Battery Powered Heating and Cooling Suit with Location Spotter

[1]Virendra Singh Rathore, [2]Rohit Kumar, [3]Ritu Soni, [4]Shashikant Kumar, [5]Ved Prakash, [6]Prof. Jitendra Singh

Department of Electrical Engineering,
SKIT, Jaipur

Abstract: This paper proposes battery powered heating and cooling suit with location spotter based on low cost microcontroller developer circuit. Temperature related inconveniences such as heat stroke, heat rash, frostbite, hypothermia and others have been a persistent problem for people throughout history. Some of these conditions, when left unchecked, have led to unfortunate deaths. The current technological solutions made to keep people thermally comfortable such as air conditioning and heating units have come a long way and have been successful in helping people obtain comfort in their dwellings (e.g. home or car), but are not personal mobility solutions. This is why a heating/cooling suit is a very beneficial product for the masses. Such a suit allows the user to control and monitor the internal temperature of the suit from high temperatures to low temperatures, depending on the season. A 12 V DC lead acid rechargeable battery is used for storing the energy and also using conventional battery charging unit also for giving supply to the circuitry. ATMEGA16 Microcontroller is the heart of the circuit as it controls all the functions. The E-Uniform is operated in two modes, summer mode and winter mode. Which helps the soldier to bear any kind of external environment. This project has an Extension Part which includes the interfacing of GSM and GPS, which gives the location of the soldier exactly with the latitude and longitude value and is also messaged to the concern person at the war or at boundaries.

Keywords: Solar panel (optional), 12v lead acid battery, Peltier plate, ATMEGA16 microcontroller, GPS and GSM module.

I. INTRODUCTION

A 12 V DC lead acid rechargeable battery is used for storing the energy. We are using conventional battery charging unit also for giving supply to the circuitry. This Conventional power source uses regulated 5V, 500mA power supply. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the output of secondary of 230/12V step down transformer. There is a suit like this available in market and cost is very high. Because many of that suit parts are mechanical, gripping devices that devices are made with nano, fiber technology. This suit consisting of pumps to provide cool and heat. This pumps sprays water on to human body for cooling body. We can provide both cooling and hot service with E-Uniform. Temperature related inconveniences such as heat stroke, heat rash, frostbite, hypothermia and others, have been a persistent problem for people throughout history. These conditions have led to unfortunate deaths.

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.

Soldiers are the Army's most important resource. Soldiers play a vital role to protect one's country. The term soldiers include service men and women from the Army, Air Force, Navy and Marines. They will always be the one responsible for taking and holding the duty in extreme weather conditions throughout the year. While providing security for the nation, they may face troubles in extreme hot/cold weather conditions. The user controls the peltier plate temperature by varying the variable resister. The suit is very flexible to wear, convenient, cozy, healthy and less in weight. The user wears an E-Uniform as a dress, and also there is a facility to switch on TEC in the E-Uniform.

II. LITERATURE REVIEW

As we know that, the physical principles upon which modern coolers are based actually date back to the early 1800's, although commercial modules were not available until almost 1960. The first important discovery relating to thermoelectricity occurred in 1821 when a German scientist, Thomas See beck, found that an electric current would flow continuously in a closed circuit made up of two dissimilar metals provided that the junctions of the metals were maintained at two different temperatures. See beck did not actually comprehend the scientific basis for his discovery, however, and falsely assumed that flowing heat produced the same effect as flowing electric current. In 1834, a French watchmaker and part time physicist, Jean Peltier, while investigating the "See beck Effect," found that there was an opposite phenomenon[1] whereby thermal energy could be absorbed at one dissimilar metal junction and discharged at the other junction when an electric current flowed within the closed circuit. IC 7805 is a 5V Voltage Regulator that restricts the voltage output to 5V and draws 5V regulated power supply. It comes with provision to add heat sink. The maximum value for input to the voltage regulator is 35V.

It can provide a constant steady voltage flow of 5V for higher voltage input till the threshold limit of 35V. If the voltage is near to 7.5V then it does not produce any heat and hence no need for heat sink. If the voltage input is more, then excess electricity is liberated as heat from 7805. It regulates a steady output of 5V if the input voltage is in rage of 7.2V to 35V. Hence to avoid power loss try to maintain the input to 7.2V. In some circuitry voltage fluctuation is fatal (for e.g. Microcontroller), for such situation to ensure constant voltage IC 7805 Voltage Regulator is used [2].

