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Portable Water Bottle Heating and Cooling System

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ABSTRACT

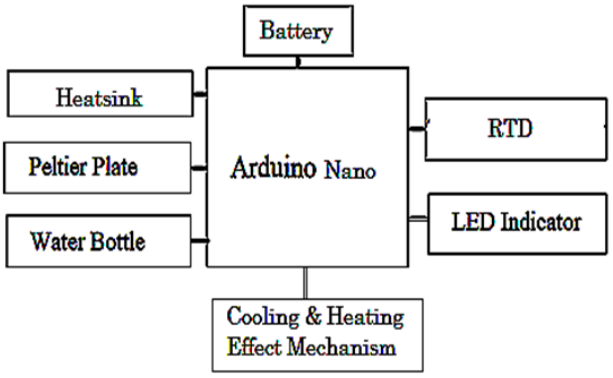
Both very cold and very hot temperatures could be dangerous to health. Excessive exposure to heat is referred to as heat stress and excessive exposure to cold is referred to as cold stress. In a very hot environment, the most serious concern is heat stroke. At very cold temperatures, the most serious concern is the risk of hypothermia or dangerous overcooling of the body. The proposed system is a battery power heating and cooling Bottle, This system attempts to perform an experimental study on one of the applications of Thermo Electric Generators under the benefit of the ARMY. Even as a well-developed technology, the efficiency of TEG hasn't reached the standard in order for it to be used in Energy Production. But with different ways of approaching this technology, we could benefit other needs like a Portable Cooling Bottle. In this project we have designed a prototype which can perform simultaneous heating and cooling which also includes electricity generation for mobile charging. We shall discuss regarding its Design and various other approaches involved to accomplish the given task.

Keywords: Arduino Uno, DS18B20 Temperature Sensor, water bottle, TEC plate, heat sink. Relay driver, Battery

I. INTRODUCTION

Energy crisis is the most concerning issue in the world now. The amounts of energy resources are limited and more expensive, so reducing energy waste becomes one of the most important challenges in the world. Thermoelectric technology provides an alternative to traditional methods of solar power generation, generation from waste heat, heating and cooling. Thermoelectric module can convert heat energy to electrical power directly. Compared with other methods Thermo Electric Modules (TEM) possesses the salient features of being compact, light-weighted, noiseless in operation, highly reliable, maintenance free, and involving no moving or complex parts. It is environment friendly operation, free of carbon dioxide emission and radioactive substances and does not contribute to the depletion of natural resources. Thermoelectric phenomenon was observed in 1821 by Seebeck. Extension to Seebeck research, in 1834, Peltier discovered that the passage of an electric current through a junction between two dissimilar conductors in a certain direction produces a cooling effect[1][2]. A correlation between the Seebeck and Peltier coefficients was experimentally proven by Thomson which is known as Thomson effect. This effect correlates the heating or cooling in a single element when current passes through it in the presence of a temperature gradient.

II. SYSTEM BLOCK DIAGRAM AND DESCRIPTION



BLOCK DIAGRAM DISCRIPTION

The Arduino based smart bottle cooling and heating hardware of six section namely battery, sensing unit DS18B20 Temperature Sensor, Arduino, LED indicator, relay driver and a few discrete components. The sensors sense parameter and give output to the Arduino Arduino will compare with standard value and output given to the indicator. This is used to provide 12V battery supply to the circuit. The Bottle can work both in manual or automated mode. In automatic mode the bottle reads the temperature via temperature sensor In this project Device that transfers heat from one side of the body to the other side of the body and thereby making one side of the body extremely cold (ice formation may happen depending on the current supplied and the room temperature) and other side of the body gets hot. (Heat dissipation is required in order to protect the module from getting damaged).Temperature sensor monitoring the temperature of bottle.

HARDWARE REQUIRED

1. Arduino Board
2. Battery.
3. Temperature sensor DS18B20
4. Relay Driver
5. TEC plate module
6. Display LED indicator

HARDWARE DISCRIPTION

1. Controller board as Arduino:

The ATmega328 is a single chip Microcontroller created by Atmel and belongs to the Mega AVR series. The Atmel 8bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, SPI serial port, 6-channel 10-bit converter, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughputs approaching 1 MIPS per MHZ

Specifications :-

Microcontroller - ATmega328P – 8 bit AVR family microcontroller.
Operating Voltage. - 5V
Input Voltage (recommended). - 7-12V
Input Voltage (limits) - 6-20V
Digital I/O Pins. - 14 (of which 6 provide PWM output)
Analog Input Pins -6 (A0-A5)
DC Current per I/O Pin. - 40 mA
DC Current for 3.3V Pin -50 mA
Flash Memory -32 KB of which 0.2 KB used by boot loader
SRAM. – 2 KB

2. BATTERY

A battery is a device consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-

energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to include devices composed of a single cell.

Fig: 12V Battery Diagram

3. **Temperature sensor DS18B20**

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. The constriction of the sensor is rugged and also can be purchased with a waterproof option making the mounting process easy[3]. It can measure a wide range of temperature from **-55°C to +125°** with a decent accuracy of **±5°C**. Each sensor has a unique address and requires only one pin of the MCU to transfer data so it a very good choice for measuring temperature at multiple points without compromising much of your digital pins on the microcontroller.

