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AUTO-COOLING HELMET SYSTEM

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Abstract: The safety of people is the most important thing, especially on the roads, where riders face a lot of danger. Seventy percent of people who die in car crashes do so from head injuries. This shows how important it is to have good helmet technology right away. Even though it's important to wear hats, problems like being too hot and sweating are common. In order to fix this problem, our project is focused on creating a thermoelectric cooling system for motorbike helmets that uses Peltier modules. A heat sink, a metal tunnel, and a Peltier coil make up the device. Our concept is meant to make things less uncomfortable while also making them safer. We test the cooling system's performance over a range of time periods using thorough experiments. The goal of this study is to improve helmet technology so that riders are safer without sacrificing comfort. This could lead to fewer deaths and injuries on the roads.

Index Terms: Auto-Cooling Helmet System, Arduino Uno, Solar Pannel, DHT11, Peltier Plate

1. INTRODUCTION

Motorcycle helmets are very important safety gear for riders because they greatly lower the risk of injuries and deaths in motorcycle crashes. Because they are so important, many countries have rules that require motorbike riders to wear approved helmets. The main job of a motorbike helmet is to protect the rider's head from contact forces during a crash, which lowers the risk of traumatic brain injuries [1].

Modern motorbike helmets are made with high-tech materials that protect riders well while also being comfortable and easy to use. In most cases, these helmets have two main parts: an outer shell and an inner cushion. The upper shell is made of strong materials like fiberglass, Kevlar, or acrylonitrile butadiene styrene (ABS) plastic and is the first line of defense against outside strikes [2]. Sharp items can't go through it, and it keeps the structure strong so the inner parts can stay in place.

The inner lining of the helmet is just as important. It is made up of a thick layer of foam that is meant to absorb and spread out impact energy. The expanded polystyrene foam or expanded polypropylene foam in this layer works as a cushion for the rider's head to lessen the seriousness of head injuries in the event of a crash [3]. But even though these safety steps are necessary to keep riders safe, they can make things more uncomfortable, especially if the helmet keeps heat in.

Insulation features of the foam cushion, like those used in cooling systems, stop heat from moving from the rider's head to the outside world. Because of this, the inside of the helmet can get very hot very quickly, hitting 37°C to 38°C [4]. This rise in temperature can have big physical and mental effects on the rider, like making it harder to feel things and focus, which can make riding even more dangerous.

Heads are especially good at cooling off because their high skin temperature and steady blood flow make it easy for heat to leave the body [5]. The insulation effect of the helmet's inner layer, on the other hand, stops this natural cooling process, making the rider's surroundings uncomfortable and possibly dangerous. Getting this problem solved is necessary to make sure that motorbike riders are safe and comfortable in all weather conditions.

Thermoelectric refrigeration technology has come up as a possible answer to the need for better hat cooling. This new method uses the Peltier effect, which is when a straight current flows through semiconductor materials and creates a temperature difference, which lets heat from the surroundings be absorbed [6]. Adding thermoelectric cooling systems to motorbike helmets lowers the amount of heat that builds up and makes the rider more comfortable without putting their safety at risk.

Adding thermoelectric cooling to motorbike helmets is a big step forward in making riders safer and more comfortable. Riders can enjoy better temperature control in their helmets thanks to cutting-edge technology. This lowers the risk of heat-related pain and cognitive damage during long rides [7]. Additionally, thermoelectric cooling devices help people concentrate and be more alert by keeping their heads at the right temperature. This makes riding safer overall.

In this situation, the goal of this paper is to look into how thermoelectric cooling systems can be improved and added to motorbike helmets to make riders safer and more comfortable. Through a thorough study of the basic ideas, design factors, and performance features of these kinds of systems, this research aims to help motorbike helmet technology keep getting better. By tackling the important problem of managing heat, we hope to make riding motorcycles safer and more fun for people all over the world.

2. LITERATURE SURVEY

A lot of study has been done on bicycle helmet use because it is so important for keeping riders from getting head injuries. A lot of research has been done on different elements of helmet design, airflow, thermal comfort, and how well cooling works to make them safer and better for the user. This literature review takes ideas from important research papers and books in the field to give an account of the most important results.

When Finnoff et al. [1] looked into what stops bikers from wearing helmets, they found that things like pain and inconvenience were big ones. This study shows how important it is to address user issues in order to get more people to wear helmets and follow safety rules.

Ventilation is a key part of keeping bicycle helmets comfortable in hot weather. Brühwiler [2] made a hot, sweating manikin head form so that he could correctly measure how headgear ventilates. By simulating real sweating conditions, this study gives us useful information about how air flows and heat moves inside helmets, which helps designers make better ventilation systems.

