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Smart Way To Reduce Car Cabin Temperature By Garnering Solar Power Without Perforation

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ABSTRACT

Making an eco-friendly choice can sometimes be expensive and time-consuming. Taking an option that improves rather than impairs the planet might take a little bit more effort but it is worth it. Vehicles play an inevitable role in modern life. At the same time, they are also major consumers of fossil fuels, thereby contributing to the degradation of the environment by the emission of greenhouse gases. Cooling a vehicle parked under the sun consumes more fossil fuel as compared to a car parked indoors. A viable solution to mitigate the environmental impact of these vehicles is to provide initial cooling prior to switching on the air conditioner. This paper proposes a cooling system for the car cabin by harnessing the solar energy to drive an air cooler by charging and discharging a supercapacitor bank. The control setup regularly monitors the temperature inside the cabin. Furthermore, the proposed system has proved to be more efficient in diminishing the cabin temperature significantly, thus providing comfort to users as well as reducing the consumption of fossil fuel.

Keywords: Solar energy garnering, Temperature control, Wireless power transfer

1. INTRODUCTION

Climate change is the defining issue of our time. Enhanced greenhouse effect and consequent global warming, pollution, etc. are posing a great threat to the existence of life on earth. From shifting weather patterns to rising sea levels, the impact of climate change is too massive and unpredictable. Without drastic action today, adapting to these impacts in the future will be more difficult and expensive. Fossil fuels used in vehicles are one of the major contributors of greenhouse gases. Any technology which brings about a slight reduction in green-house gas emissions holds its importance. This paper proposes such a technology; a solar-powered cooling system that can be implemented in modern cars for cooling. A car parked outside during the hot summer season develop a rise in temperature. The high temperature developed inside the car cabin speed up the ageing of various parts of the car and may produce harmful gases. To cool the car cabin a large amount of fuel needs to be used compared to a car parked in a considerably colder atmosphere. Due to the depletion of fossil fuel levels, society has reached the point of switching to alternative resources.

The car cabin temperature can be reduced using a technology that uses a Peltier cell and a system consisting of two electric motors and rolling cloth. This setup sucks hot air from the cabin and pushes it through the wet rolling cloth thereby releasing cool air with moisture content. It has the drawback of increasing the humidity inside the car cabin [1]. An alternative to this technology is a system that uses solar energy to power a phase change cooling module [2]. It consists of an air pump, water tank and PCM tank which makes the cooling device bulkier. Thus the cooler occupies enormous space inside the cabin which makes it cumbersome as well as costlier. Another method is to use a thermoelectric cooler which uses the Peltier effect to cool the cabin [3]. But this system requires more power to operate and hence more solar energy.

The paper put forward a solar-powered cooling system that uses solar energy to cool the car cabin i.e., to reduce the temperature to a level that is comfortable to the passengers. Using this system, when the temperature goes beyond a particular threshold as fixed by the user the car cabin can be cooled by driving an air cooler using the electrical energy from solar panel transferred using Wireless Power Transfer (WPT) method. The entire system can be externally controlled using an android application if needed. Using the developed application, the user can even instruct the device to cool the car in advance.

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2. PROPOSED METHODOLOGY

The system can be divided into three sections, Namely:
A. Solar collector Mechanism
B. Energy Conduit
C. Temperature control and cooling module

A. Solar Collector Mechanism

The collector consists of solar panels attached to an 'M' shaped frame. It consists of four panels each of which will be fixed to one of the legs. This 'M' shaped frame will be such that it can be opened and closed using a dc motor. This completely foldable frame can be kept inside the car and once the car is parked under the hot sun this frame can be kept on the top of the car to aid the cooling process by collecting solar energy.

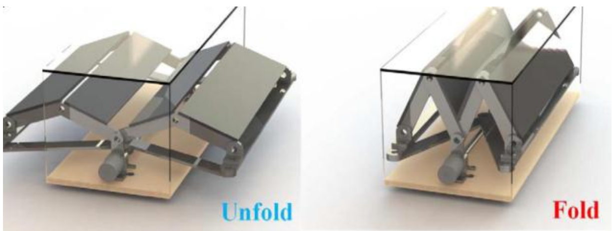

Figure 1: Solar Collector Mechanism

B. Energy conduit

The energy conduit setup consists of solar panels, wireless power transfer unit and supercapacitors. The solar panel converts the received solar energy to equivalent electrical energy. This energy is used to charge the supercapacitor that can be charged and discharged to drive the cooling device when required. The electrical energy output from the solar panel is transferred using wireless power transfer technology to charge the supercapacitor. For wireless power transfer, a WPT module can be used. It provides a stable 5V output supply. This WPT module consists of two coils. One of which acts as a transmitter module and the other act as a receiver module.

