

Solar Fridge with Temperature Control and Monitoring System Using Bluetooth Module

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Abstract:- Nowadays world global warming is being increasing year by year. There are many reasons like pollution, deforestation, water contamination, etc... In coming years, the major problem before us is depletion of ozone layer which is caused by the release of CFC's. Some of the equipments which cause this effect are refrigerators, AC's. In this project we are mainly focusing on a solution to control this problem we have focused on refrigerators which releases CFC's. Here we are designing a mini solar Bluetooth based refrigerator with temperature control with temperature monitoring system which is cheaper as well as eco-friendly. Here we are using ARDUINO allows dynamic and faster control. Liquid crystal display (LCD) makes the system user-friendly. The sensed and set temperature values are simultaneously displayed on the LCD panel.

In this project we are using solar panels for charging a Lead Acid Battery (12V, 1.2 Amp hrs), a peltier thermoelectric device which when connected to battery generates cooling effect on one side and heat is dissipated on other side through heat sink, a cooling fan is used for dissipating the heat from the heat sink. A regulator 7803 is used to drive the internal cooling fan and LED. The temperature sensor LM35 senses the temperature and converts it into an electrical signal, which is applied to the ARDUINO through ADC. The analog signal is converted into digital format by the analog-to-digital converter (ADC). The sensed values of the temperature are displayed on the 16x2-line LCD. The temperature range of the sensor is 1°C to 255°C.

This project uses regulated 5V; 500mA power supply. A 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer. In this project we have controlled temperature by using external Bluetooth device (Mobile, Computer) with the help of Bluetooth terminal application. For this purpose, here, we are using voltage control circuit which is connected to ARDUINO and HC-05 Bluetooth is connected to ARDUINO. In ARDUINO ATmega328-PU microchip is used.

Keywords: Thermoelectric effect; Arduino; Solar fridge; Bluetooth; Temperature control and monitoring

INTRODUCTION

The 21st century is the era of smart technology. It is said that modern life is unimaginable without the modern technology around us which makes our life comfortable and lavish life. Modern technology has advanced to another level of automatic and smart system.

There is no need to introduce the advancement of technology in modern times, as we know the advancement has gone a long way and has gone a long way and has almost reached to its peak of modernization. Today innovation has turned into a coordinated piece of individuals' life.

One of the advanced evolutions of the modern technology is the wireless technology. Wireless ARDUINO based technology for remote temperature monitoring and controlling the system is proposed for mobility, low cost, low power, small size etc. ISM band communication technologies such as Infrared, Bluetooth etc. are of particular interest in these features.

Bluetooth has been used in wide range and the technology is available in the market. This encourages us to introduce it to remote temperature monitoring and controlling system. The system will be continuously able to monitor the temperature conditions of the refrigeration. LM35 temperature sensor is been performed over other devices mainly because of its accuracy.

The main purpose of wireless application through android mobile phone system ARDUINO model is to make it easy for the user to analyze or to control the temperature conditions based on the recorded temperature data.

This fridge will be suitable for cooling purposes meant for small objects and will have a relatively small chilling time as compared to the normal refrigeration systems. In most of the rural areas of our country, the electric supply is either sporadically available or not available at all. The most severe effect of this problem is on the Primary Health Care Centers. Due to no electricity, most of the PHC's do not maintain adequate supply of medicines and equipment which need to be kept in a cold environment. So, in case of any emergency, the patient is to be referred either to the town or city hospital which results in loss of precious time and may prove fatal for the patient.

1. THERMOELECTRIC EFFECT

The thermoelectric effect is a phenomenon by which a temperature difference is directly converted to electric voltage and vice versa. On the measurement-scale of everyday life, a thermoelectric device creates a voltage when there is a different temperature on each side. Conversely, when a voltage is applied to it, it creates a temperature difference. On the scale of atoms which are

charge carriers, an applied temperature difference causes charged carriers in the material, whether they are electrons or holes, to diffuse from the hot side to the cold side, similar to a classical gas that expands when heated hence, the thermally induced current. Which effect used to generate electricity, to measure temperature, to cool objects, or to heat them or cook them because the direction of heating and cooling is determined by the sign of the applied voltage, thermoelectric devices make very convenient temperature devices make very convenient temperature controllers. [3]

2. MATERIALS USED

In this project, various equipment's and materials are used for the proper functioning and performance of the fridge. These equipment's and materials are as follows:

