Air Conditioned Helmet Using Phase Change Module and Harnessing Energy Through Wind

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Abstract
This paper presents the working of peltier module based air conditioned helmet. The advantage of this helmet is that it provides comfortable ride during hot summers and the best part is it works on free energy that is wind and hence do not cause pollution Therefore, it increase the use of helmet and reduces the rate of accident.Experimental work is carried out and result is presented to demonstrate the feasibility of the proposed approach. In the experimental work, a prototype model is built to verify the prototype results. Peltier module is used to create the hot and cold junction when dc supply of 12V is given.

Keywords-Helmet, Peltier module (TCE1-12706), DC motor (12V), Boost converter, Heat sink, Micro fan (12V).

Introduction

The helmet is an important safety device for bike rider. Most of the accidents on roads are caused when the driver is not wearing the helmet. Although there are many varieties of helmet designs available in the market Yet a large number of riders persist in riding without helmets, or with the chinstrap undone, as during the scorching heat of the summers riders feel suffocation and there is sweating due to hot climate Carpenter [1] observed that during hot conditions the temperature inside the helmet reaches up to 38^{o}C. So our project provides a helping hand in eradicating this problem by providing the air conditioning effect inside the helmet to make the helmet free from suffocation and the riders can easily wear it during hot summers as it has cooling effect. Tan and Fok [2] presented a cooling method of helmet using phase change material. To implement the above mentioned effect inside the helmet our project uses the principle of peltier effect which states that "whenever two dissimilar metals are joined to form two junctions and electricity is passed through it, heat is absorbed at one junction while heat is released at the other junction". In our project we have used the cold junction to make the helmet cool during hot summers and hot junction can be used to make the helmet warm in cool winters. In this way the temperature inside the helmet can be controlled throughout the year. This method is better than other type of ventilation provided by the manufacturers as they do not provide enough ventilation to the rider [3].

Buist and Streitwieser [4] developed a thermoelectric cooled helmet which is having a thermoelectrically cooled liquid filled cushion for the top interior safety of a helmet. In this they used a single, 12-volt thermoelectric module to remove heat from the liquid cushion through a flexible twisted wire heat collector present within the cushion. We have used a phase change material which works on the above mentioned principle of peltier effect which will make the inner part of the helmet warm or cold as per the requirement of the rider. We have also installed a fan at the top of the helmet in order to harness the energy from the wind through a dc motor and this energy will be stored in the rechargeable battery fixed inside the helmet. The stored energy will now drive the phase change material, moreover this energy can also be used to recharge mobile phones etc.

A number of additional features like SOS, GPS tracking, pulse measuring, step counter, alcohol detection etc can be installed inside the helmet which can convert the "Energy helmet" to "Health helmet". Our project expresses a great concern over the rising fatality rate due to helmet. So whenever your beloved are out with their bikes you can keep a check on them. In cases when the rider is in danger he could connect to his family members through SOS feature. The main objective is to promote the use of helmets without compromising the quality of ride.

Design

The major component of the energy helmet include: A cavity as external/internal air channel, Micro fan as a heat extracting device, peltier module, cooling chamber, boost converter, DC motor(12V), Buck booster and heat sink. On the top of the helmet DC motor along with the attached blades is mounted which will rotate when the wind strikes on it and produce energy by rotation. Here DC motor works as a generator. Now the harnessed energy of low potential will be converted in to high potential with the help of boost converter so a

rechargeable battery of 12V can be charged. Now the other devices will run on the free energy harnessed through wind. Buck converter is employed to convert the 12 V to 5V through which we can charge mobile phones any time anywhere. The heat sink is used to increase the rate of heat transfer from hot junction of thermoelectric module so that excess heat can be ejected to the surrounding. To increase the efficiency of thermal module micro fan is used to eject the heat from hot side to the ambient surroundings.

Peltier Module

The peltier module is a semiconductor based electronic component that functions as a heat pump. It is also known as thermoelectric cooler. When 12V DC supply is given to peltier module, heat gets transferred from one side to another side. This module consists of 127 semiconductors which are coupled in the area of 40mm x 40 mm. It can generate a temperature up to 90^{o} C.

