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Prototyping Solar Powered Helmet

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ABSTRACT

The paper presents a unique design and prototype of a helmet capable of providing a comfortable and salubrious experience to the Delhi-NCR riders. The digitally controlled mechanism, while creating a pollution-free and breathable atmosphere, also provides live data of the environment in which the helmet is present. Solar panels provide continuous power to the system. The design uses the technology of thermoelectric cooling to provide cool air for the users through solar energy trapped by solar cells placed on the top of the helmet. A fan sucks the hot and polluted air from the outside, and pumps clean and cool air on to the face of the rider. The air first passes through the filters and then through the thermoelectric Peltier cooling unit. Further, temperature sensors are used to adjust the level of cooling or temperature inside the helmet. Also, an adjustable switch is provided, as an alternative to the user, through which he can control the temperature.

Keywords: Gas Sensors, Internet of Things (IoT), Microcontroller, Peltier Effect, THP2 Filter.

INTRODUCTION

A number of solar powered helmets are available in the market but all cater to rotating a motor or charging a mobile or both. Even in the research context, an IEEE maker project presents certain features (controlled by phone) that are possible with smartphone. Hence, our solution provides a ground-breaking step. As we know the air in Delhi is highly polluted and bike riders are the most vulnerable. Exposure to polluted air, especially while waiting at the traffic light, very often, leads to breathing problems to the bikers. The situation worsens during peak summer months when wearing a helmet also causes perspiration. Through our environment-friendly solar powered helmet, we aim to make life more comfortable for the bike riders. While designing the product, the focus was to optimize the use of solar energy without compromising on our goal to provide clean and cool breathing air to the user.

Previously, various attempts have been made to harness solar power to build similar helmets [1] [2]. Some of them were developed to provide cool air by fixing a DC fan or to simply charge a phone [3] [4]. One also might have come across solar hats, solar powered welding helmets, but they also end up in producing the same fan features or light intensity fluctuations [5]. An IEEE maker project indulges into different features by adding bluetooth, GSM/GPRS,

emergency switch and a cooling fan into their helmet. A security helmet idea-wise is appealing, and when we talk of these features on a helmet, it does seem viable as these features are already present in low-cost smartphones [6].

To the best of our knowledge, our solar powered helmet is the first product wherein the aim to provide clean air to its users is successfully met. The salient features of the product are:

1. Solar power operated: An efficient flexible solar panel or individual solar cells would charge the attached battery under the sun and store excessive power for use when the sun is down.
2. Cooling effect: Indian climate is largely tropical, and with the increasing rise of temperature that we are witnessing in present times, wearing a helmet becomes suffocating for the users given the perspiration and the polluted air that we breathe on our roads. This is where Peltier effect comes to their rescue. With the help of Peltier coolers and brushless DC motor, we have created a pleasant experience for the rider, where the vents in the headgear of the helmet blows cool air on the face. The inflow of air and the temperature could be regulated by the rider or can be set to automatic settings using the installed temperature.
3. Air filter: This is the most important aspect and by the use of THP2 fine filters, we have been able to provide 98% filtered air. Bike riders and the traffic policemen who have to be on road for a long time can greatly benefit from this.
4. Sensors: Apart from the temperature sensors, we have also introduced sensors to detect the pollution level, with exact count of the particle concentration in the air.
5. IoT: Special modules that can send data to a remote server can be very useful to enable pollution control departments to keep a real-time check on the air pollution across the city.
6. Live Navigation: Although the design also includes the front shield with a live navigation, we have omitted this for prototyping as it is a high-end technology. However, we intend to include it in future.
7.

