Revolution Design of Eco-Friendly Electric Solar Vehicle inspired by nature

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***Abstract*— As we all know, that there is no future of vehicles propelling from I.C. Engines. Because it is well known to all that fossil fuel is limited and it is coming to its end. This vehicle also causing the global environmental issues like global warming, ozone layer depletion.**

So, we have to move towards eco friendly vehicles like vehicles propelled by electric motors, bio fuel etc. As we know, solar energy is everywhere so it is more convenient to move towards electric solar vehicles. Which are eco friendly as well as providing free energy to propel the motor.

The designing and simulation of solar vehicle is done by various software some of them are Solidworks, Catia V5. Surface designing is done in Autodesk alias autostudio.

Keywords*— *Eco friendly, solar vehicle, green vehicle

I. INTRODUCTION

Fossil fuel, which is given by the earth. And it is limited, although we are using it limitlessly from a long time for producing electricity, vehicle propulsion and many more.The burning of this fossil fuel causes pollution and it is limited too. In pollution burning of fuel in I.C. engines have a big role. This pollution resulting in front of us in the form of climate change.Now, we have to take a step towards the eco-friendly vehicle. Here solar electric vehicle may play a vital role. Since it is electric so there are environmental issues. There is combination of battery and solar vehicle which increases the range or reliability of the vehicle.This features of the EV's giving strong option towards us as a replacement of conventional I.C. engine automobiles.

Research Survey

The main initial step of any product design is market research and taking ideas or data from the past and the present. By doing this we can get the exact idea that what we have to do with our product.

After a long survey of the existing market we had feel that there is revolution of electric vehicles which will take over the whole automobile market very soon. The research of past attempts of this type of electric vehicles we extracted the cons. These can be easily removed by the current technologies.By applying all this research and survey we can ensure that there will no cons.

III. Design Idea

As we all know that the god is the best creator, designer, inventor. So, in order to prepare the best design for the vehicle we had used the bio mimicry. Here we had taken the inspiration from crimson sunbird. Here is some design (sketches) which shows the initial steps of our designing.

