

Adaptable Jacket Based on Climate Conditions Using ARM Microcontroller

S. Annapurna Devi¹, P. Ramesh Kumar²

^{1,2} (Electronics & Communication Engineering, Aditya College of Engineering & Technology, Surampalem.)

Abstract:

The climatic conditions are changing with the era to era. Nowadays, to the people climatic conditions are very annoying and unusual. Throughout the history of human beings, temperature related inconveniences such as heat stroke, heat rash, frostbite, dehydration, hypothermia, etc. are the major problems and one cannot escape from these problems. Some of these conditions are led to unfortunate deaths of people. Some technological solutions made to keep people thermally comfortable such as air conditioning units, are most successful in helping people in their homes & in cars etc. but not in personal mobility situations. If one wants to move in such type of climatic conditions, climate adaptable jacket is a very beneficial product. This jacket can naturally keep up the specific temperature inside the jacket, so as to reduce the temperature; it initiates the fan that is placed inside the jacket. The design of this jacket gives better protection to the soldiers & navy people who are working in extreme weather conditions. This jacket allows the user to control and monitor the internal temperature of the jacket from high to low temperatures, with the use of the thermoelectric effect and displays the results in both GPS & GSM Modules.

Keywords— LPC2148 microcontroller, Thermo-electric coolers (TECs), Peltier plates, GPS & GSM modules, LM35 temperature sensor, Relay.

I. INTRODUCTION

In market, there is a suit like this and cost is very high. Because the suit many parts are mechanical and gripping devices. This suit consists of pumps & radiators to provide cool and heat. For cooling the body, these pumps spray water on human body. We can provide both cooling and hot service with this jacket. The different climatic conditions such as very cold and very hot temperatures could be dangerous to health. Heat stress causes because of excessive exposure to heat and cold stress causes because of excessive exposure to cold. In a very hot environment, the most risky condition is heat stroke as well as at very cold temperatures, the most serious concern is the risk of hypothermia or dangerous overcooling of the body.

Important resources of Army are soldiers. Soldiers play a very important role to protect one's country. The

term soldiers means which includes service men and women from the Army, Air Force, Navy and Marines. They will always be taking and holding the duty in extreme weather conditions throughout the year. While providing security for the country, they may face troubles in extreme hot/cold weather conditions.

The proposed system is adaptable jacket based on climate conditions using ARM microcontroller, by which the people/user can easily control the temperature of the jacket. The user controls the peltier plate temperature by the condition of the relay. The jacket is very flexible to wear, convenient, healthy and light in weight. The user wears a climate adaptable jacket as a dress, and also there is a facility to switch on TEC and observe the temperature status in the LCD, which is placed in this jacket.

II. BLOCK DIAGRAM

The final design is microprocessors based system, that the system makes heat and cool both sides of TECs by using rechargeable battery power supply. That the heat and cool functionality selected by using push button switch/mode and we can adjust heat and cool by relay operation. To provide the power supply to the circuit the lead acid rechargeable battery is used. Generally The TECs are outside of the circuitry which are connected through wires and placed with in the jacket so user can easily adjust position of TECs and it is not harmful to human body. The system also using LM-35 temperature sensor, GPS & GSM modules, and 16X2 LCD screen. The temperature sensor is using to sense the climatic temperature continuously and display it on LCD screen.