Using thermal head manikins, Martinez et al. [3] did a full study of how heat moves around in bicycle helmets, both globally and locally. Their work gives us useful information about how heat moves and how well it insulates against heat, which helps us test and make helmet designs safer and more comfortable.

How well bicycle helmets block wind also affects how well they keep you cool and how well they work. Alam et al. [4] did experiments to see how the heat comfort and aerodynamic qualities of race and leisure hats were different. Their results show that ventilation and aerodynamics have pros and cons, which makes it more important to build helmets that balance both features well.

According to Reid and Wang [5], they created a way to measure how well bicycle helmets cool, focusing on how heat is lost and how air flows. By keeping track of changes in temperature and wind rates, their study shows how well different helmet designs cool people, which can help make cooling systems that work better.

De Bruyne et al. [6] looked at how heat moves around under bicycle helmets and found that sensible and hidden heat losses vary in different parts of the helmet. Their research shows that heat loss rates are very different, which shows how important it is to think about spatial effects when designing and testing helmets.

To understand thermal mechanics in bicycle helmets, you need to know the basic rules of heat and mass movement. In their guidebook, Incropera et al. [7] give a full review of these principles, explaining ideas like conduction, convection, and radiation that control how heat moves. This theory approach is a good place to start studying how to keep helmets cool and comfortable.

Cohen [8] looked at studies that measured the thermal qualities of human skin. This gave him new information about how skin controls its temperature and gets rid of heat. To make helmets safer and more comfortable for users, designers need to know about these bodily factors.

Human anthropometric data on head and face sizes are very important for making helmets that fit a wide range of users well. Zhuang and Bradtmiller [9] did a study of head-and-face anthropometry among respirator users in the U.S., which gave us useful information about differences in the skull and face and how to choose the right size. This knowledge is very important for making helmets that protect riders the best and are the most comfortable to wear.

Standards and testing methods set by regulatory groups like Standards Australia [10] make sure that protective hats are safe and of good quality. According to these guidelines, helmets must pass strict tests to see how well they protect against impacts, let air flow, and keep you warm. It is important for makers to follow these rules so they can make helmets that meet safety standards and protect riders properly.

In conclusion, the literature review shows that study on bicycle helmet design, airflow, and temperature comfort is very broad. Researchers want to improve the safety and user experience of riders around the world by removing hurdles to helmet use, making cooling systems work better, and using scientific principles of heat transfer. To drive innovation and make sure that bicycle helmet technology keeps getting better, it's important for governing bodies, businesses, and universities to work together.

3. METHODOLOGY

a) Proposed Work:

The E-Helmet method we're proposing takes into account the important role people play in keeping the country safe and easing the problems caused by extreme weather. This creative answer includes a flexible electronic outfit made to make cops working in tough environments safer and more comfortable. The E-Uniform has two modes: summer mode and winter mode. This lets people adjust to different weather situations.

The system has advanced temperature control features that change the temperature inside the uniform depending on the mode that is being used. In summer mode, the E-Uniform uses cooling technologies to protect against heat stress. In winter mode, it uses heating elements to keep you warm and stop pain caused by the cold. This adaptable and efficient E-Uniform not only puts the health and safety of our cops first, but it also makes them more effective in a variety of settings, which eventually helps keep our country safe and successful.

b) Block Diagram:

Fig 1 Proposed Block Diagram

The block diagram shows how the different parts of a temperature regulation device that uses an Arduino Uno microcontroller are put together. A switch module on the Arduino Uno controls a Peltier plate that is part of the device. The energy that the Arduino Uno needs to work is provided by a controlled power source. A sun screen also charges a battery, which powers the whole system, including the switch that controls the Peltier plate. The Arduino Uno is linked to a DHT11 temperature and humidity sensor to keep an eye on the weather. The Arduino Uno takes in data from the sensor and uses the switch to control how the Peltier plate works, keeping the temperature where it should be. This setup makes sure that the temperature is kept stable, and the solar screen provides clean energy for long-term use.

c) Components Used:

1. ARDUINO UNO:

Based on the ATmega328P chipset, the Arduino Uno is a well-known open-source microprocessor board. It has both digital and analog input/output pins, which let it connect to different sensors, motors, and other electrical parts. The Arduino IDE (Integrated Development Environment) is used to program the Uno. This makes writing and sending code easier. It is the main control unit in the system mentioned, making sure that parts like the switch, Peltier plate, and sensor all work together.

