Battery Powered Heating and Cooling Suit with Peltier Device

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Abstract—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. What is even more common is the unsatisfaction that people have with the weather at various points of the year. People often complain that it is either too hot or too cold. 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. What if one has to be out in the weather? The addition or subtraction of layers with coats and jackets or beach wear, are popular solutions to that problem, but do not always yield upmost satisfaction, for layers become cold over time and sunburn is a serious problem. 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. Creating the most comfortable thermal environment for the user within an enclosed space of small proximity while providing comfort, practicality and mobility is the objective of this suit. With the use of the thermoelectric effect, microcontroller technology and a bit of ingenuity, this suit can be realized.

I. INTRODUCTION

Embedded systems are electronic devices that integrate microprocessors with in their achievement. The obvious concentration of the microprocessors is to make simpler the system design and make available elasticity. Having a microprocessor in the apparatus helps in variable the hare-brained, origin modifications or putting collectively pioneering visage are only difficult of amend the software that manage the appliance or in other words set accumulation machine systems are electronic systems that contain a microcomputer to execute a detailed committed application. The computer is hidden inside these products. Embedded systems are ubiquitous. Every week millions of tiny computer chips come pouring out of factories finding their way into our everyday products. Embedded systems are self-contained programs that are embedded within a piece of hardware. Whereas a regular computer has many different applications and software that can be applied to various tasks, embedded systems are frequently set to a certain assignment that cannot be distorted exclusive of physically manipulating the circuitry. An alternative way to think of an embedded system is as a computer system that is shaped with optimal effectiveness, in that way permit it to absolute definite functions as immediately as potential. 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.

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II. LITERATURE SURVEY

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 Seebeck, 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. Seebeck 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 "Seebeck Effect," found that there was an opposite phenomenon 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. 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 century 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. There are also reported developments in so-called vacuum thermoelements. 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.

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 Thermovelocity 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.

III. EXISTING SYSTEM

Existing system is a heating/cooling jacket, in which the user can control the temperature through controls and thermo-electric devices that are embedded in the suit. The functionality of the suit is, once turned on, the device displays the temperature of the inside of the suit in an LCD displays. Initiating the hot or cold functions are as simple as pushing a button, and a rotary knob allows the user to control the internal temperature of the suit. To undertake this project and conduct useful research that would yield a successful design, several design challenges had to be taken into account. A primary obstacle was coming up with a delivery method to spread the heat/anti-heat to as much of the garment as possible. The safety of the potential user is also important. The design cannot be hazardous, and the product shouldn’t burn or shock the user. Therefore parameter limitations and proper wiring and encasement procedures ought to be implemented. There is also a cost limitation on the project so our design could not exceed that cost. The design considers size limitations of garments worn by people and avoids excess bulk, weight, waste, and user uneasiness, all at a low cost. The thermoelectric cooler is a solid state heat pump made of thermocouples of high-efficiency semiconductor material that creates a difference in temperature of its two sides when a voltage is applied and current runs through it. None of the current system contains IOT. Connectivity, Transfer of heat or cold is either through cooper tubes, through thermo conductive fluid. Existing system are all manual, either the jacket is controlled through knobs or on and off switch.

Disadvantages:
- High cost and cant movable from one place to other.
- A bit difficult regarding manufacturing.
- Requires drying of garment when it is over cooled.
- Make sure that both push buttons should not be pressed at a time.
- Limited battery resource.
- Slow cooling action.
- Jacket in operation for two hours.

IV. PROPOSED WORK

The implemented process of this project is ongoing. The electronics has been prototyped and is mostly working as expected. The H bridge circuit allows the TECs to become hot or cold, but we are experimenting with different variations to maximize gradient temperature. The PWM does control the temperature of the TECs. The programming aspect is in progress. Communication with the periphery indicators, the LCD module and the Temperature sensor is soon to be completed. The final challenge is to find the right material for the suit, and observing the effects of the TEC’s on the pads.

In this design is a microprocessor based system that heats and cools one side of several TECs by using an H bridge circuit that is enabled and controlled by "hot and cold" pushbuttons and a rotary variable resistor. The voltage across this variable resistor is used to pulse width modulate the signal to the H bridge through software, allowing the user to adjust the
gradient temperature that the TECs generate. The TECs will ultimately come out of the circuit via their wires and be attached (on the side that we are using) to heating/cooling pads that are placed in strategic places within the suit. The system also uses a temperature sensor, and an LCD module to continuously sense and display temperature in Fahrenheit or Celsius. This design was chosen because it is effective, lightweight, impressive and within our budget.

An H bridge has four switches, two on the same side (in series), and the other two on another side, these two sides are connected by the nodes between the two switches on each of the sides. This forms an “H”, hence the name. When a battery is connected across the top of the H and the lower “H” is grounded the circuit is complete. Now when the power is on and two diagonal switches are closed (while the others are opened), a current flows one way through the middle of the “H”, and if a motor is connected in that middle, the motor spins one way. If a TEC is connected, the one side heats up while the other cools down. Reverse the polarity and the motor spins the other direction, while in the TEC’s case, the hot and cold sides switch. The electronics has been prototyped and is mostly working as expected. The H bridge circuit allows the TECs to become hot or cold, but we are experimenting with different variations to maximize gradient temperature. The PWM does control the temperature of the TECs. The programming aspect is in progress. Communication with the periphery indicators, the LCD module and the Temperature sensor is soon to be completed. The final challenge is to find the right material for the suit, and observing the effects of the TEC’s on the pads.

Advantages:

- The jacket can be easily controlled.
- As our electronic gadget runs on battery, it is a portable and easy to use.
- The jacket is easy to wash, as the electrical parts detachable.
- It can be used to people who are exposed to the scorching summer sun like the policeman or the industrial worker whose work environment is often a high-temperature one.
- Portable jacket will help us to have an optimal Temperature all the time.
- Suit can be used to monitor the temperature, humidity of the patients in hospitals.
- Suit can also be used to for the old people who are susceptible to temperature change.
- Soldiers generally face extreme Cold and Hot conditions, the suit can be used to comfort the soldiers in these regions.

V. RESULTS

The below figure represents the electronic part of the suit, it operates the heating and cooling operation.
The above figure represents the modeling of the Peltier plate inside the suit, LDPE is used as an thermal insulator and copper sheet is used for transfer of heat across the body.

Advantages

- Fit and forget system
- Reliable
- Compact size
- Affordable prize (Low cost)
- Low Maintenance
- The jacket can be easily controlled.
- As our electronic gadget runs on battery, it is a portable and easy to use.
- The jacket is easy to wash, as the electrical parts detachable.
- Suit can be used to monitor the temperature, humidity of the patients in hospitals.
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Applications

- Used in military applications.
- This uniform can be used for all the climatic applications.
- Soldiers can work in extreme climatic applications.

VI. CONCLUSION

The final design of the project was an arduous journey that required repeated brainstorming and research. However, the design process provided a learning experience that augmented the authors' knowledge of Computer and Electrical Engineering. In this project, the complexity and practicality behind
the embedded system design was learned and understood to create a system that would maximize the functionality of the TECs through the thermoelectric effect. The future scope of our project is to make it washable, lightweight. Decrease the weight of the equipment’s and jackets much further adding pulse monitoring system and GPS location system to the implement. Decreasing the cost of equipment used and make it affordable to the common users.

REFERENCES


