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Smart Solar Vehicle

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ABSTRACT- The main idea of the project is to design a solar car that aims to tackle the problems related to pollution, shortage of fuel and to monitor various parameters that improves the safety of the driver. The paper surveys a few existing systems and provides an overview of a solar car that incorporates various safety features.

Keywords – Solar Energy, Safety Parameters, Monitoring and Control, Torque, Kill Switch, Motor, Sensors.

I. Introduction

A solar car is a solar vehicle used for land transport. The solar vehicle depends on a solar array to convert sunlight to electricity. Usually PV cells in solar panels are used to convert sun's energy directly into electric energy. This solar power is used to power the propulsion systems and other auxiliary controls. Usually the modules may be connected in series or parallel, to reduce the expenses the power converter and Dynamo are used. The battery is charged completely and then solar energy obtained is used to charge the battery. Steps are taken to prevent overcharging and unnecessary drainage of power from the battery. So the design of the car is also limited by amount of energy input to the car.

II. Objectives

a) Reducing the use of fossil fuel

Certain plug-in electric vehicles that pull electricity from gas-fired plants produce up to 60 percent fewer emissions than a conventional car with an internal combustion engine.

Hanergy says that five to six hours of sunlight should allow the cars' thin-film solar cells to generate between 8-10kWh of power a day, allowing the car to travel about 80km on solar power alone. Maximum range is about 350km.

b) Improving Safety of the driver

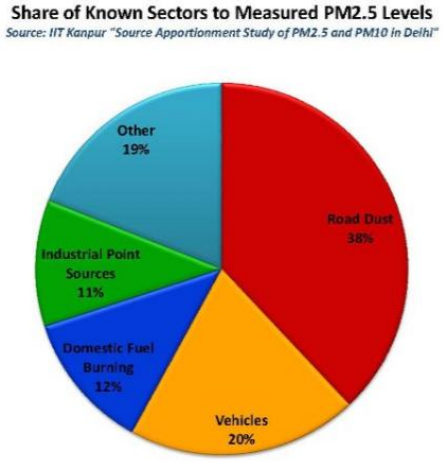
It is done by using impact detectors directly connected to the kill switch. So when there is a collision the kill switch turns off the entire system.

The driver vitals, battery temperature, battery power level and power generated are to be displayed on the dashboard for ease of operation. This information can also be monitored by the manufacturer by storing the information obtained in the cloud for successive improvements.

III. Existing Systems

a) For reducing the pollution levels

The government of capital city of India, Delhi has enforced limited number of vehicles based on whether the license plate ends in even or odd numbers. Thanks to the soaring level of hazardous PM 2.5 pollutant as seen in Figure-1, which is 12 times above WHO's safety level (as of November 2016).



[Figure-1]

Beijing Started road space rationing in 2008 to curb pollution levels ahead of Olympics.

China also followed ***End-number license policy***, ***Yellow-label car policy*** – vehicles that have yellow stickers indicate the vehicles are prohibited to enter 5th Ring Road of Beijing, ***small passenger car purchase policy*** - thereby purchaser must not already have a passenger car registered under his/her name.

In **Japan** hybrid cars are much popular. Here Toshiba and Honda partner to see how well the solar and electric vehicles go. Japan is also studying hard to produce commercially viable solar based electric vehicle. Honda has announced a new version of electric car as in Figure-3, MC-beta-a micro commuter which operates with less than 11kW.

[Figure-3]

b) For Safety

In many parts of North America *the* ***Bait car*** is used by law enforcement agencies to capture thieves who steal the car. These cars can be remotely controlled and monitored.

The *Mercedes-Benz* uses ***adaptive cruise control*** which incorporates sensors, radar to maintain constant speed whenever required. The Figure-3 shows the cruise control with which the required speed can be set.

[Figure-3]

The ***blind spot detection*** is a technology that alerts for blind spots while switching lanes and parking.

[Figure-4]

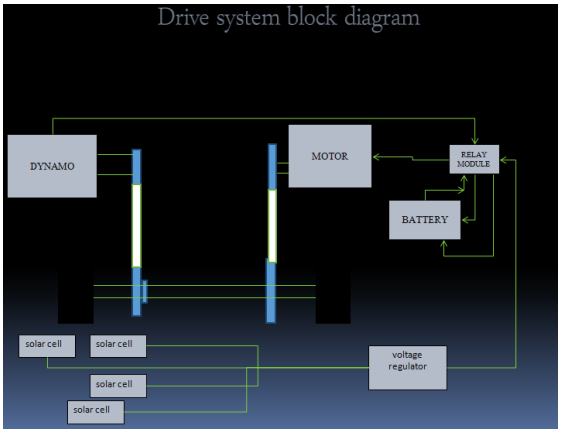
The Figure-4 represents the Truck fitted with a Samsung LCD display which assists the vehicles behind the truck to switch lanes or overtake the truck with a clear visualisation of vehicles on the other lane.

