9v fixed power supply is redistricted to give. The IC gives little fluctuation, in that case, the maker should use a capacitor to remove fluctuations. Buy 7809 regulator IC from Roboelements across India and get only high quality or the original product.

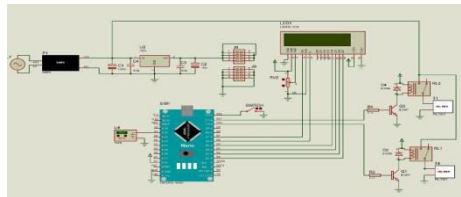
This is the basic L7805 voltage regulator, a three-terminal positive regulator with a 5V fixed output voltage. This fixed regulator provides a local regulation, internal current limiting, thermal shut-down control, and safe area protection for your project. Each one of these voltage regulators can output a max current of 1.5A.

3.3. BLOCK DIAGRAM:



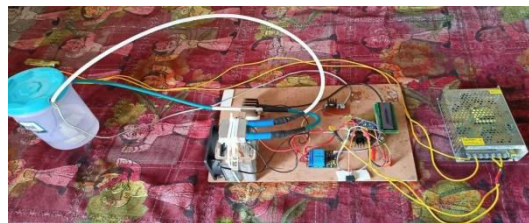
SMPS is connected with voltage regulator which controls voltage in Audrino Nano. A switch is attached with Audrino nano for manual and automatic cooling and temperature sensor to read temperature. LCD display is connected with Audrino nano to detect the temperature. Also relay 1 and relay 2 are connected with Audrino Nano to control both the heating and cooling peltier.

3.4. CIRCUIT DIAGRAM:



Circuit is constructed using Arduino nano and DS 1820 temperature sensor and other components. We are using 16x2 LCD to display current temperature and set points. DS 1820 gives analog output proportional to the temperature which is given to Arduino analog input A0. Which is then compared with set points if it is more than set point, It means the temperature is more so we turn off the heating element such as heater which is connected to relay output. If temperature is less we turn on the relay (heater). We are displaying status of heater on off on the LED and LCD also. Two tactile switches are used to set the temperature set point.

3.5.WORKING :



1. We supply 220 V to the Smps .It converts voltage by voltage regulator from 220 to 12 V
2. 12V is required for Audrino Nano to function Audrino Nano is connected with relay circuit and LCD display screen. Audrino Nano work as a microcontroller it controls all the functions and programming.
3. We can change the program for difference in temperature . We had set 40°C as minimum temperature and 50°C as maximum temperature from programming.

IV. RESULT

If we do manual cooling it's minimum temperature is 31°C.

As we start switch automatic cooling starts it automatically start cooling as temperature increases from 50°C and stops cooling as temperature goes below 40°C

We get a slight difference between fix temperature.

Upto 5 to 6 °C increase in Heating peltier as heating process is more faster than cooling process. We get less than 1°C difference in cooling temperature.

V. CONCLUSION

Controlling the temperature is a major problem in our rapidly evolving world and it needs cost-efficient solutions. This Temperature Control System shows a way to get the temperature value and displaying the value on a graphical LCD via Audrino nano . In this Project temperature values are measured in analog form, and then it is converted to digital by the Audrino nano.



The user can configure a set-point temperature value and control an external heating and/or cooling device by using the Temperature Control System.

VI. FUTURE SCOPE

Energy demand for space cooling will more than triple by 2030 – consuming as much electricity as all of China and India today so we need simple ,energy efficient and portable solution so, automatic temperature controller with cooling system is an option.

Use as cooling purposes .The project can be enhance in future by increasing the number of peltier plates and radiator fan; so it will help in industries and for medical purpose(peltier-cooled incubator for blood bank).

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