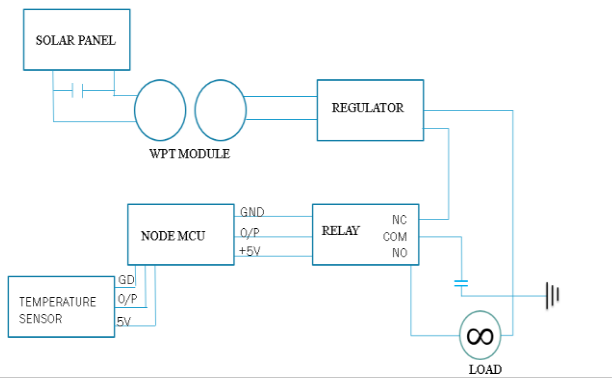

Figure 2: Circuit diagram

C. WPT Module

This module uses an electromagnetic field to transfer electrical energy between the transmitter circuit and the receiver circuit.

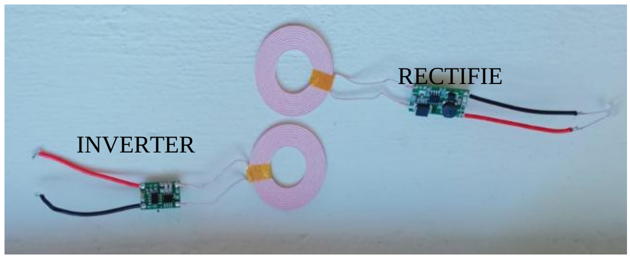

Figure 3: WPT module

One of the coil creates an alternating electromagnetic field from within the transmitter circuit powered with 12V. The second coil takes power from the electromagnetic field and converts it back into electrical energy to feed the receiver circuit that outputs 5V.WPT provides an efficiency of 70 percent with the transmission distance up to 20mm.

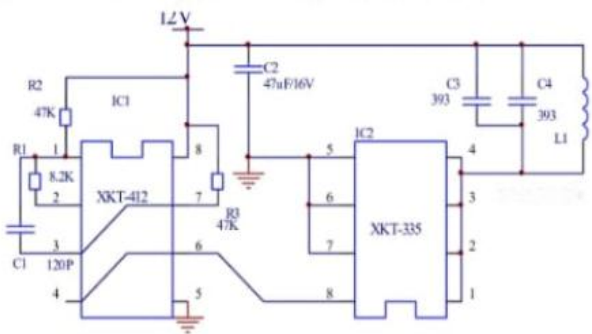

Figure 4:Transmitter circuit of WPT module(Inverter)

The coil with the transmitter circuit will be placed on the top of the car on the roof as attached to the solar panel wherein the receiver circuit will be placed inside the car. The transmitter module consists of an oscillator(XKT412) and an IC(XKT3055) for inversion.

The energy from this receiver circuit will charge the supercapacitor with much faster charging and discharging rate are suitable for this application as compared to a standard capacitor. The supercapacitor occupies a length of 20.5mm width of 19.3mm and a height of 6.5mm and has an operating voltage of 5V and capacitance of 10F.

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D. The temperature control and cooling module

The temperature control and cooling module comprises of
1.Temperature sensor 2. Relay 3. Programmable NodeMcu 4.cooler
The relay coil consists of two positions
1. Normally closed 2. Normally open

The relay coil will normally be in the closed position such that the supercapacitor keeps on charging. The temperature sensor can be programmed for a particular threshold value (say 32) using NodeMcu. When the car is parked outside the temperature will rise. The temperature sensor keeps on monitoring the temperature inside the cabin. Once the temperature reaches the threshold value to which the sensor has been programmed, its output will become high. The NodeMcu has its input from the temperature sensor and relay at its output. When the temperature sensor output becomes high the NodeMcu will send input signal to relay coil such that it switches from normally closed to normally open position. Under normally opened position of relay, the control setup will be such that the supercapacitor keeps on discharging to drive the cooling device. An android application can also be developed so that temperature can be controlled and minimized by the passenger itself in advance.