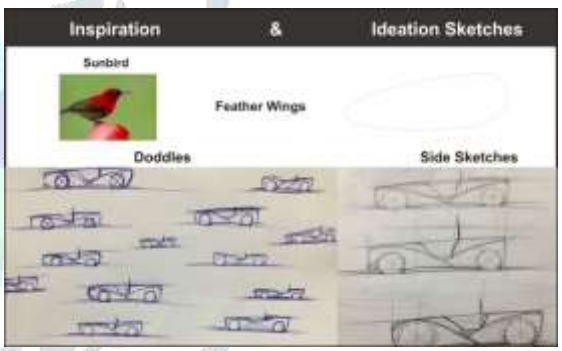


Figure 1 Initial Sketches of Vehicle

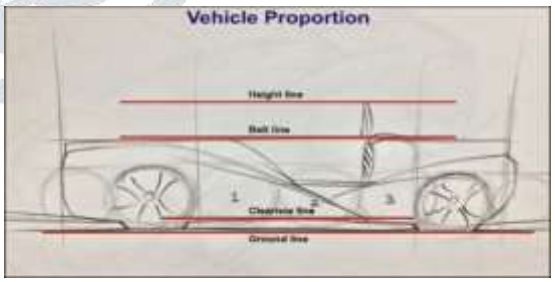


Figure 2 Vehicle Proportions

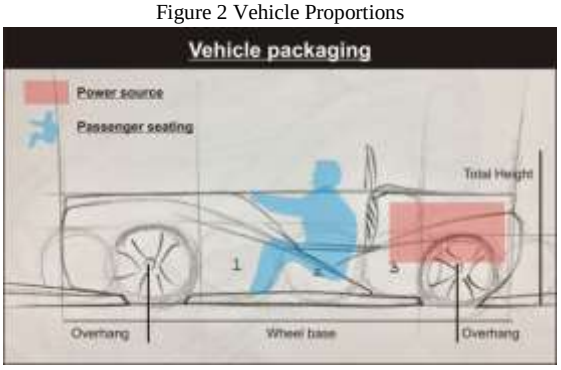


Figure 3 vehicle packaging

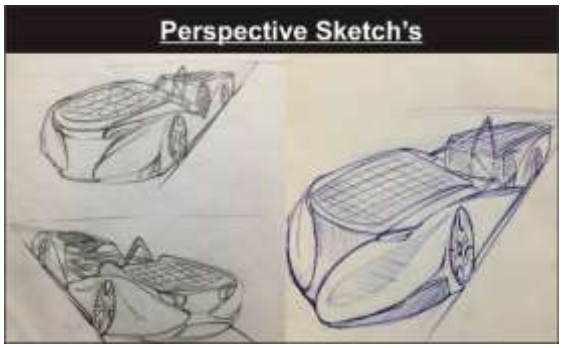


Figure 4 Perspective Sketches

IV Fabrication of Solar Vehicle

As we had our inspiration through birds following frame has been design accordingly to give that different cut from other and to create the correct rhythm. Here some pictures to demonstrate-

Figure 5 Isometric view of the frame

Table 1 Vehicle Dimensions

Length of the vehicle	102 inches
Width of the vehicle	58 inches
Height of the vehicle	42 inches
Wheel base	70 inches
Ground clearance	3.25 inches
Tyre size	DIA:12 inches
Chassis	Seamless circular pipe dia:1-inch, thickness: 1 mm

The above table shows the basic dimensions of the vehicle. Here circular cross-sectional pipe is used in order to give it to a structural rigidity and stability. Due to the use of circular cross-sectional pipe frame becomes light in weight and having enough strength. These dimensions give the basic idea about the designing of the vehicle. From this we can say that this design is prepared by keeping in the mind the safety and the comfortability of the occupant. In this vehicle rear wheel drive is used driven by electric motor. This motor is powered by li-ion batteries having following specifications as shown in table below.

Table 2 Battery specification

Battery type	
Voltage per battery	12 V
Current	84 Ah
Discharge time	2.64 Hrs.
Weight	40 Kg
No. of battery used	4

In order to propel the vehicle, we are using BLDC motor of power 2000W delivering peak torque of 7.5 Nm at 2917 rpm. Other details regarding the motor is as shown below

Table 3 Motor specification

Type	Permanent magnet BLDC
Voltage	48 V
No load current	5 A
Rated current	45 A
Rated speed	3000±100 RPM
Rated torque	7.6 Nm
Max. output torque	22 Nm
Rated power	2000 W
Max. power output	3000 W
Efficiency	>83%