METHODOLOGY

a) General Description

Figure I. shows the direction of the air flow. The fans in the side walls help bring the air from outside and filter it in the front, flush out the unwanted material and ultimately, the Peltier coolers, help in reducing the temperature. And finally, the air reaches the face of the

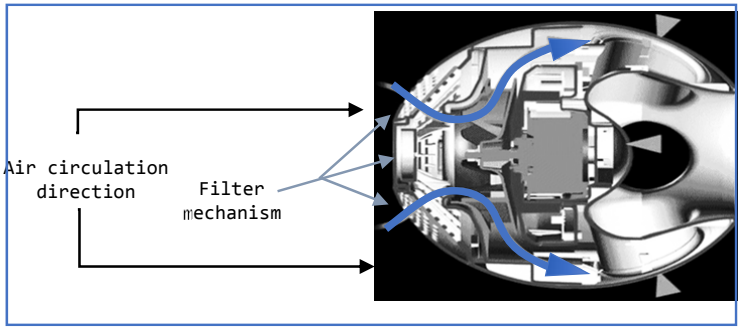

Figure I: Air flow mechanism with filter placing

rider.

A cartridge filter for filtering organic vapours and acidic gases such as Sulphur dioxide, Chlorine dioxide, Hydrogen sulphide, Hydrogen fluoride has been used.

The design consists of a solar panel on the outer covering of the helmet in such a manner that it can trap light appropriately, flexible solar cells are recommended for the same [7]. The current-voltage specifications of the solar cells should be chosen according to the requirement of the components used. In the present case, an Nvis Solar Panel of 50 Watt, capable of charging a 12 Volt battery was used. The battery pack was placed at the bottom-back position (Figure II) in order to minimize the weight borne by the user while wearing the helmet.

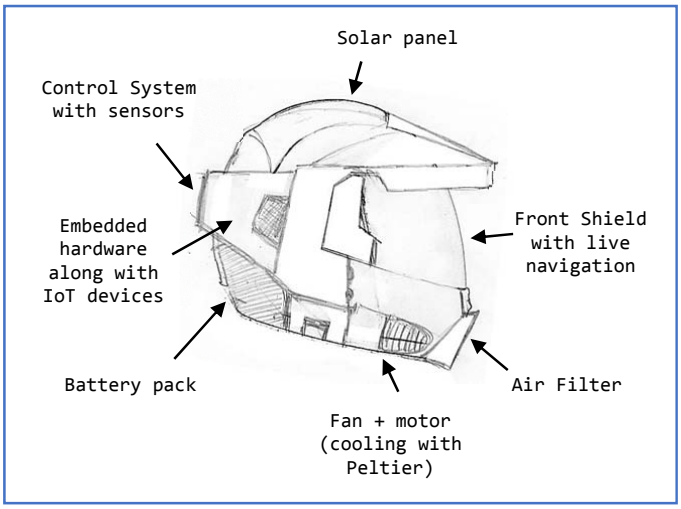

Figure II: Proposed design

Embedded hardware includes various sensors, communication devices, microcontroller, power management module, switches and motor drivers. IoT [8] was introduced to the helmet by accessing internet and sending different data across the server for logging and researching. All the components were designed in flexible PCB(s) [9], in order to make it more compact and balance the weight. The components used in prototyping is discussed in the next section.

The front shield navigation panel is an advanced Augmented Reality (AR) technology currently in R&D process across the globe. One such product is being developed by 'Livemap' [10]. This helps the rider understand the street in a more advanced way and reach his destination in a more intelligent fashion with live feeds and direction prompts for routes.

b) Prototype

The prototyping of the above design was done on a readily available open face helmet. And the components were fixed/packed on its different sites. The solar panel used was a regular 50 Watt 6 cells connected to a charge controller. A regular solar panel was put for testing along with a 6 Volt 3500 mAh battery.

The filter installed in the system consists of 3M^{TM} Gas and Vapor Cartridge [11] capable of protecting against a variety of harmful gases like Carbon monoxide, Sulphur dioxide, etc. along with particulate matter of diameter size of 10 micrometres. The filter was tested with a

half-sized mask and was attached towards the front side of the helmet as graphically