3. DESIGN OF SYSTEM

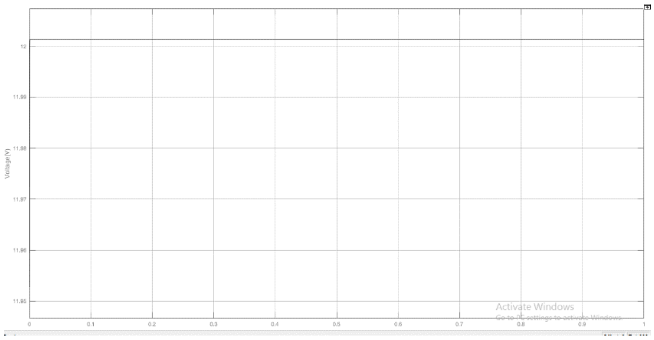
A.Solar Panel

The input voltage of the WPT module is 12 V, so the panel output voltage should be 12 V. The power required for the load is 10W. Taking into consideration all the possible losses, Panel is designed for a total output power of 12watts. Therefore 4 panels are required with each solar panel rated 12V,3 W

B.Super Capacitor

The operating voltage of the supercapacitor is 5V and the load resistance used is 5 ohms. The cooler (load) is designed to operate for 5 minutes ie**, Time constant**(T)

$$T = RC = 5 * 60 = 300s \qquad (1)$$



On solving, the capacitance value is obtained as 60F.

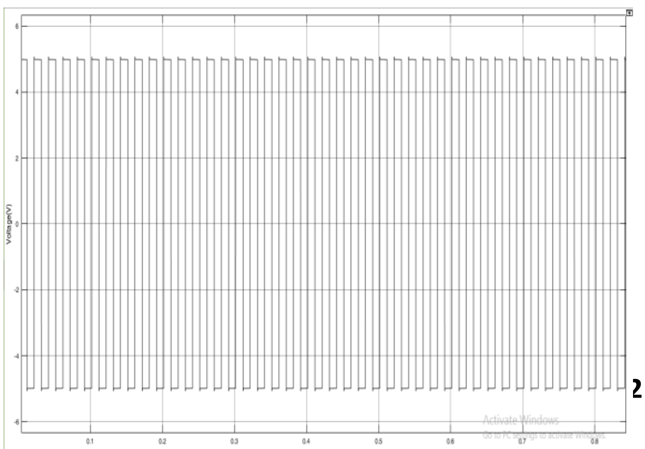
$$C = \frac{T}{R} = \frac{300}{5} \qquad (2)$$

Hence 6 capacitors need to be connected in parallel with each capacitor rated 5 V, 10 F.

4. SIMULATION

The components used in the simulation includes Solar panel, Inverter, WPT, Rectifier and Supercapacitor. The WPT module is simulated using a linear power transformer. The simulation of various hardware components has been done and the results are shown below.

Figure 5 : Output of solar panel



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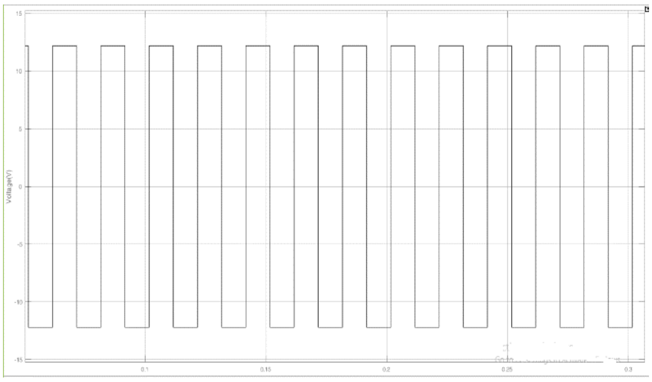

Figure 6 : Output of inverter

Figure 7: Output of WPT

figure. The solar collector mechanism was placed on the roof of the car with the WPT module's transmitter coil connected to it. The WPT coil with the receiver was placed inside the car, the distance between the transmitter coil and receiver coil being 1.5 cm. The supercapacitor cooling device, and the control setup has also been developed. The solar energy is converted into electrical energy and is stored in the supercapacitor via WPT module.To increase the current carrying capacity of the WPT module, IC XKT3055 has been replaced with transitor 2N3055. When the temperature inside the cabin rises and reaches the threshold value, the supercapacitor starts discharging, and driving the cooling device and hence cools the cabin. The temperature sensor is programmed for a temperature of 32^{o}C. The cabin temperature is made visible on the serial monitor and it shows that the cabin temperature is minimized. Once the cabin temperature reaches 28^{0}C, the relay switches to normally open position and the fan is switched off.