For more information on specifications of 7805 Voltage Regulator please refer the data sheet here (IC 7805 Voltage Regulator Data Sheet). The Peltier effect was discovered early in the 19th centuary. but has only been seriously exploited during the second half of the 20th century. This was no accident, since the development of materials that would yield worthwhile thermoelectric refrigeration depended on knowledge of the physics of semiconductors, a deeper understanding of heat conduction by the lattice and new metallurgical techniques. Thus, bismuth telluride, already known to have interesting thermoelectric properties, was soon developed into the material that is essentially what is used in today's thermoelectric coolers. At the present time, there are novel methods for the controlled deposition, layer by layer, of multi-phase systems, for example by molecular beam epitaxy, and theoretical treatments of the thermoelectric properties of one- and two dimensional conductors [3].

There are also reported developments in so-called vacuum thermo elements. So, too, is there the need for refrigeration systems that do not depend on CFC's or other undesirable gases. It seems, then, that the time is right for us to expect significant advances in the field of Peltier cooling [4].

The Gerbing EX Jacket is the most advanced heated motorcycle jacket on the market. The Extreme Element Jacket will keep you warmer, safer and more comfortable than ever before. Part of our most technologically advanced riding system, the EX jacket has removable coreheat12 Thermo velocity Protection, telescoping lycra cuffs, a full complement of certified back, shoulder, and elbow impact protectors, ample reflection panels and full ventilation to keep you moving at speed in any condition. The SN754410 is a quadruple high-current half-H driver designed to provide bidirectional drive currents up to 1 A at voltages from 4.5 V to 36 V. The device is designed to drive inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications[5].

III.   BLOCK DIAGRAM

The final design is a microprocessor based system that the systems makes heat and cool both sides of TECs by using battery power supply. That the heat and cool functionality selected by using push button switch/mode and we can adjust heat and cool by variable resister. The solar panels are used to power up circuitry and the output of solar panel is stored in lead acid battery. Generally The TECs are outside of the circuitry which are connected through wires and posed with in the suit so user can easily adjust position of TECs it is not harmful to user body. The system also using the GPS, GSM modules, LM-35 temperature sensor and 16X2 LCD screen. The temperature sensor are using to sense the climatic temperature continuously and display it on LCD screen.
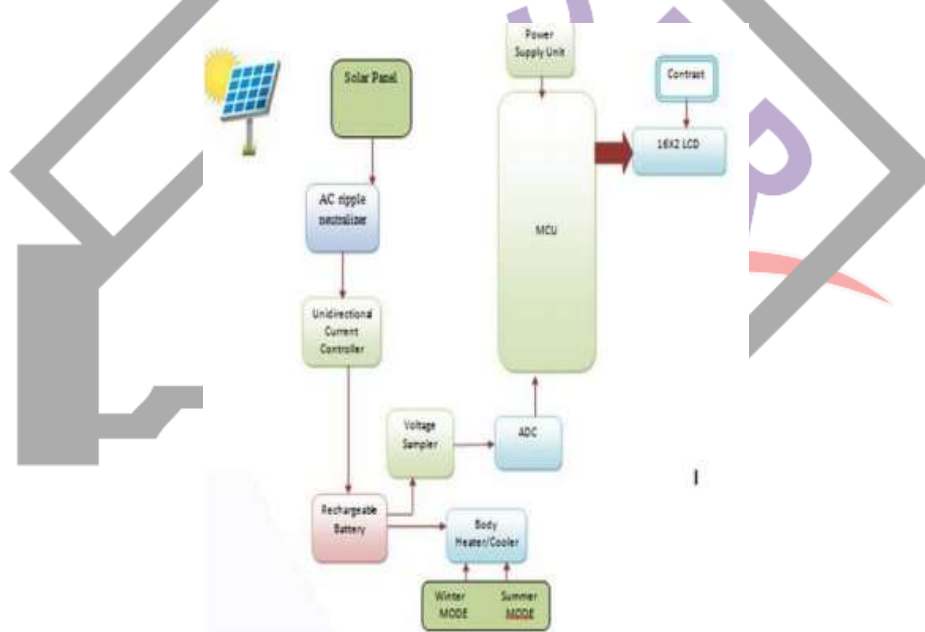