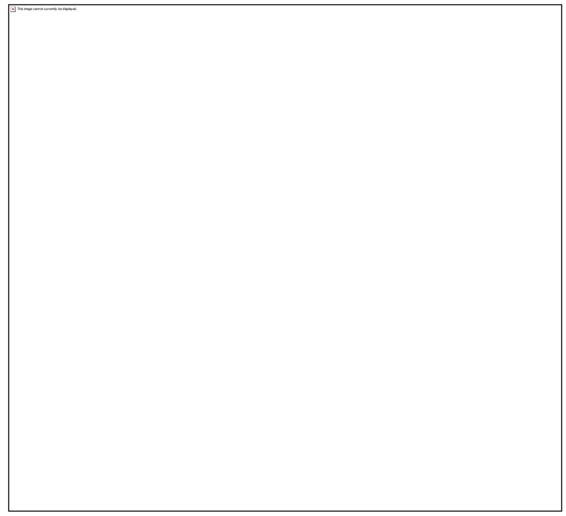

Fig 2 Arduino Uno

2. REGULATED POWER SUPPLY:

A controlled power source is an electrical device that keeps the voltage output fixed even if the input voltage or load changes. It usually has parts like voltage regulators and filtering circuits that make sure the power flow is steady and reliable. In the system being described, the controlled power source gives the Arduino Uno microcontroller a steady voltage. This makes sure it works right and lets you precisely handle devices like the Peltier plate that are attached.

3. SOLAR PANNEL:

A solar panel is a piece of equipment that uses photovoltaic cells to turn sunlight into electricity. When these cells take in sunshine, electrons are freed. This makes direct current (DC) energy. Most solar panels are made of silicon-based materials and are put on roofs or in solar systems to get the most sunshine. In the setup outlined, the solar screen uses energy from the sun to charge a battery. This gives working parts like the Arduino Uno and switch clean power.

4. BATTERY:

That's what a battery does: it saves electrical energy chemically and releases it when it's needed. The battery stores energy from the solar panel and is used as a power source in the system explained. In the event that solar energy is not available, it powers parts like the Arduino Uno and switch. The battery keeps the system running all the time, making it reliable and stable, especially at night or when there isn't much sunlight.

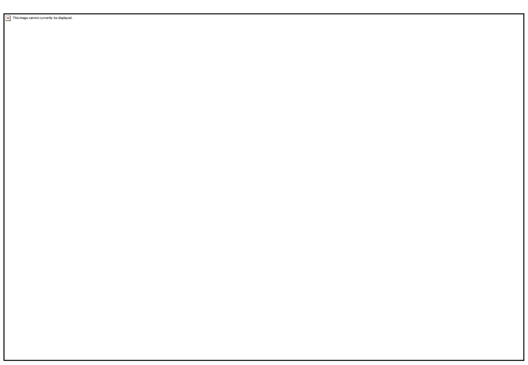

Fig 3 Sanca Battery 4v, 1A

5. DHT11:

The DHT11 is a digital monitor for measuring temperature and humidity that works well in a lot of different environments. It has a sensitive humidity sensor and a resistor for measuring temperature built into one piece. A digital output lets the sensor talk to the Arduino Uno microprocessor, which lets the temperature and humidity levels be tracked in real time. In the setup outlined, the DHT11 sensor allows accurate tracking of the surroundings for effective temperature control.

6. RELAY:

Electricity flows between two lines with the help of a motorized switch called a relay. It has a coil and at least one set of connections. Depending on the type of relay, when the coil is turned on, it makes a magnetic field that opens or closes the connections. In the setup outlined, the switch controls the power to the Peltier plate. This lets the Arduino Uno change how it works based on the conditions outside.

7. PELTIER PLATE:

A Peltier plate, which is also called a thermoelectric cooler or TEC module, is a semiconductor device that changes the temperature of something when an electric current flows through it. Depending on which way the current flows, this effect, called the Peltier effect, lets the plate move heat from one side to the other. The Peltier plate controls the temperature in the system described, either cooling or heating it depending on what the Arduino Uno tells it to do.