Specifications of peltier module TEC1-12706

- Input voltage-12V
- Maximum voltage-15.4V
- Maximum current-6A
- Maximum Power-92W
- Maximum Temperature-138^{o}C
- Power Cord-200mm
- Size- 40mm x 40mm x 3.9 mm

Figure 1: A typical TEC1-12706 peltier module[5]

Wind Energy Harnessing Assembly

It is an important assembly which makes helmet as "Energy Helmet". DC motor and blades are the main components which help in harnessing the wind energy. In this section of assembly DC motor works as a generator which receives mechanical input from the attached blades there by generating an output voltage

Figure 2: DC motor and blade assembly

Diode Bridge

As the blades are free to rotate in any direction and the direction of rotation depends on the direction of wind. Due to the clockwise and anticlockwise rotation of the blades there is fluctuation in the polarity of output voltage from positive to negative. In order to maintain the constant polarity of output voltage Diode Bridge is connected to the output terminals of dc motor which will maintain uniform polarity, irrespective of type of rotation.

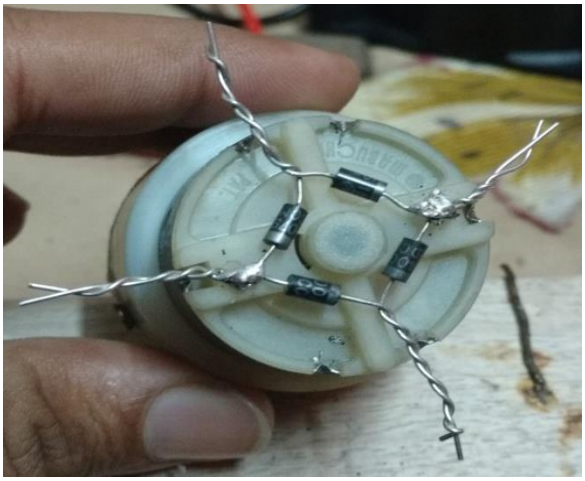

Figure 3: Diode Bridge

Boost Converter

As the output obtained from the DC motor is of low magnitude which cannot charge 12V DC battery as its input voltage requirement is 14V to 15V.So boost converter is used to convert the low output voltage of DC motor to high voltage as per the requirement of the battery. The output of the boost converter can be controlled by using the trimmer attached to the circuit.

Heat Sink

Effective heat transfer mechanism is most important for the cooling of helmet. In order to obtain this rectangular fin type

heat sink is which will radiate the heat generated by peltier module out of the helmet. For the effective transfer of the heat thermal grease is applied over the surface of peltier module as well as on the back of heat sink. Heat sink plays an important role as it increases the overall efficiency of the energy helmet.

Micro Fan

Micro fan works as an air pump which facilitates the cool air to be transferred uniformly inside the helmet. This micro fan is powered by the rechargeable battery and it has separate switches for its operation.

Cell Phone Charging Module

Additional feature of the helmet is that it can charge mobile phones also. To implement this feature cell phone charging module along with buck converter is used. Buck converter maintains the output of 5V to run the phone charging module. Now this module is connected to the rechargeable battery through buck converter. USB cable is also connected to module to charge the cell phone.

Cooling Chamber

The cooling chamber is built in the inner periphery of the helmet. It consists of thermoelectric cooler for cooling purpose. Cooling chamber acts as a channel where the air is cooled.