Fig1: Block Dia. Of Proposed System

IV.   HARDWARE DESIGN

A. LM35 temperature sensor: The LM35 Precision Fahrenheit-Celsius temperature sensor was used and it is connected ATMEGA 16 microcontroller. The LM35 is used to sense climatic temperature and gives analog voltage as output. This analog voltage is converted into decimal form by programming ATMEGA 16 controller and also this will be displayed on the 16X2 LCD, which is shown in below figure.
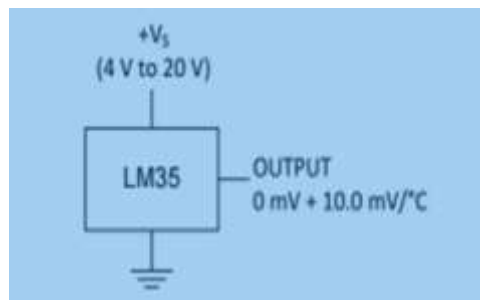
Fig2: Symbol of LM35 Temperature Sensor

B. Thermoelectric coolers: Thermoelectric coolers (TECs), also called as peltier plates or peltier coolers.
Which works based on principle of thermoelectric cooling. In 1834, the peltier was discovered thermoelectric cooling principle. The peltier plate is combination of two different types of semiconductor devices (plates), one device is N-type semiconductor another one is P-type semiconductor. The two semiconductors must be different, we need two different electron densities to produce heat or cool. Peltier plate converts voltage into heat (temperature) and heat into voltage. When voltage applied to the peltier plate then the current passing through peltier plate. When the current passing through two different semiconductors then there will be produced heat. The electric current flow changed from the electrons less in bound side to electrons more in bound side when the two different semiconductors are in contact. The reason for this is the Fermi level energy of N-type semiconductor and P-type semiconductor are different. so the electrons always move from high Fermi level side to low Fermi level side .This process repeated up to the both semiconductor Fermi level energies become equal. It produces heat from one side semiconductor plate to another, typically the temperature is 40°C to 7080°C when we use modern peltier plate. In this project 5vTEC1-04905 Peltier plate are used and it is connected to Battery through power supply unit.
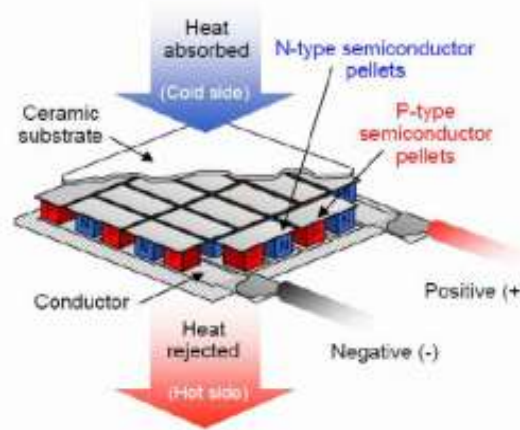

Fig3: Thermoelectric coolers (TECs)

Technical specification:
• Max current: 1.5A @ 5V
• Suggested Voltage range: 5V to 7V
• Maximum temperature differential (Tmax @ Qc = 0): 65°C
• 127 Peltier elements
• Silicone seal
• Dimensions: 30mm / 1.18" x 30mm / 1.18" x 3.29mm / 0.12"
• Wire Length: 289.56mm / 11.4"
• Weight: 11.43g