This motor has following performance parameter as plotted in the graph below

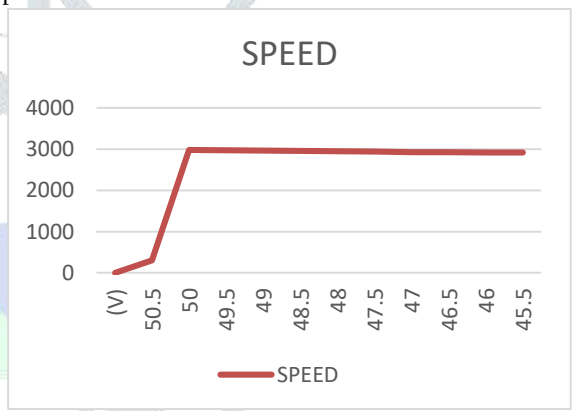


Figure 4 Graph between Speed and Voltage

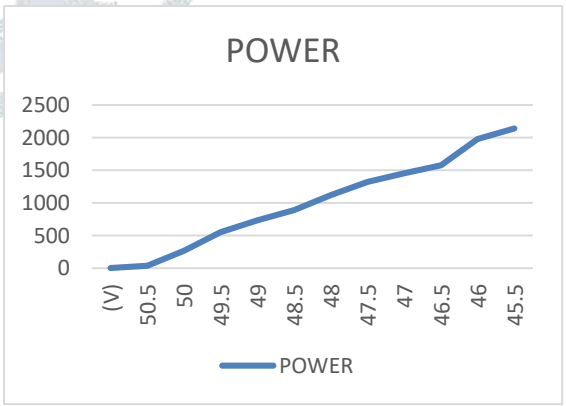


Figure 5 Graph between Power and Voltage

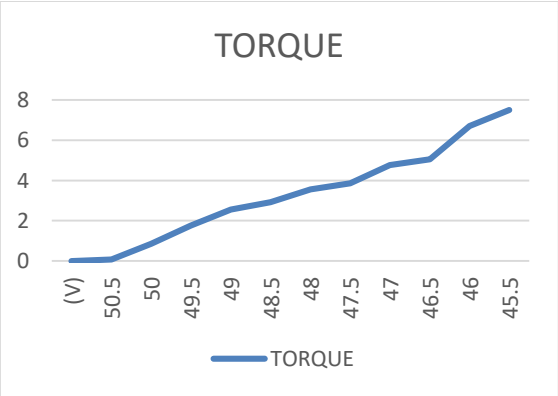


Figure 6 Graph between Torque and Voltage

In order to drive the vehicle as long as possible we have to keep charging the battery pack. To recharge the power pack unit, we had installed solar unit having following specifications

Table 4 Specification of solar panel

Cell type	Mono crystalline
No. of panels	2
Total available area of panel	3312 inch2
Max. power	300 Watts per hour
Connector type	MC4 compatible

To support all the components, we have to provide a suitable frame which provide enough strength and stability. In order to fulfil these requirements, we had used the seamless pipe of material AISI 4130. The mechanical properties of the material are as follows

Table 5 Material specification

Element	**Weight %**
Poission ratio	0.285
Tensile strength	731 MPa
Yield strength	460 MPa
Mass density	7850 Kg/m3

vehicle wiring system is also required. A good wiring can improve the efficiency of the vehicle by some instant. The wiring of the vehicle is shown in diagram

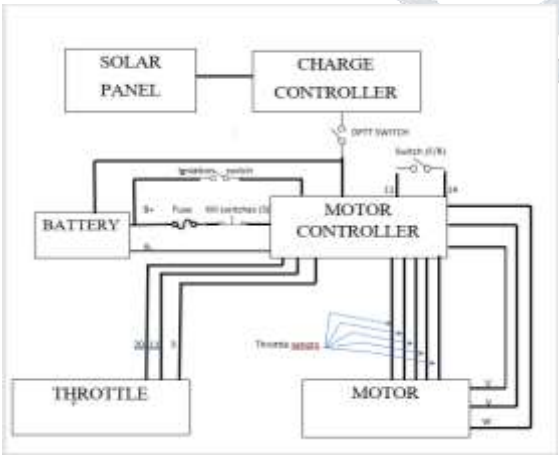


Figure 7 Wiring diagram

The power produced by the solar panels has to utilized efficiently. In order to make sure the maximum utilization a PWM controller is used. The controller will collect the energy from solar cells and send it to the battery to charge it at constant rate although the environmental condition is varying outside.After installation of all the component the vehicle will look like this as below

Figure 8 Assembled isometric view prepared in Solidworks and rendered in keyshot 6

4.1 Calculation for Various Parameters:

Static structural analysis

4.1.1 Front impact

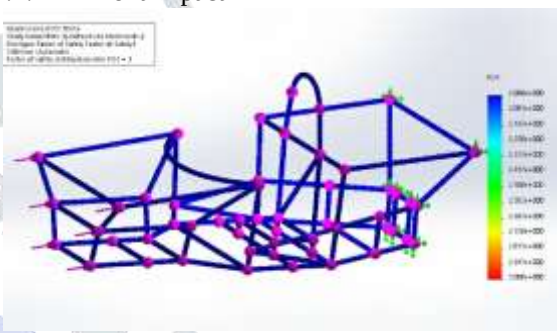


Figure 9 Front impact (FOS)

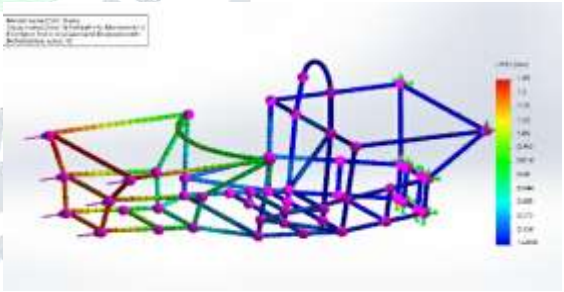


Figure 10 Front impact (displacement)