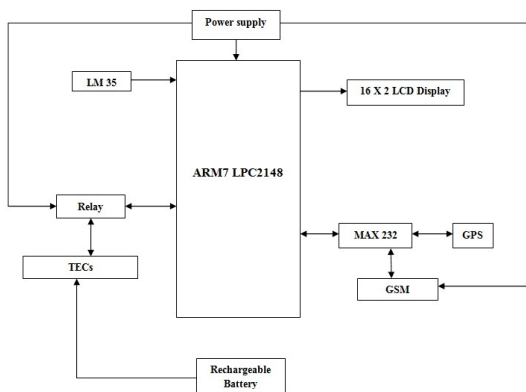


Fig1. Block Diagram

III.HARDWARE DESIGN

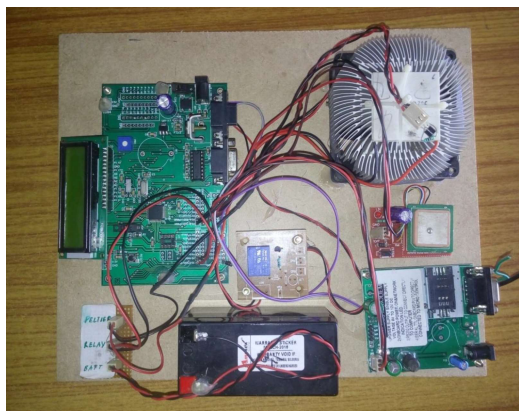


Fig2. Hardware Design

A. LM35 Temperature sensor:

The LM35 is a very Precision integrated circuit Fahrenheit-Celsius temperature sensor and it is connected to the ADC pin of LPC2148 micro-controller. It is used to sense atmospheric temperature and gives analog voltage as output. This analog voltage is converted into decimal form by programming in the LPC2148 microcontroller and this will be displayed on the 16X2 LCD, which is shown in below figure.



Figure3. Temperature displayed in LCD Display

B. Thermoelectric coolers (TECs):

Thermoelectric coolers (Thermoelectric coolers (TECs) are also called as peltier plates or peltier coolers. TECs work on the basic principle of thermoelectric cooling. In 1834, the peltier was discovered thermoelectric cooling principle. The peltier plate is made by the combination of two different types of semiconductors. It is having two different devices (plates), one device is N-type semiconductor and another one is P-type semiconductor. It is required to have two different electron densities to produce heat or cool, so the two semiconductors must be different. Peltier plate converts heat (temperature) into voltage and voltage into heat (temperature). When the voltage is applied to the peltier plates through the rechargeable battery then current will flows through the peltier plates.

Heat will be produced, when the current is passing through the two different semiconductors. 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. This is because of Fermi level energy of N-type semiconductor and P-type semiconductor is different. So the electrons always move from high Fermi level side to low Fermi level side. This process repeated up to the both Fermi level energies become equal in semiconductors. The diagram of TECs is shown in the below fig4.

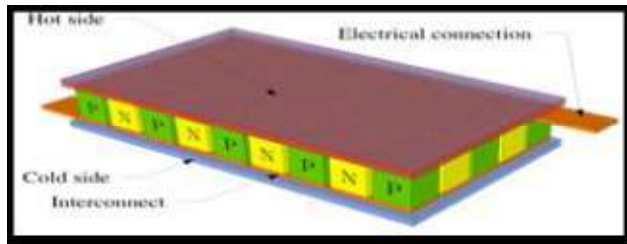


Fig4. Thermoelectric coolers (TECs)

It produces heat from one side semiconductor plate to another; typically the temperature is 40°C to 60-80°C when we use modern peltier plate.

The power supply unit regulates the battery voltage into 5v as it is required by the peltier plate, so peltier plate becomes heat or cool depends on the current flow direction. By using peltier plate we can easily create heat or cool. Temperature gradient will occur, due to current flowing through the junction either in forward bias or reverse bias. The upper and bottom sides of semiconductors are covered with ceramic plates in a TEC & N-type and P-type semiconductors are connected side by side to form contact. The amount of heat or cool is directly proportional to the applied voltage i.e. current. Typically 5V peltier plate provides 40°C, 20°C heat and cool respectively.

C. Relay:

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. These are used to interface an electronic circuit (working at a high voltage) to an electronic circuit which works at low voltage. It is used in the places where it is required to control a lot of circuits with only one signal. When current flowing through the control coil, the electromagnet starts energizing and thus develops the magnetic field in the relay. Thus the upper contact arm attracted to the lower fixed arm of the relay and thus closes the contacts causing a short circuit for the power to the load. If the relay was already de-energized when the contacts were closed, then contact move oppositely and make an open circuit.

D. LPC2148 Microcontroller:

LPC2148 is the widely used type of IC from ARM-7 family. It is manufactured by Philips and it is pre-loaded with many inbuilt peripherals making it more efficient for the beginners as well as high end application de-

veloper. The LPC2148 microcontrollers are based on a 16-bit/32-bit. It is a 32-bit general purpose microcontroller, with high performance and less power dissipation. ARM (Advanced RISC Machine) processor operates on the principle of RISC (Reduced Instruction Set Computer). In LPC2148 microcontroller Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously.

