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Implementation and Design of Solar Powered EV

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Abstract: ***A solar car is a vehicle that is powered entirely or partially by the energy from the sun by using photovoltaic cells to convert sunlight into electricity. Solar cars have zero tailpipe emissions and are much better for the environment. Due to the problems caused by combustion engines on the environment, the automotive sector is quickly becoming outdated and being quickly converted to a fully electric vehicle. The report explains how the stored solar energy will be used to power a permanent magnet synchronous motor. The report outlines some advantages and disadvantages of solar vehicles. In addition, fuel prices are rising, and the daily running cost of the vehicles was becoming too high; now there is a need to reduce the running cost of the vehicles. The solar vehicle revolution is here, and we are part of it.***
Keywords: Solar car working ,Solar panel calculations ,Battery calculation ,Solar car circuit design ,PMSM

I. INTRODUCTION

Carbon-based fuels are hazardous to the environment, and there is also a scarcity of carbon-based fuels. Solar energy is chosen as an alternative since it provides clean, safe, and sustainable energy. Solar energy has innumerable benefits among other sources of energy. We are making an effort to work on our project to use the energy obtained from the solar to drive the vehicle instead of using other fossil fuels; this makes it completely eco-friendly, and the solar vehicle is better in all aspects compared to combustion engines.

Solar vehicles are completely eco-friendly and energy-efficient, as they emit zero tail pipe emissions. Transportation is a fundamental requirement of modern life, so to fulfill the requirement with zero running cost, we must introduce solar vehicles.

II. BASIC SCHEME

1) The proposed outline is suitable to reduce the rate of emissions caused by fossil fuels.
2) The plan of action is to generate electricity through solar panels, which is further used to run the vehicle.

III. WORKING

Solar vehicle is driven by a PMSM motor, powered by DC battery instead of using fossil fuels. The energy captured from the sun is used to charge the batteries, which could improve the overall efficiency of the electrical vehicle. The batteries can also be charged with an external power supply by using a plug-in charger.

The key components in the solar vehicle are:

1) Electric motor
2) Motor controller
3) Rechargeable batteries
4) Solar panels

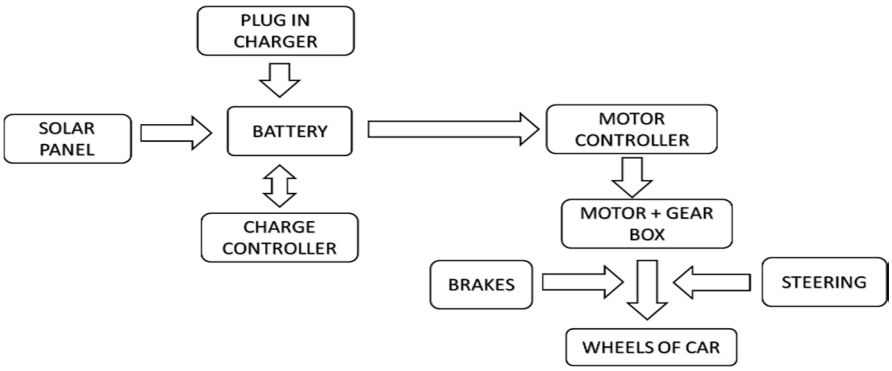

Fig:1 Basic block diagram

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The solar energy captured by the solar panels is used to charge the batteries through the charge controller; additionally, we can also use a plug-in charger to charge the batteries. The charged energy in the batteries is used to drive the electric motor through a speed controller. The speed controller decides how much power is to be delivered to the motor with respect to the acceleration throttle position. When the acceleration throttle is fully pressed, it gives the rated output to the motor; when the accelerator throttle is released, it gives 0 volts of output. The motor is coupled to the gearbox of that vehicle, which delivers mechanical power to the shafts of the vehicle's wheels.

IV. DESCRIPTION AND THEIR FUNCTION OF EACH COMPONENT:

Permanent magnet synchronous motor: The synchronous motor is basically similar to the rotating type of alternator. It consists of a stator and a rotor. The stator contains 3-phase balanced windings, and the rotor contains permanent magnets where the rotating magnetic field is excited. It works on the principle of magnetic locking.

The PMSM motors are highly efficient, safe, smooth, and have high dynamic performance. It produces smooth torque with less noise. Field-oriented control (FOC) is used to control the torque and speed of the PMSM motors.