A. Peltier Module

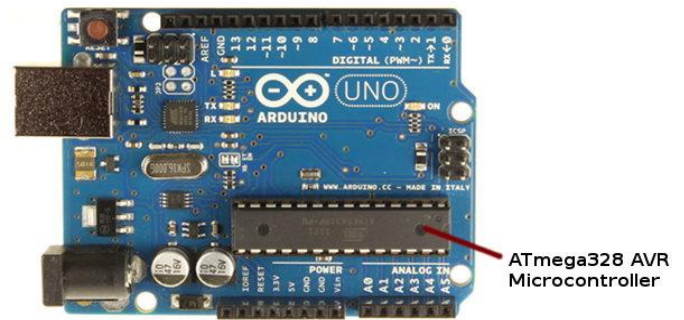


Peltier modules are a unique electronic device that can create a temperature differential when powered. When 12V is applied, one side will begin to get cold while the opposite side will get hot. The module is rated to 5A at 12V and is rated to a maximum temperature differential of 66°C. Dimensions: 40 x 40 x 3.7mm. Peltier module can convert thermal energy into electricity is provided to the peltier module then absorption of heat (cool side) on one side and rejection of heat (hot side) on other side. Conventional systems can use or generate harmful gases like ChloroFluoro Carbons (CFCs) and Hydro Chlorofluorocarbons (HCFCs). The peltier module can't use or generate these harmful gasses. Peltier module can operate on DC power source. By using proper closed loop circuit, the peltier module can control precise temperature. For more efficiency heat sink and cooling fan can be attached to the peltier module. [1]

B. Battery

The battery is used in this fridge has following specifications 12 Volt, 7.5 ampere hour. In this fridge one lithium battery is used. To charge these batteries solar panel is used.

C. Arduino Uno



The Arduino Uno is an 8-bit microcontroller board on the ATmega 328. It has 14 digital pins and 6 analog pins and other power pins such as GND, VCC, it has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It has SRAM 2kb and flash memory 32kb, EEPROM with 1kb. Arduino is open source hardware board with many open source libraries to interface it on board microcontroller with many other external components like LED, motors, IR sensors and many other things one wants to interface with Arduino board. Arduino is complete board which includes all things to connect with external peripheral and to program through computer. It contains everything needed to support the microcontroller. We either need to connect it to a computer using a USB cable or power it with an AC-to-DC (7-12V) adapter. The Arduino circuit acts as an interface between the software part and the hardware part of the project. [7]

D. Voltage Control Circuit



This circuit is used for low-voltage control signal from the Arduino to control a relay, which is capable of handling and switching high-voltage or high-power circuits. A relay consists of an electromagnet that, when energized, causes a switch to close or open. Relays provide complete electrical isolation between the control circuit and the circuit being controlled.

E. Bluetooth Hc-05



A HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4 GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx17mm. Hope it will simplify your overall design/development cycle. [8]

F. 16*2 Display

An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16x2 LCD display is a very basic module commonly used in DIYs and circuits. The 16x2 translates to a display 16 characters per line in 2 such lines.

G. Multi Voltage Power Supply Pin



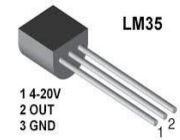
Multi voltage power supply pin is integrated circuit which takes one input voltage and converts in different output voltages like 2.5V, 3.3V, 5V etc.

H. Three Way Switch



The 3-way switch was originally developed to allow users to control a light from two different locations but here it is used to change the effect of peltier effect. A regular switch has only two connections and simply cuts the flow of electricity through the switch or allows the current to pass through it. Three-way switches each have three connections and are used in tandem.

I. Temperature Sensor LM 35



The LM35 temperature sensor is used to detect precise centigrade temperature. The output of this sensor changes describes the linearity. The o/p voltage of this IC sensor is linearly comparative to the Celsius temperature. The operating voltage range of this LM35 ranges from -55° to +150°C and it has low-self heating.