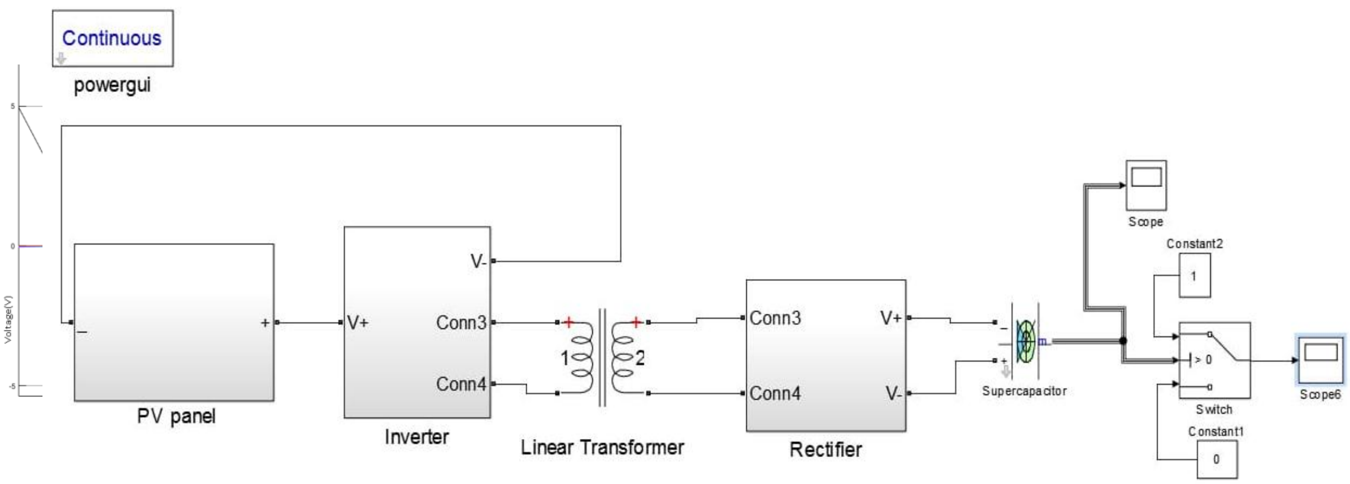

Figure 8: Simulink model of complete system

Figure 9: Charging and discharging waveform of supercapacitor

5. HARDWARE

An experimental setup has been set up to evaluate the performance of the proposed system and is shown in the

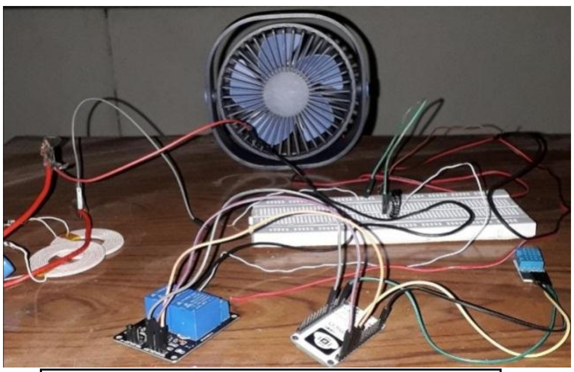

Figure 10:Experimental setup

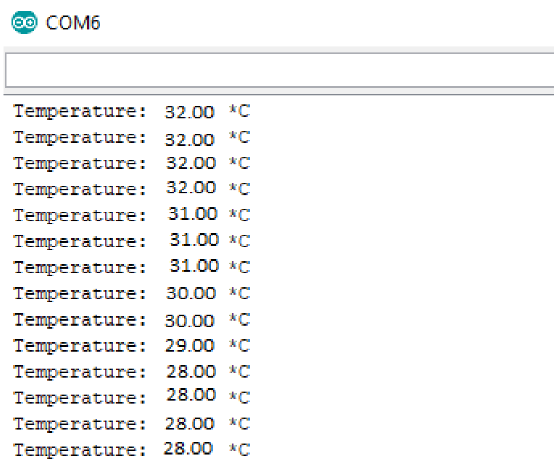

Figure 11: Serial monitor reading

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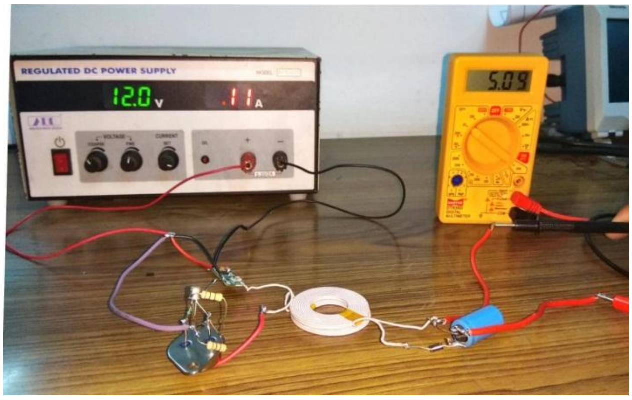

Figure 12: Input and output of WPT

6. CONCLUSION

A smart cooling system had been developed for reducing the car cabin temperature by harvesting the scorching sunlight. The system was able to successfully diminish the rising temperature thereby mitigating the damage to the dashboard and other accessories. Also, the wireless power transfer technology implemented helps in making the system portable and avoid piercing the car surface.The entire system can be externally controlled using an android application.

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