In all aspects, PMSM and BLDC are highly suitable to drive electrical vehicles due to their advantages over other conventional motors.

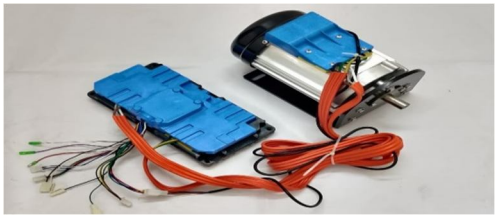

Fig 2. PMSM motor.

Motor specifications:

Maximum Power Output (Watt)	4000 W
No Load Current (Amp)	6.5 Amp
Rated Current	60 Amp
Voltage (V)	60 Volt
Rated Speed (RPM)	3700±100
Maximum Output Torque	46.34 NM
Rated Power	3000 W
Rated Torque	13.24 NM

Controller specifications:

Peak Protection Current	110 Amp
Rated Voltage (V)	60 Volt
Under voltage protection (V)	53 Volt
Throttle Voltage	1 Volt to 1.56 Volt
Rated Power	6600 W

V. BATTERY AND SOLAR PANEL CALCULATIONS:

1) Battery capacity is 12 x 100 x 5 = 6000 Wh.

2) Let us say the battery is 50% discharged. Then, discharged battery capacity (watt-hour) = 6000 x 50% = 3000 Wh.

3) Let us assume we use lead-acid batteries. Then, at 85% efficiency, Then, energy required for full charge = $\frac{3000}{85\%}$ = 3529 Wh.

4) Let us say you are using a 250-watt solar array and an MPPT charge controller. Then, solar output = 250 x 95% = 237.5 W.

5) The National Renewable Energy Laboratory's PV Watts Calculator uses 14.08% as its default value for system losses, so adjusted solar output = 237.5 x (100% - 14.08%) =204.06 W

6) Charge Time = 3529/204.06 = 17.27 hours.

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VI. CIRCUIT DIAGRAM

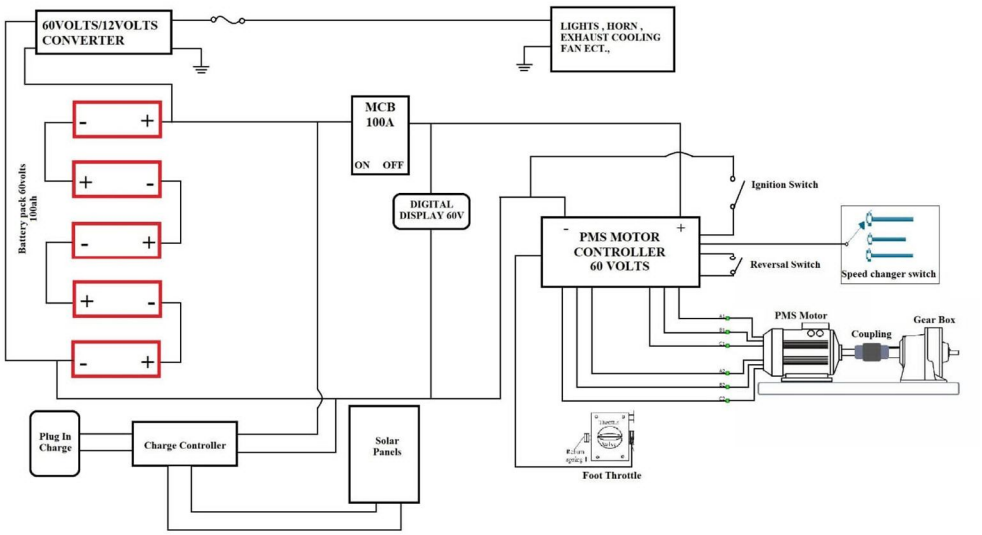

Fig 3. Circuit diagram

The energy obtained from the 250-watt solar panels is used to charge the batteries through a charge controller. It approximately takes 17 hours to charge the batteries under moderate sunlight. In addition, a plug-in charger can also be used to charge the battery pack for quick usage; it charges the batteries in approximately 3 hours. Twelve-volt, 100-amp-hour batteries of five numbers are connected in series to obtain a sixty-volt supply, which is used to power a PMSM motor through a controller. MCB is provided between the batteries and PMSM controller for protection purposes. The controller delivers the desired output power according to the acceleration throttle position, and the motor is coupled to the gearbox of the vehicle, which delivers mechanical power from the PMSM drive to the shaft of the wheels. A buck converter is used to step down the DC voltage of 60 volts from the battery pack to 12 volts for further use of the lights and horn.