The ARM7TDMI-S processor also employs a special feature, extra instruction set, called Thumb Instruction set, which makes it ideally suited to more number of applications with memory restrictions, or applications where code density is an issue. This LPC2148 microcontroller has in built ARM7TDMI-S CPU core and it is 32/16 bit microcontroller with 512KB of programmable flash memory also it has 64 pins from which 45 pins programmable I/O lines with 2 ports, 14 ADC channels and 2 UARTS. LPC2148 controls the interfacing units of the circuitry. LPC2148 has two IO ports each of 32-bit wide, provided by 64 IO pins. Each pin can perform multiple functions. The

LM35 Precision Fahrenheit-/Celsius temperature sensor have three pins. The first pin of the LM35 is connected to VCC & the second pin is connected to the Microcontroller input, the third pin is connected to GND. Single PIN female to female wire is required to connect with the leads of LM35 temperature sensor. So when the temperature is sensing, it gives the sensor reading to controller in the form of analog voltage and displayed on the LCD.

The ARM7 LPC2148 Primer board kit supports in system programming (ISP) which is done through serial port. There are 2 input channels. There are 2 output channels that each correspond to an input. When the input is applied to relay, the relay turns on and the '+' output is connected to +12v. When the relay is off, the '+' output is connected to Ground. The '-' output is permanently wired to Ground. Control the relay operations by using LPC2148 Primer Board. Here we are using two Relays. The relay consists of a coil and a switch. When the coil is energized, the switch closes, connecting the two contacts together. ULN2803 is used as a driver for port I/O lines, drivers output connected to relay modules.

E. GPS (Global Positioning System):

GPS modules are popularly used for positioning, navigation, time and other purposes. Global positioning system is an earth orbiting satellite based system that pro-

vides signals available anywhere on or above the earth, twenty-four hours a day, which can be used to determine precise time and the position of a GPS receiver in three dimensions. GPS antenna receives the location position values from the satellites in the form of latitude & longitude values. GPS gives information about:

1. Position at that time
2. Precise orbital information (the ephemeris)

The GPS device continuously transmits information in the form of serial data to LPC2148 controller through the serial protocol RS-232. UART is an asynchronous serial communication protocol, which is used to provide the communication between two off-board devices or modules or microcontroller units. Here UART asynchronous serial protocol is used to interface GPS with LPC2148 microcontroller. To interface GPS module with UART three signals are required, which are RXD, TXD and GND. RS-232 DB-9 connector is used to connect TXD, RXD, GND pins of UART to GPS module.

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 LPC2148 to receive data from GPS. The transmitted data of GPS is in the form of NMEA (National Marine Electronics Association) standard consisting latitude and longitudes values of location.

The serial data which is received from GPS device is stored in SBUF register by using UART protocol. Through GSM this information is transferred to authorized or concerned person. So we can widely use proposed jacket (E-Uniform) in military & navigation applications. The latitude and longitude values of the location are also displayed in LCD, which is shown in below figure.



Fig5. 2400 and 12100 are latitude and longitudes values

F. GSM (Global System for Mobile Communication):

GSM (Global System for Mobile communications) is digital cellular technology used for transmitting mobile voice and data services. GSM is used to convert analog data into digital and compress digital data then sends it through the dedicated channels with two user's data. Each user have own time slot to communicate with another user in the dedicated channel. In proposed design using GSM-SIM 300 model GSM module, it works at different frequencies i.e., 900MHz or 1600MHz and PCS 1900MHz .In proposed system GSM is used for send the jacket wearing person latitude, longitude, climatic temperature values to another person. It is shown in below figure6.

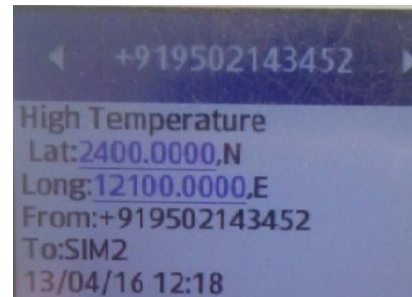


Fig6: message received by another person.