Block Diagram Of Energy Helmet

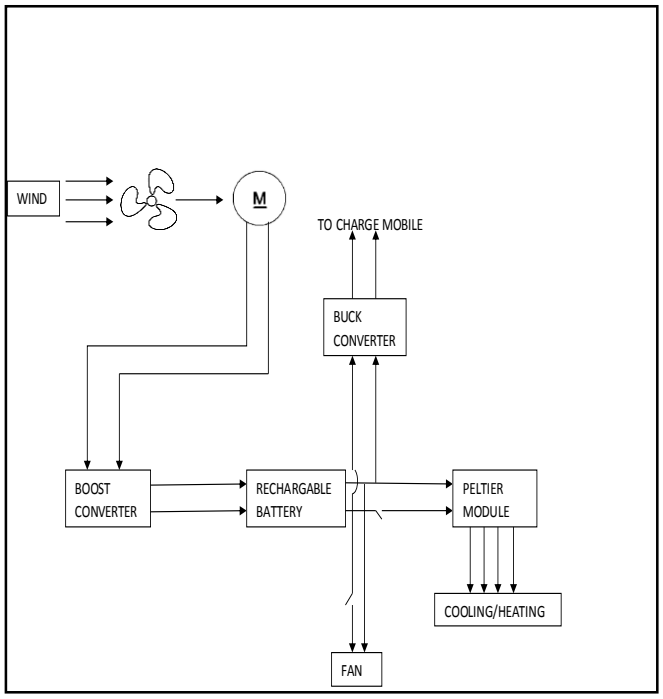

Figure 4: Block diagram showing the functioning of helmet.

The above block diagram shows the overall functioning of the helmet. Incoming wind strikes the blades which in turn results in the rotation of DC motor thereby producing the electrical energy. The low magnitude of voltage obtained from the output terminals of the dc motor is amplified through boost converter. The amplified voltage charges the rechargeable battery. Now this battery drives the whole circuitry.

Results

The observations for moving conditions recorded by digital thermometer are s follows:

Table 1: Cooling Effect With Respect To Time

Reading No.	Time(min: sec)	Temperature in (^{o}C)
1.	00:00	32.50
2.	00:15	32.50
3.	00:30	32.08
4.	00:45	32.08
5.	01:00	31.80
6.	01:15	31.70
7.	01:30	31.60
8.	01:45	31.40
9.	02:00	31.20
10.	02:15	30.80
11.	02:30	30.40
12.	02:45	30.20
13.	03:00	29.80
14.	03:15	29.60
15.	03:30	29.30
16.	03:45	28.90
17.	04:00	28.20

Initial temperature = 32.50^{o}C (1)

Final temperature =28.20^{o}C (2)

Time = 4min (3)

Cooling rate = (Final temperature – Initial temperature)/Time ***(4)***

Cooling rate = (32.50 – 28.20)/4 (5)

Cooling rate = 1.075^{o}C/min (6)

Thus during the operation of 4min of helmet, a cooling of 4.3^{o}C is obtained when tested on the real condition.

Fabrication of Helmet

Figure 5: Micro fan assembly

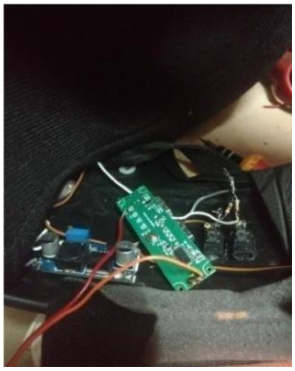

Figure 6: Boost converter

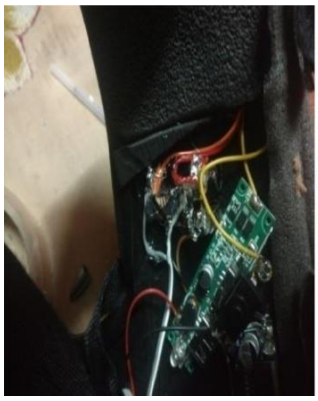

Figure 7: Charging Module

Figure 8: Top view of Helmet

Conclusion

The prototyping of Air conditioned helmet using phase change material and harnessing energy through wind has been done. The desired cooling performance is achieved and further improvements for achieving still higher rate of cooling can be done by using higher power thermoelectric.

References

[1]. Carpenter, B., 1987. Heads, Helmets and Heat. Road dissipate the heat. Rider Magazine.

[2].Tan, F.L. and S.C. Fok, 2006. Cooling of helmet with phase change material. Journal of Applied Thermal Engineering, 26: 2067-2072.

[3].Bill, C., 2009. Zeus ZS-806 Helmet Review, http://www.webbikeworld.com. Retrieved October 2, 2009

[4]. Buist, R.J. and G.D. Streitwieser, 1988. The Thermoelectrically cooled helmet. Proceedings of the 17 International Thermoelectric Conference, Arlington, TX, USA, pp: 88-94.

[5]. BC Robotics, Peltier Thermo-Electric Cooler Module(12V).