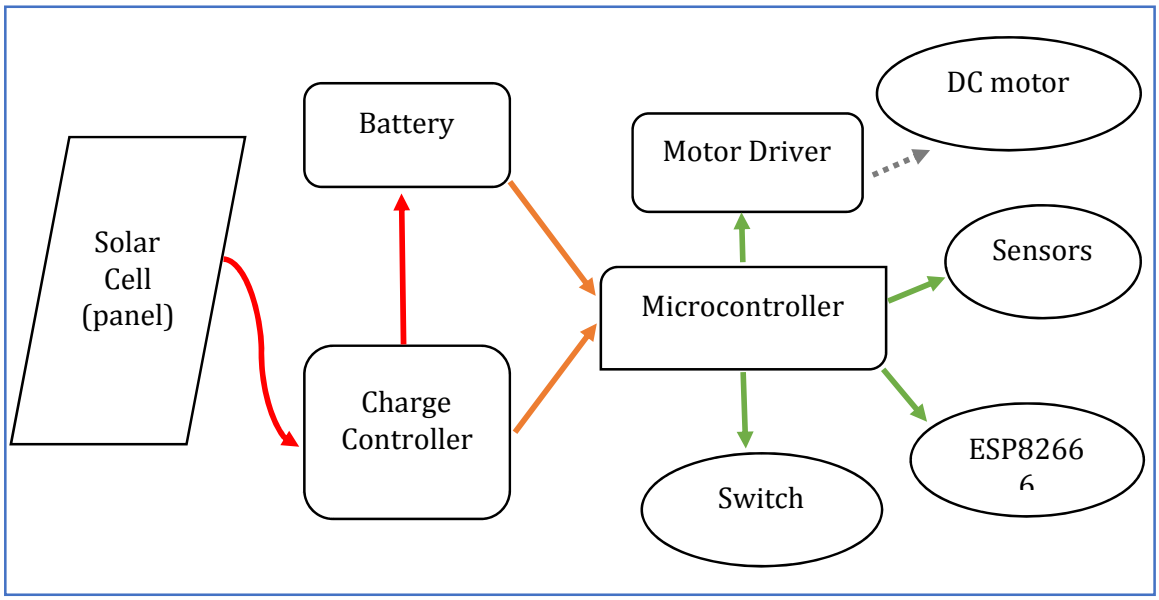

Figure III: Basic flow of embedded components and control system

presented in Figure II.

The microcontroller chosen is an 8-bit AVR architecture developed by Atmel and loaded into prototyping PCB by Arduino [12]. Currently Arduino Uno [13] was deployed as it best suits the electronic configuration and works on very little power requirement. Figure III. shows the current control system, wherein the power is derived from the solar panel.

For the fan, we chose DC brushless sleeve bearing fan, providing 6000 RPM and maintaining air flow of 5.57 cubic feet per minute and that also at 5 volts and 0.12 amperes of current. For cooling, the thermoelectric Peltier cooler was chosen according to the dimension of the fan and which could produce freezing temperature in a few seconds. The power requirement of the cooler was managed with pulse width modulation, in order to achieve efficient results. The same concept was programmed on the controller to automate the cooling mechanism including the motors speed.

The sensors deployed were:

i) DHT11 [14] – Temperature and humidity sensor
ii) MQ2–gas sensor, can detect LPG, i-butane, propane, and smoke
iii) MQ7– gas sensor, detects Carbon monoxide
iv) MQ135– gas sensor, senses benzene, alcohol and smoke
v) DSM501A– dust sensor, able to sense tobacco smoke, pollen, house dust, etc. and particles of nearly 1-micron size [15]