III. SOFTWARE DOCUMENTATION

The microcontroller coding is programmed in the following manner. The code starts with the initialization of the interrupt vector table (in order to handling interrupts properly), the configuration of the ports, and initialization of the stack pointer, interrupt controls, and LCD module. The main loop of the code checks the input pin of the LM35 sensor for temperature information in the form of binary. The temperature information in the form of binary is converted to decimal. If the Celsius scale is first selected, the main loop of the code calls the conversion interrupt routine where the data from the sensor is converted into decimal and then return back to the loop. The stored temperature send to the LCD module to display. This continues to place until an interrupt occurs. The main loop checks if the hot & cold makes relay contact. So relay is used to temperature control for the jacket. If the temperature is increased TECs activated. Once it done, the routine pops the registers from stack and returns to the main loop. At the same time both GSM & GPS modules activated and the information is displayed in the LCD Display and message send to mobile phone.

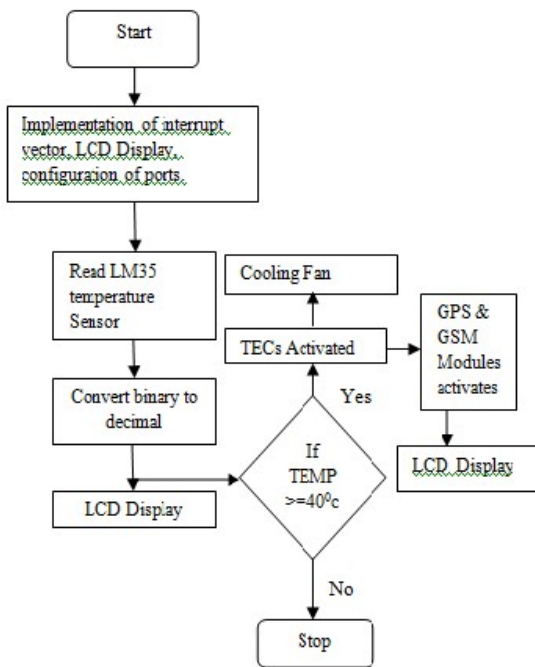


Figure7: Flow chart of the programming methodology.

IV. CONCLUSION & FUTURE SCOPE

The project "Adaptable jacket based on climate conditions using ARM microcontroller" is successfully tested and implemented. This system is smaller, lighter and [1] Gregory Paul and Edward Gim, David Westerfeld "Battery powered heating and cooling jacket" IEEE Long Island Systems, Applications and Technology Conference (LISAT), 2014.

[2] Goldsmid, H.J. "Timeliness in the development of thermoelectric cooling" IEEE Xplore, N.P. 18 Aug. 1998. Web. 13 Dec. 2013.

[3] "Milwaukee Heated jacket" Review. N.p., n.d. Web. 13 Dec. 2013.

[4] "Cool Vest with 3 portable reservoir options for hot and humid days-stay dry & keep cool ." Veskimo Personal Cooling Systems. N.p., n.d. Web. 13 Dec. 2013.

[5] "Operation of thermoelectric cooling plate operation". <http://www.activecool.com/technotes/thermoelectric.html>

[6] "LPC2148 data sheet and its operation". <http://www.wvshare.com/datasheet.html/LPC2148-PDF.html>.

[7] "Peltier plate operation, construction and usage" http://en.wikipedia.org/wiki/Thermoelectric_cooling.

<https://www.sparkfun.com/datasheets/Components/LM7805.pdf>.

with low power consumption, so it is more convenient. This can help soldiers to work even in extreme climatic applications.

For the future expansion, this uniform can easily be powered by a small portable solar panel and made more eco-friendly. The use of solar panel gives continuous output of power without less maintenance. We can also include rain drop sensors, humidity sensors for efficient working of jacket. These jackets can be wearable in all conditions and in all seasons. We can utilize this jacket to shield us from over-heating and over-cooling. We can also place heart beat sensor in the jacket.

REFERENCES

[8] "Peltier effect (physics)." Encyclopedia Britannica Online. n.d. Web. 13 Dec. 2013.

<http://www.britannica.com/EBchecked/topic/449424/Peltier-effect>.

[9] "LM35 Data Sheet and operation" <http://www2.ece.ohio-state.edu/passino/LM35.pdf>.