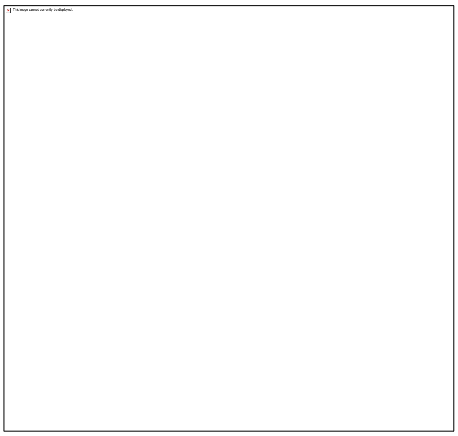

Fig 4 Peltier Plates

d) Working Process:

Here's how the auto-cooling hat system works:

1. Solar panels use the sun's rays to charge the battery, which makes sure there is always power.

2. The regulated power source gives the Arduino Uno microcontroller a steady energy.

3. The DHT11 sensor sends information to the Arduino Uno about the temperature and humidity inside the helmet.

4. The Arduino Uno checks the data from the sensors to see if cooling or warmth is needed.

5. If cooling is needed, the Arduino Uno turns on the switch, which lets electricity move to the Peltier plate.

6. The Peltier plate uses thermoelectric technology to either take in heat or give it off, based on which way the current flows.

7. Cooling mode: The Peltier plate pulls heat from inside the helmet, lowering the temperature and making the rider more comfortable.

8. Heating mode (if needed): The Peltier plate sends heat into the helmet, keeping it at the right temperature when it's cold outside.

9. Constantly checking and adjusting: The Arduino Uno keeps an eye on sensor data and changes how the Peltier plate works to make sure the rider is safe and comfortable at all times.

4. EXPERIMENTAL RESULTS

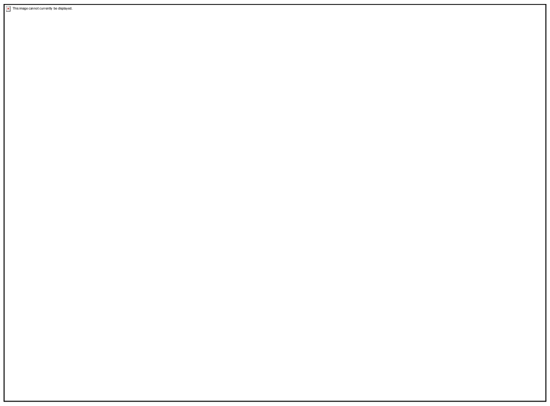

Fig 5 Output Screen

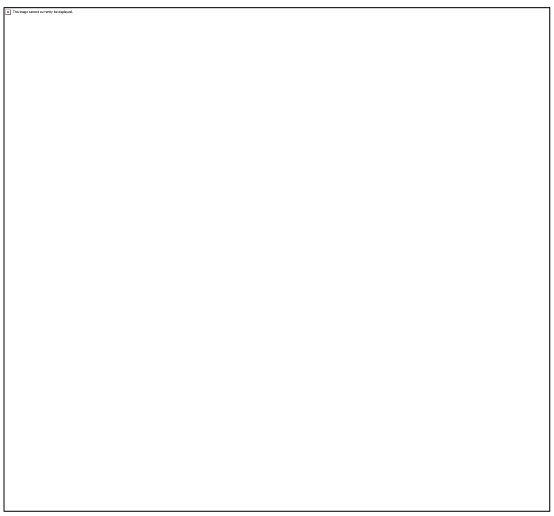

Fig 6 Output Screen

S.no.	Time(in mins)	Ambient temperature (deg)	Peltier plate temp (deg)
1.	02:00pm	32	32
2.	02:05pm	34	28
3.	02:10pm	35	25
4.	02:15pm	35	25
5.	02:20pm	35	25

Fig 7 Output Screen

5. CONCLUSION

To sum up, the testing of a thermoelectric cooling device for motorcycle helmets has shown promise in meeting the desired cooling performance. But to make it even more useful, changes need to be made in the future. One important part is changing to a higher power thermoelectric generator to make cooling more efficient, but the power source needs to be able to handle the extra power demand. Getting rid of the noise made by the internal fan is also very important, so a low-noise fan needs to be installed for user comfort. Using materials other than metal for heat sinks can also help them get rid of heat more quickly. Taking into account how the helmet's aerodynamics affect its performance in the future can also help improve cooling while keeping the rider safe and comfortable. By solving these problems and making changes, the cooling system can provide better thermal comfort and safety for riders, making riding more enjoyable and possibly lowering the risk of pain and injuries caused by heat.

6. FUTURE SCOPE

Peltier plate-based e-helmets have a bright future ahead of them because they can offer advanced features like active cooling and heating, temperature control that can be customized, and connection with smart devices. Better safety features, like ones that sense impacts and send out emergency alerts, could make riders a lot safer. Adding green energy sources for long-lasting use and looking into uses besides personal safety, like in medical and industry settings, could also make them more useful. But more study and development are needed to make these new e-helmets more efficient, lower their costs, and make sure that a lot of people use them.

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