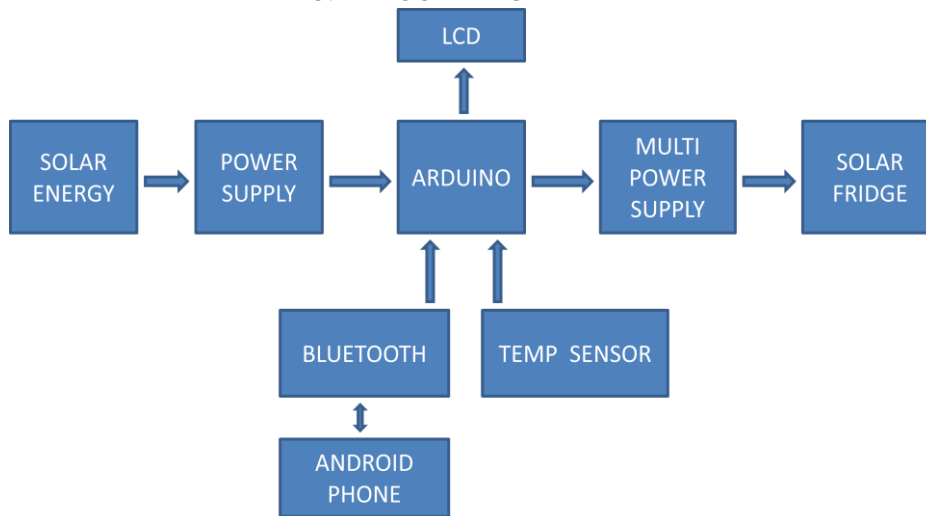
J. Closed System

Closed system is a physical system that doesn't exchange any matter with its surroundings, and isn't subject to any net force whose source is external to the system. A closed system in classical mechanics would be considered an isolated system in thermodynamics. Closed systems are often used to limit the factors that can affect the results of specific problem or experiment.

K. Android Phone

In this project we will control the temperature of solar fridge using Android phone by using an application when we will get from Android play store which is Bluetooth Terminal. By installing this application, we can give signal to Arduino with the help of Bluetooth with in the form of commands.

3. BLOCK DIAGRAM



4. CONSTRUCTION OF FRIDGE

Firstly, take a small plastic box of given dimensions to prevent air leakage which is used as insulator. The door of this box from outer side is done so as to provide mechanical support and blocking of air. The Peltier unit is well placed in the box by making two small holes. In the box the Peltier unit is kept on heat sink with hot side attached to the heat sink surface and cold side inside the box. The idea is that if we replace the power supply we can change the hot side to cold side and cold side to hot side simultaneously, because here three-wayswitches is used to change the effect hot to cool or cool to hot. The connection of three-way switch is in between Peltier unit and multi power supply pin.

The heat sink is linked with a fan which is used to dissipate the heat of heat sink into outer atmosphere i.e. out of box. So, the one side of Peltier unit is unable to affect the temperature inside the box and to measure the temperature

change the LM35 sensor is connected which gives signal to the ARDUINO. All the electrical connections are made putting a switch for on/off and a LED's are as an indicator whether the fridge is working or not. One 12V DC, 7.5Ah battery is connected to the cooling fan and bridge rectifier is connected to give 5V continuous power supply. This 5V supply is given to the multi power supply pin and ARDUINO. Also, by using the diode in between the connection we can check the Solar panel is correctly connected or not. To see this output, LED is used. Bluetooth, Voltage control circuit, LM35 temperature sensor and LCD is connected to the ARDUINO. The input of Voltage control circuit comes from ARDUINO and output connected to the Multi power supply pin. All the electrical connections are made strong by soldering them and all the wires are arranged properly so as to avoid any inconvenience for the user.



Working Fridge with temperature monitoring system

As shown in the above figure, it can be observed that the solar refrigerator is glowing also LCD showing the temperature inside the refrigerator simultaneously showing the relay condition which is 0 means OFF state and 1 means ON state.

5. WORKING OF THE PROJECT

The fridge is provided 12V DC, 7.5 ampere battery. But ARDUINO and some components works on only 5V power supply because of that bridge rectifier is used which gives 5V DC filtered supply. To start the fridge, the switch is turned on. When the switch is turned on; a LED starts glowing indicating that the fridge is now online. Now Peltier thermoelectric device which is insulated from the cooling side and arranged in the fridge generates cooling effect on inner side and heat is dissipated on outer side. On the heat side of the Peltier unit, a heat sink along with fan works to dissipate the heat from the Peltier unit in the outer environment. The Peltier thermoelectric device will be so arranged in a box with proper insulation system and heat sink so that efficient cooling takes place at all the time. By using three ways switch model refrigerator switches cooling effect as well as heating effect.