Fig4: TEC1-12703 5v Peltier plate

C. ATMEGA 16 Microcontroller: This ATMEGA16 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost microcontroller is needed. Perhaps the most common implementation of this chip is on the popular Adriano development platform, namely the Adriano Uno and Adriano Nano models.. ATMEGA16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD.
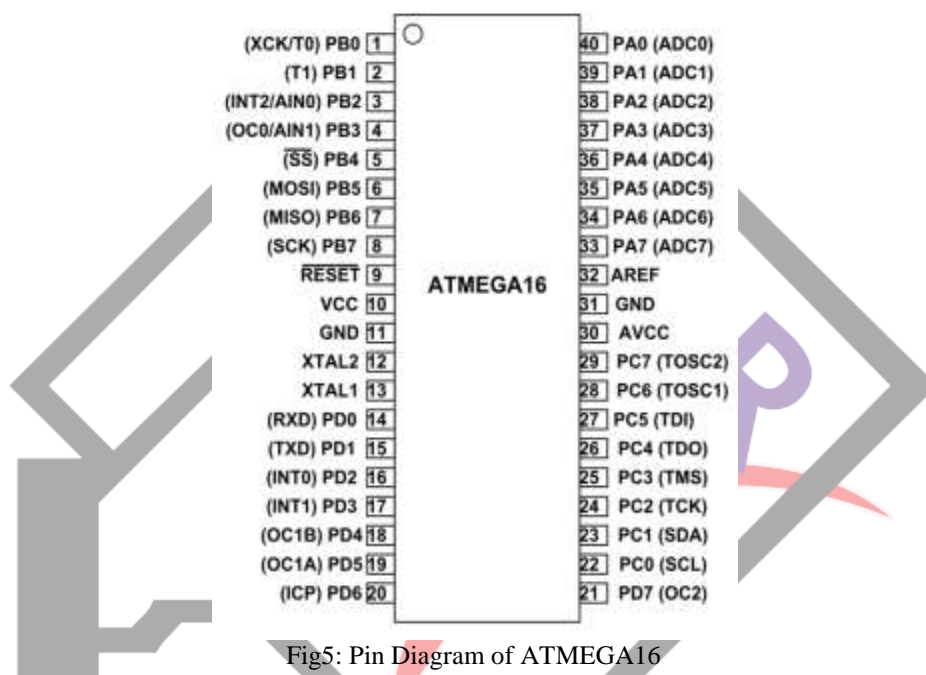

Fig5: Pin Diagram of ATMEGA16

ATMEGA16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. ATMEGA16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. ATMEGA16 can work on a maximum frequency of 16MHz. ATMEGA16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively.

D. GPS (Global Positioning System): GPS modules are popularly used for navigation, positioning, time and other purposes. GPS antenna receives the location values from the satellites. GPS gives information about: 1)Position at that time 2)Precise orbital information (the ephemeris) The GPS device continuously transmits serial data to ATMEGA 16 controller through RS-232 serial protocol. UART is an asynchronous serial communication protocol, actually which is used to provide the communication between two off-board devices or modules or microcontroller units. Here UART are used to interface GPS with ATMEGA 16 microcontroller. We need three signals to interface GPS module with UART, which are RXD, TXD and GND. The TXD, RXD, GND pins of UART connected to GPS module via RS232 DB-9 connector. A serial driver MAX232, it is a 16 pin IC is used for converting RS-232 voltage levels into TTL voltage levels. There are four electrolytic capacitors which are used with MAX232. And also we need to generate a serial interrupt from ATMEGA 16 to receive data from GPS. That the transmitted data of GPS consisting latitude and longitudes values of location in the form of NMEA (National Marine Electronics Association) standard. So we can widely use proposed suit (E-Uniform) in military applications. The latitude and longitudes values also displayed on LCD.

Fig6: 17.44 and 78.44 are latitude and longitudes values

E. GSM (Global System for Mobile Communication): GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM converts analog data into digital and compress digital data then sends it via dedicated channels with two user's data. Each user have own time slot to communicate with another user .

Fig7: massage received by another person

In proposed design using GSM-SIM 300 model GSM module, it works at different frequencies i.e., 900MHz or 1800MHz and PCS 1900MHz.In proposed system GSM is used for send the suit wearing person latitude, longitude, battery voltage and climatic temperature values to another person.

V.   CONCLUSION

 The project "Battery powered heating and cooling suit with location spotter" is successfully tested and implemented. This system is smaller, lighter and with lower power consumption, so it is more convenient. Which can help soldiers to work even in extreme climatic applications. It is a highly durable and self repairing solar technology and also ideally suited for mobile applications. It provides the conveniences of back-up and always on, on-demand small scale solar electrical power.

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