DS18B20 Sensor Specifications

- Programmable Digital Temperature Sensor
- Communicates using 1-Wire method
- Operating voltage: 3V to 5V
- Temperature Range: -55°C to +125°C
- Accuracy: ±0.5°C
- Output Resolution: 9-bit to 12-bit (
- Unique 64-bit address enables multiplexing
- Conversion time: 750ms at 12-bit
- Available as To-92, SOP and even as a waterproof sensor

4. **RELAY DRIVER**

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays[4]. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

QUICK OVERVIEW

- Operating Voltage: 5 V
- Max Current: 20 mA
- Relay Contact Current Capacity at 250 V AC: 10 A
- Relay Contact Current Capacity at 30 V DC: 10 A
- Single Pole Double Throw (SPDT) Configuration
- Power supply indicator lamp

Features:

- 1 channel relay module.
- One normally closed contact and one normally open contact.
- High impedance controller pin.
- Default High-level trigger.
- Pull-down circuit for the avoidance of malfunction.
- Power supply indicator lamp.
- Can be controlled various appliances & other Equipment with Large current.
- Standard TTL Level logic controlled.
- The module is compliant with international safety standards.
- With 4 fixed screw holes, hole diameter 3.1mm, convenient installation, and fixation.

Specifications:-

Operating Voltage (VDC):- 5
Max. Current (mA):- 20
Current Capacity at AC250V:- 10A
Current Capacity at DC30V:- 10A
Length (mm):- 38
Width (mm):- 26
Height (mm):- 18
Weight (gm):- 13
Shipment Weight: - 0.105 kg
Shipment Dimensions: - 7 × 5 × 2 cm

5. PELTIER PLATE (TEC12706)

Thermoelectric is defined as the generation of electricity from a given temperature difference or vice versa. Solid state devices capable of producing power, these devices are environment friendly that come with low maintenance and reliability. They use a very simple concept of running on a temperature difference and as long as this criteria is being fulfilled, energy is produced. The concept of thermoelectricity can be classified into 2 parts. Thermoelectric Coolers (TEC) and Thermoelectric Generators (TEG). In order to run a TEC, a certain amount of current has to be input along with maintaining a temperature difference which gives a cooling power and the coefficient of performance of the device can then be measured [5].

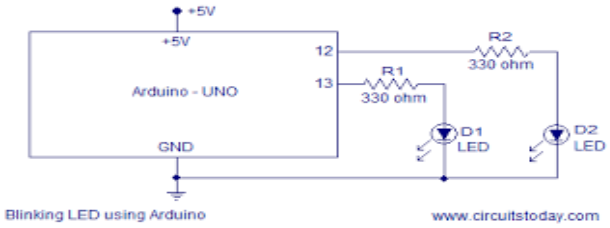
Fig. Peltier Plate TEC 12706

6. HEATING AND COOLING MECHANISM

Device that transfers heat from one side of the body to the other side of the body and thereby making one side of the body extremely cold (ice formation may happen depending on the current supplied and the room temperature) and other side of the body gets hot. (Heat dissipation is required in order to protect the module from getting damaged).

7. LED INDICATOR-

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device). The construction diagram of the temperature LED indicator is shown in Figure



III. SYSTEM CIRCUIT DIAGRAM

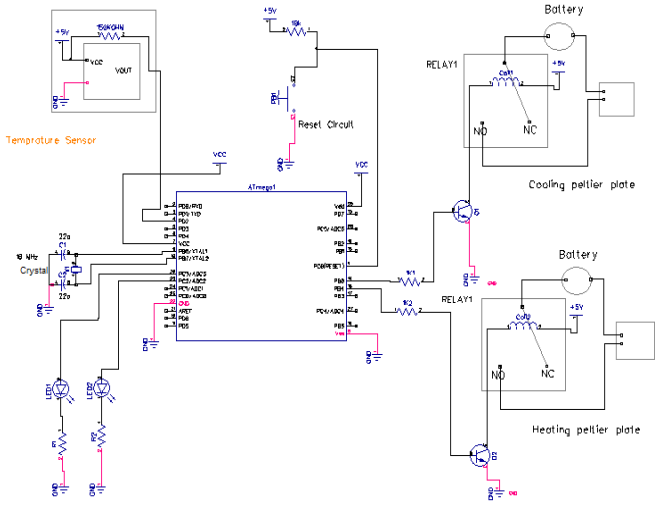


Fig. circuit diagram of project

IV. SOFTWARE REQUIREMENT

a)Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2.The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

V. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

Advantages

- Ability to Heat and Cool with the same module.
- High Reliability.
- Precise Temperature Control.
- Environmentally Friendly.
- Compact size of performs.

Disadvantages

- Limited battery resource.
- Slow cooling action
- Single TEC modules have small power. Combine them to thermopile and then cascade or parallel these thermopiles to be a cooling system with high power, from 1mW to10KW.
- The hot side temperature should not exceed 60°C, or it may be damaged. Do not power the TEC modules for a long time when there is no hear sink. Make sure there is enough heat dissipation devices for TEC modules.

APPLICATIONS

- Applicable on Army different environment (hot & cold)
- Water dispenser
- Chemical plant

VI. CONCLUSION

This system is smaller, lighter with low power consumption, so it is more convenient. We can using this bottle in both seasons like summer and winter. We use a lithium-ion battery instead of a normal battery because the lithium-ion battery has a higher charging and discharging rate. This can help soldiers to work

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