VII. CONCLUSION

The objective of the project is to design a less expensive solar-powered electrical vehicle. According to the target, the solar-powered electrical vehicle is designed for an approximate mileage of 40–50 km. As a result, the solar car is free of toxic gases and pollutants, making it highly economical for modern transportation.

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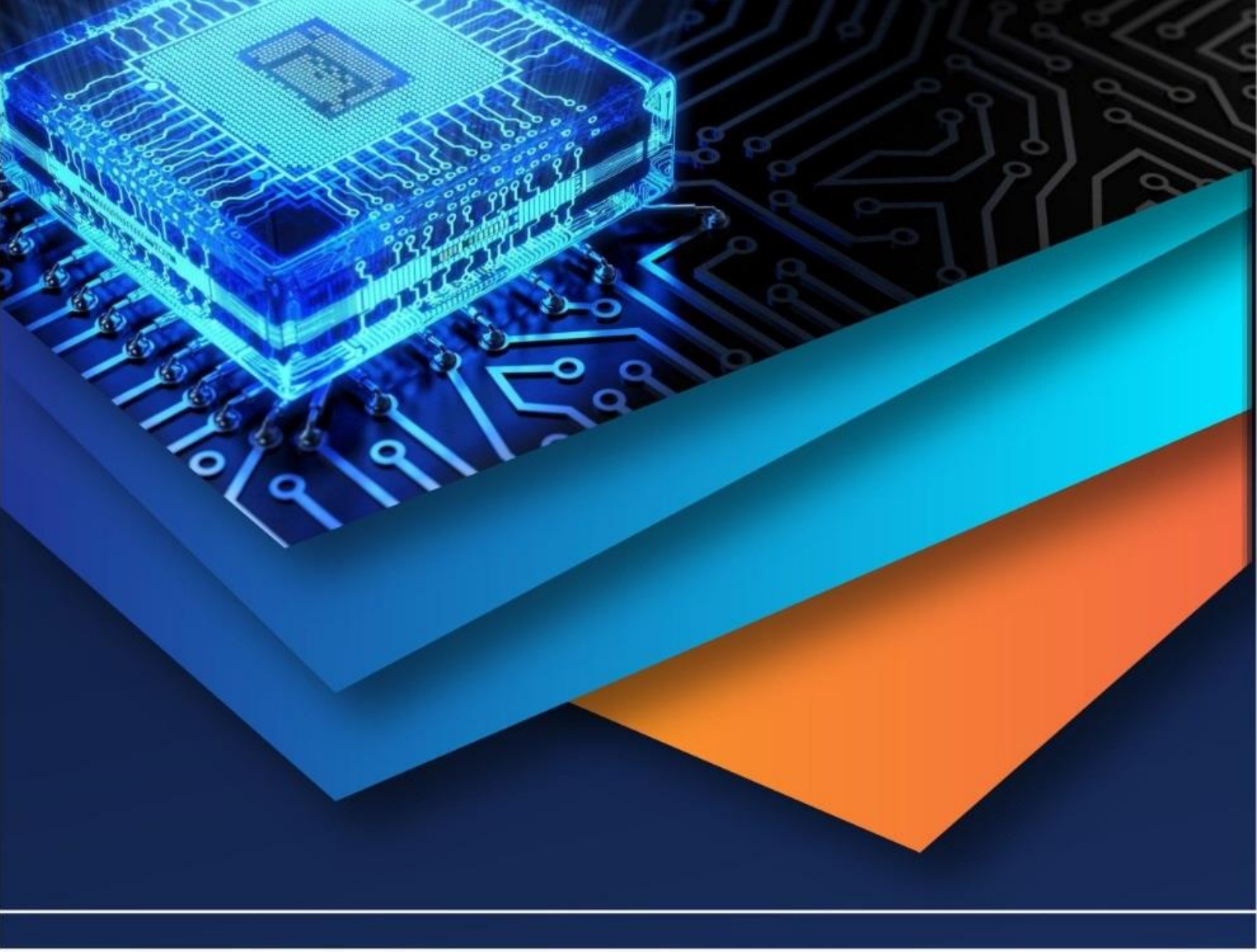

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