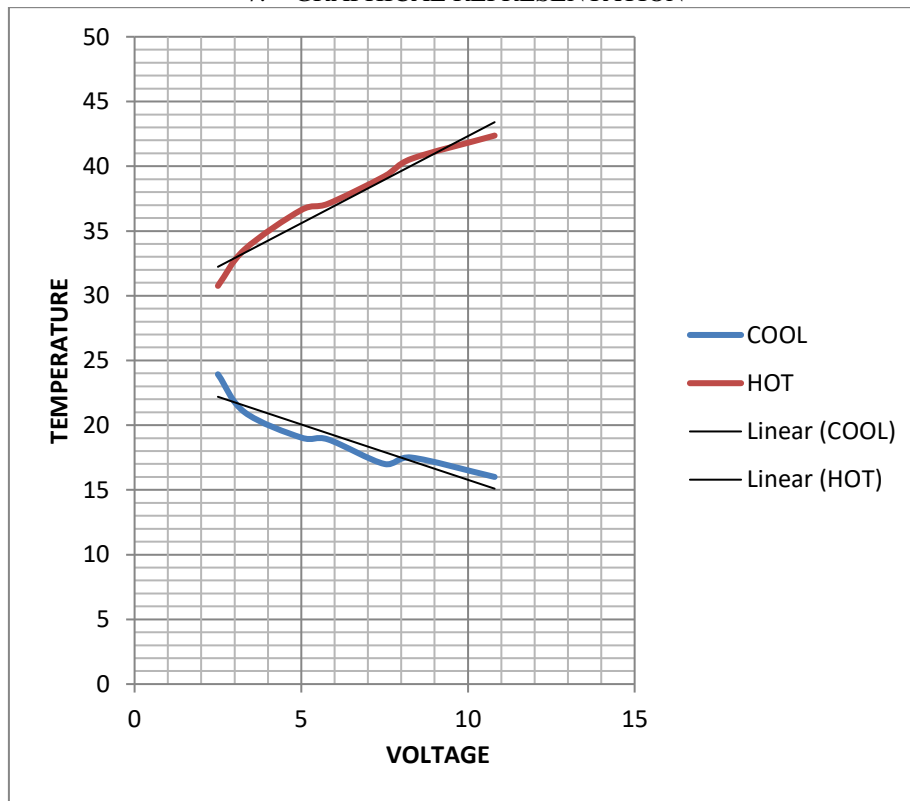
The Peltier unit gets different power supplies from multi power supply pin. Voltage control circuit gives input,

by signaling ON/OFF states where the multi power supply circuit contains the different voltage inputs e.g. 2.5V, 3.3V, 5V. Etc. and this output is going to Peltier unit. Where ARDUINO takes signals from LM35 sensor and showing the output on the LCD. The ARDUINO giving signals to the relay which voltage control circuit contains. The relay working as a switch here and giving output to the multi power pin. The LCD shows the ON/OFF state of the Relay. The Bluetooth is connected to the ARDUINO, where ARDUINO is programmed in C language. This Bluetooth is gets connected to the external mobile device which contains Bluetooth terminal application. From which user giving signals to the ARDUINO, and ARDUINO controls and monitors the output of the refrigerator. ARDUINO gets signals and makes control on relay which can be ON/OFF and our solar fridge works. By this method we can monitor the temperature of fridge and also, we can control the temperature on same time by using mobile devices.

6. OBSERVATION TABLE

VOLTAGE	COOL	HOT
2.5	23.00	30.76
3.3	21	33.57
5	19.04	36.62
5.8	18.9	37.1
7.5	17	39.23
8.3	17.5	40.57
10.8	16	42.37

7. GRAPHICAL REPRESENTATION



8. RESULTS

The main aim of this project is to develop a Solar Fridge with Temperature Control and Monitoring System using

Bluetooth Module. Which would be basically running without a compressor, thereby this aim has been successfully achieved.

Also the main purpose to develop this solar fridge was to make it environmental friendly which is the most wanted requirement of today's world and since it is eco-friendly its application has been seen in many other important sectors for example in rural areas where daily products needs its attention, mainly near the coasts regions from where edibles are needed to be transported to the tracker place and the foremost important sector is medical area for storing blood and pharmaceuticals and also for transporting organs like heart, kidney etc.

And we not only have achieved the cooling mechanism successfully but it can also be useful for shallow heating purpose with the help of the Peltier module. This Peltier module is the major reason for making this module this module environment friendly, since these Peltier modules cannot generate or produces any harmful gases and the efficiency of the solar fridge is further been increased by using a monitoring system i.e. a Bluetooth module where the temperature can be set from a particular distance, which is another important feature in today's technology.

9. CONCLUSION AND FUTURE SCOPE

This solar fridge with temperature control and monitoring system using Bluetooth module is more reliable than other portable refrigerators. It is cost efficient and eco-friendly which is the most requirement of modern era. By controlling the temperature range of cooling unit, and monitoring it can be used in various sectors like rural areas where dairy products need a lot of attention, near the coasts from where the marine edibles need to be transported to the market area, medical area for storing blood and pharmaceuticals. The efficiency of the refrigerator can be increased by increasing the number of peltier plate module which will help in increasing and decreasing the temperature in less time.

This refrigeration system which will be a better alternative for conventional refrigeration system also to achieve better coefficient of performance and temperature control we can combine thermo electric cooler with other refrigeration

systems. Hence it is better to have such hybrid systems and devices to reduce total energy consumption.

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