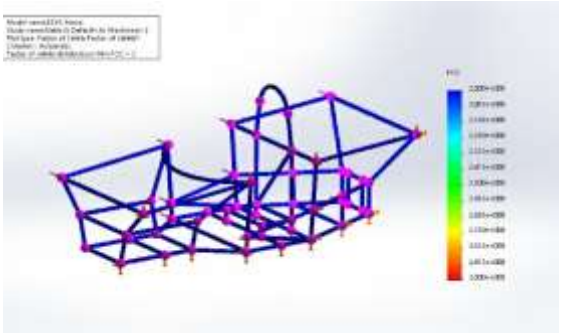


Figure 11 Front impact (stress)

Table 6 Front Impact

Impact Type (front)	Max. Value
FOS	2
Displacement	1.63 mm
Stress	3.077e+007 N/m^2

4.1.2 Rear impact

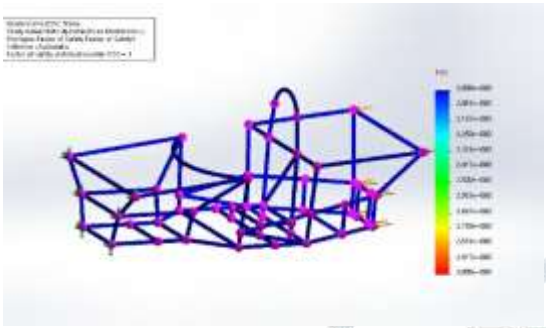


Figure12 Rear impact (FOS)

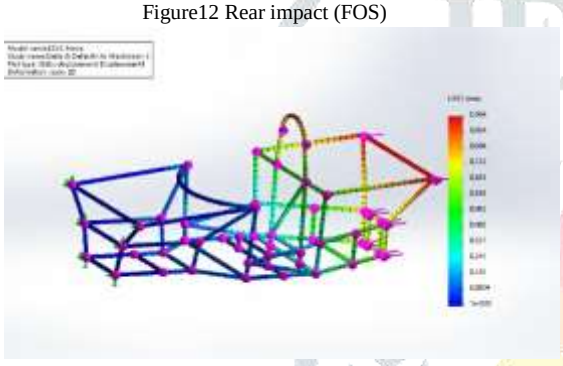
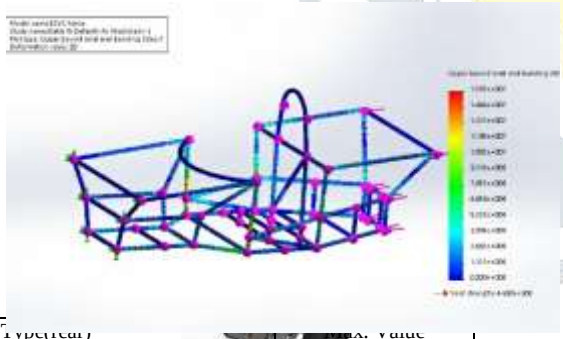


Figure13 Rear impact (displacement)



Impact Type(rear)	Max. Value
FOS	2
Displacement	0.964mm
Stress	1.597e+007 N/m^2

4.1.3Roll over

Figure15 Roll over (FOS)

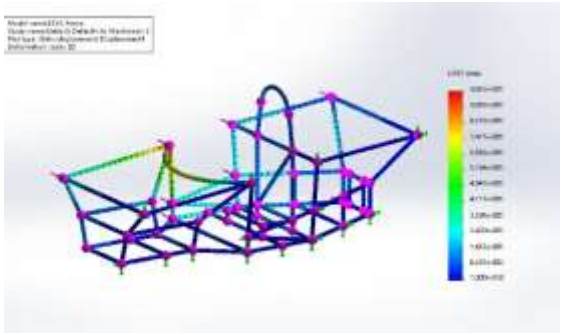


Figure 16 Roll over (displacement)