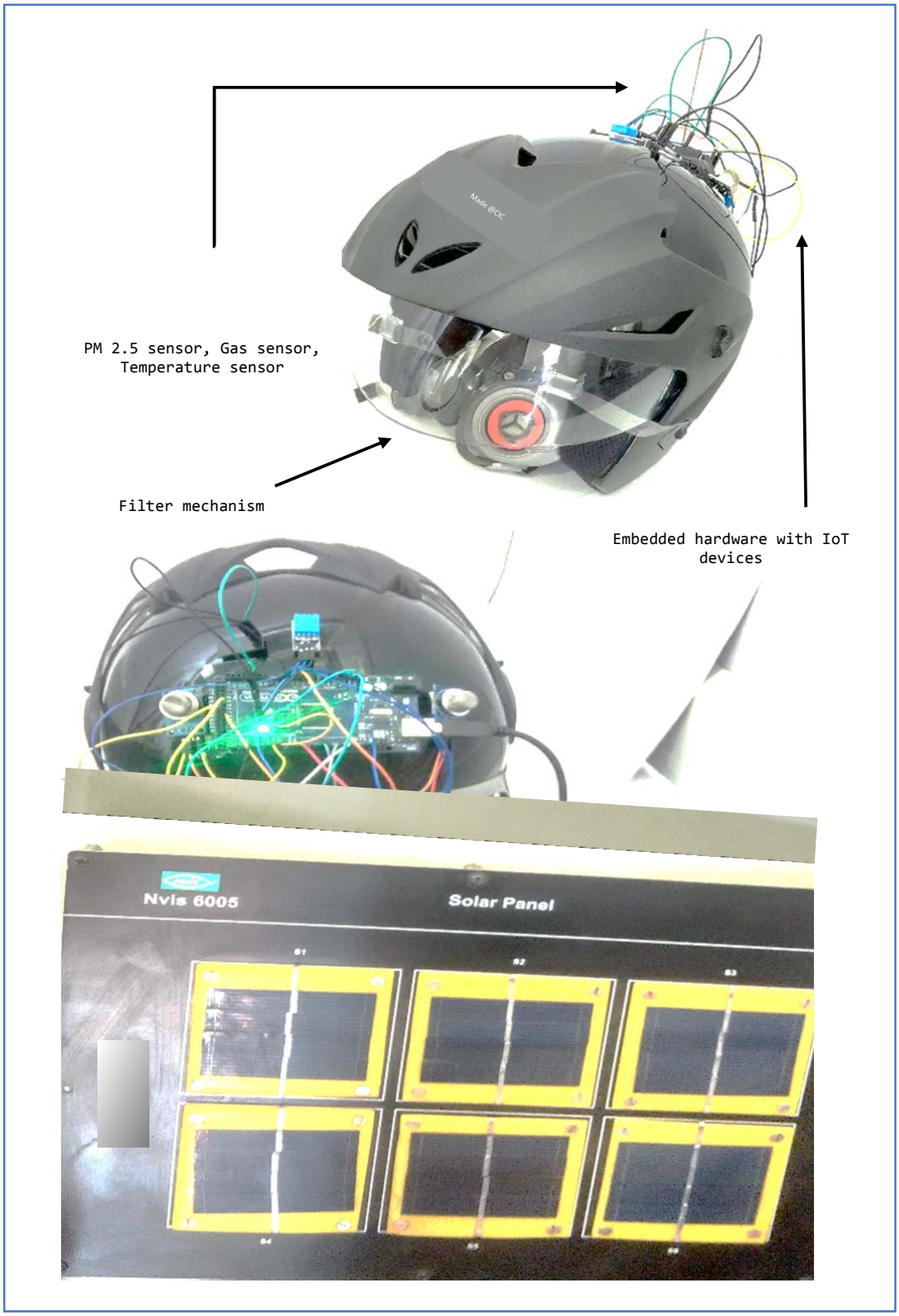

Figure IV: Prototype images

All sensors showed voltage fluctuations in proportion to the concentration of gas/particles present in the air.

ESP8266 Wi-Fi Module [16] is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to Wi-Fi network. A network script was created to send the data received from the sensors to Thingspeak (https://thingspeak.com/) server, thus enabling the device with IoT platform.

The program was written in Arduino, analyzing different temperature and humidity settings and developing the control algorithm for RPM and PWM of motor and Peltier, respectively. The sensors reading were not only sent to a remote server but their levels were also depicted in the form of led patterns and change in their colour intensity.

Figure IV. shows the fabricated helmet with an external solar panel, and circuit embedded at the back side of helmet.

RESULTS

A working prototype with all the mentioned elements and tested for its comfort and usefulness for the user has been successfully developed.

DISCUSSION

We believe our product has several unique features and the functional prototype is relevant especially in the present times when air pollution has reached extreme toxic levels with potential to cause serious damage to one's health. It can further be developed as more comfortable and aesthetically, better appealing. Several iterations would be required to build the prototype lighter in weight and to have on-board solar panel for its efficient working. We will also have to work around the placing of elements to ensure that sensors do not give conflicting data. The temperature was measured with 90% accuracy and though the filtering system worked successfully, other filtering mechanisms can still be considered for an enhanced experience.

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