In countries like Dubai to reduce the number of road accidents and to avoid over speeding, a ***Back-off Radio*** is used to intimate the driver that the safety limit between the cars is breached. We can see the sensing action in between the sedan and a SUV Figure-5.

[Figure-5]

IV. Working

In order to power the vehicle, the required voltage can be obtained from the Photo Voltaic Module. But it is expensive and a large number of panels are required to produce this voltage. So to make economic and usable in a vehicle, power converters are used and batteries are charged with the limited number of solar panels. A Boost converter along with voltage regulator can be used to meet the power requirement of the Brushless DC motor that in turn rotates the wheels of the vehicle.



[Figure-6]

The block diagram (in top view) of the vehicle in is represented in the Figure-6. The drive is rear wheel single shaft chain coupled drive. The power rating is 1.5KW and the peak torque required is 18Nm. However the torque required to run the vehicle from 0-20 Km/hr with acceleration of 1.1m/s^2 is 86.15Nm. So we use a 1:6 sprocket ratio to attain a maximum of 108Nm.For the operation ***4 batteries*** are used, each has capacity of 12 Volts and 30 Ah. These batteries are connected in series so that a total of 48 Volts and 30 Ah is available. The batteries are charged by the solar panel. To avoid overcharging a relay is used.

To further reduce the use of Number of solar panels and to meet the voltage requirements a dynamo can be charged and used for additional power supply.

The Monitoring System consists of various sensors interfaced by ***Spark Photon Microcontrollers*** with an inbuilt Wifi Module. The temperature of the battery is monitored by ***LM-35*** Temperature Sensor, speed is measured using ***IR sensors***, The Finger tip pulse sensor – ***MLX90614*** gives the driver pulse rate. A ***Doppler radar*** can be used to measure the proximity of approaching vehicles.

The Coding for safety parameters are programmed in the Photon IDE.

The simulation can be done and the output can be viewed on an app as in thus enabling a monitoring system to track the various parameters for future references.

V. Motor Selection - Calculation

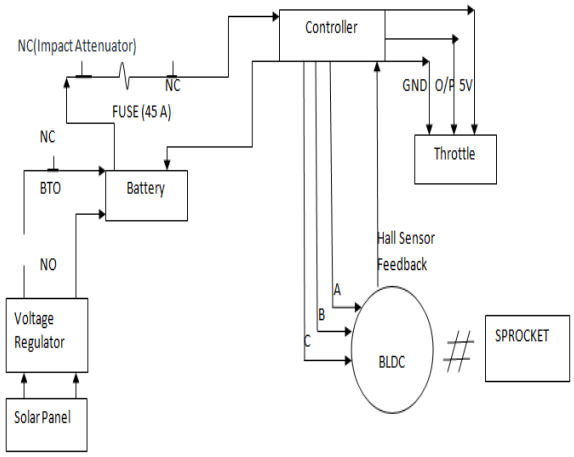
The torque required by the motor was decided based on the following calculations:

- Tractive force = Total resistive force + ma
- $F_t = F_r + F_{ad} + \alpha ma$
- Where F_r is the rolling resistance
- F_{ad} is the aerodynamic drag
- α is the coefficient of rotational inertia (1.1)
- Aerodynamic drag=0.5*density*c_d *v^2*A
- Frontal Area of the vehicle=0.25 m^2
- Density=1.2 kg/m^3
- C_d =0.8
- F_{ad}=2.08 N
- Mass of the vehicle=280 kg (including driver)
- Rolling resistance (F_r) = c_0 *w
- The rolling coefficient of car tyre on concrete road is .013
- F_r= 0.013*280*9.81
  = 35.7084 N
- Assuming that the vehicle accelerates from 0-20 km/h in 4 seconds the acceleration a=1.1 m/s
- F_t = 280*1.1 + 35.7084+2.08
  = 345.8 N
- The wheel radius is 0.25 m
- The torque required at the wheels= F_t * r
- =345.8*0.2469
  = 86.45 Nm
- Total torque required in the rear wheels would be 86.45Nm
- Maximum Tractive Effort=μR=.8*280*9.81
- F_{max}=2197.44 N
- T_{max}=550 Nm
- Therefore no slip will occur
- Power of the motor = F*v
- P = 345.8*4.2
  = 1449.5 W

- So a motor of 1.5 kW was selected

VI. Emergency Shut down

It is yet another safety feature to ensure that the adverse conditions such as fuel leakage break failure, motor failure etc are taken care to maintain the control over the vehicle. For this purpose ***Kill Switch*** is provided at the different places like dashboard, near the seat and at the front of the vehicle. On pressing the switch the electronic breaks are applied and the entire system is brought to halt and it is shut down. From Figure-7 the NC (normally closed) switches are used for Emergency Shutdown of vehicle.



[Figure-7]

VII. References

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