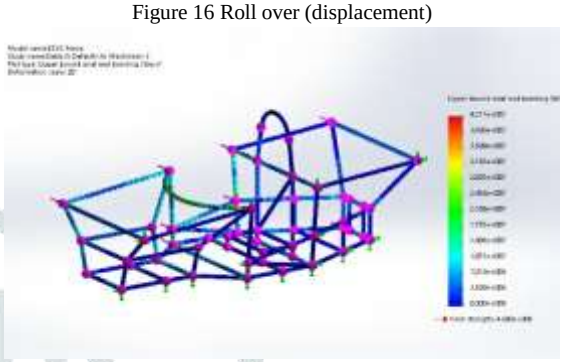


Figure 17 Roll over (stress)

V.Calculation

5.1 Braking calculation

In order to provide efficient braking hydraulic disk brakes are used.

Force transmitted = Fapp × g × Leverage =61.183 × 9.81 × 6
=3601.23 N

Braking force = 4 × Fclam =4× 18188 =7275 N

Force on tire = 2Tb / Rolling radius =(2 × 727.5) / 0.254
=5714.56 N

Total force = 4 × 5714.56 =22858.24 N

Stopping distance = v2 / (2A)=402 / (2 × 142.86)=4.59 m

Time to stop = (v × m) / Ftotal =40×160/22858.24=3.975 sec

Figure 18 Hydraulic Disk Brake

5.2 Suspension calculation

To ensure driver comfortability and vehicle stability double wishl

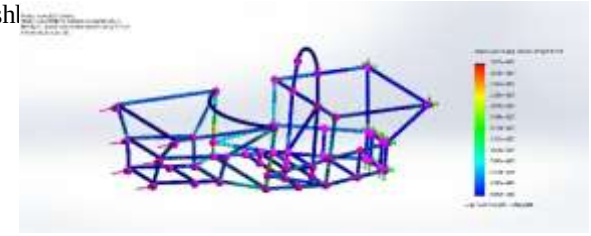


Figure 20 Double Wishbone Suspension

Weight carried by rear side of cycle = (total weight ofcycle) *(weight distributor in rear side) / (no. of suspension inrear side)
= 165*0.543/2 =45 kg.
Fmax= 45.0*9.81 = 441.45N
Fmin=441.45/2 = 220.725N
Mean force (Fm) =(Fmax+Fmin)/2. Fm= 331.0875N.
Stress amplitude (Fa) = (Fmax-Fmin)/2.
Fa=110.3625 N.

5.3 Steering Calculation

To provide good and easy control rack and pinion type steering system is used.
Max inner angle = 45°
For safety and decreasing lateral forces:
Let Δ i = 38°
tan Δ i = L / (r - (t / 2)) r=70"-tanΔ i*26.25/tanΔ i r=70.1"
R = (70 - 20.23) / 0.78 =63.8"
Turning Radius =3.5m
R=(b/sinϕ)-{(a-c)/2}
R=(70"/sin27.3)- {(52.5-46.5)/2}
R=3.5m
Ackerman angle =tan-1[L / {(L/tanϕ)-t}] = 40.008degree
Ackerman percentage/rolling percentage = (Δ / Δ inside) × 100
= (40.008 / 38) × 100
=94.55 %

F n Steering System
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As we all know that in present scenario we all have to take steps towards the eco-friendly technology. Since in automobile market has a big role in the global environment that's why we should use vehicle propelling from the electric motors.

There are some advantages of solar electric vehicle over the I.C. engines vehicles:

- Zero emission from the tailpipe. No pollution from vehicle.
- Low maintenance. Since no. of moving parts are less.
- High efficiency. Less no. of moving parts means less friction, greater efficiency.
- Subsidized. Since these vehicles are eco-friendly, therefore lot of attractive schemes from Govt.
- Smooth drive. No explosive fuel, no combustion, resulting in smooth drive.
- Instant torque. Since motor is used therefore instant torque can be achieved.

VI. Conclusion

The electric solar vehicle can be playing a key role in green vehicle segment. Our primary aim is to make great use of this pollution less green vehicle in real world so our dependency on fossil fuels reduces. Although Solar vehicles do have some disadvantages like small speed range, initial cost is high less rate of conversion of energy. But these drawbacks can be overcome by conducting further research in this area; like efficiency. The vehicle like electric solar has great scope in future.

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