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Design and Implementation of Electric Vehicle

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Abstract- *This paper describes the recent development and future technologies in Electrical Vehicle (EV) also provides an overview of the different parts and components of EV. Due to the increasing growth in urbanisation and internet connectivity the way of lifestyle has been changing day by day. In order to improve the fuel efficiency and reduce emissions in air the use of conventional vehicles has to be reduced and the implementation of electric vehicles should be promoted. The main aim of this paper is to explain the importance of EV for avoids the greenhouse gas emissions from transportation which is major environmental issue and it is increasing day by day. This issue is avoided by use of EV. Therefore EV Design in such way that it is light in weight, more efficient, and easily controllable.*

Keywords - EV, Motor Controller, Hub Motor, Battery.

1. INTRODUCTION

Nowadays it has been seen that the non-renewable energy sources have been becoming extinct day by day. Due to this the cost of fuels for running the vehicles has been increasing tremendously in order to overcome the increasing the prices of fuels. The use of electric vehicle have been taken into account, Since normal vehicle work due to combustion of non-renewable fuel which leads to global warning. It also emits harmful gases like, CO2 and CO, etc. which leads to ozone depletion, also non-renewable banks are limited and they needs centuries to recharge. The main point is that we can't recharge them according to ours needs. Mother Nature takes its own time to fill those banks. So taking in account the uses and needs of energy from fuel. We need to move to alternative and here comes the renewable energy in account.

A renewable vehicle is light weight, more efficient, pollution free, and does not harm our nature in any sense. Also renewable vehicle doesn't consist of oils, pistons, which makes the vehicle light weight and thus easy to handle. Control of this EV is easy and one can easily ride then and reach to their destination. Many automobile industries are moving towards the renewable source to power their vehicle. We have to serve a better future to our next generation so just go green.

2. ELECTRIC VEHICLE

The electric vehicles are basically classified into two types:

a) All electric vehicles (AEVs).
b) Plug-in hybrid electric vehicles (PHEVs).

All electric vehicles (AEVs) are further classified into:

i. Battery electric vehicles (BEVs).
ii. Fuel cell electric vehicles (FCEVs).

The electric energy stored in the battery is provided to the electric motor by which the electric motor is run. Since electric vehicle does not have any combustion engine, there is no chance of emission of exhaust gases in the air. Therefore it does not cause any harm to the environment making the vehicle more eco-friendly. For propelling the vehicle, the battery needs to be sufficiently charged. The electrical energy for charging the vehicle is obtained from the renewable energy sources like solar, wind, hydro-electric, etc. the most popular and efficient renewable energy source used for charging the battery is by using solar energy.

The main advantage of using solar energy is that we can implement the solar panels on the body of the vehicle. The panels can be used according to our needs. The panels can be fixed on the roof, front and rear side of the vehicle. When the pedal of EV is press, the controller gains energy from the battery. This electrical energy is delivered to the motor where it is converted into mechanical energy. This turns on the motor. This motor thereby rotates the wheel which in turn moves the vehicle.

3. HUB MOTOR

Brushless DC motors (BLDC) have been a much focused area for many motor manufacturers as these motors are increasingly the preferred choice in many applications, especially in the field of motor control technology. With the development of sensor less technology besides digital control, these motors become so effective in terms of total system cost, size and reliability.

A brushless DC motor (known as BLDC) is a permanent magnet synchronous electric motor which is driven by direct current (DC) electricity and it accomplishes electronically controlled commutation system (commutation is the process of producing rotational torque in the motor by changing phase currents through it at appropriate times) instead of a mechanically commutation system.

BLDC motors and brushed motors have some common characteristics like high speed, high efficiency and better heat dissipation. It consists of of a rotor of permanent

magnet and stator of polyphase armature winding. The difference between conventional and bldc motor is that bldc motor does not contain brushes which does not promote its commutation unlike conventional dc motors. Commutation in bldc motor is done electrically using an electrical drive that must be fed to the stator windings. The advantage of using bldc hub motor is that they eliminate the differential losses and simplify the drivetrain. These motors are connected to each wheel separately. The handling and stability of the vehicle is improved by using this structural unit. The longitudinal force can be controlled independently of each wheel. Along with these structural merits there are some physical merits like dustproof, waterproof, increase in unsprung mass and effective cooling. Due to many advances in bldc hub motor, the researchers try to increase its performance rate. Studying the weight and torque of the existing conventional vehicle, accordingly a bldc motor drive and its controller can be designed.

Therefore the cost of the vehicle is reduced due to the advances made by the bldc motor. Bldc motors are highly durable, simple in designand gives high rpm output. This motor is controlled by a motor controller. Rotor positions are required for the motor controller to control the motor. This rotor position can be found out by the motor controller by using the hall effect sensor or rotary encoder. Some other methods involve measuring of the back emf in the undriven coils of the bldc to sense the rotor position. The logic circuits control the three output terminals. The acceleration and speed are managed by advanced controllers using microcontroller.

A lead acid battery is used to energize the bldc motor. The actual speed of the motor is provided by the hall sensors mounted by the bldc motor. The reference signal is taken is taken as the signal from the accelerator which consists of the varistor output to be fed to the controller.

These two signals are compared in the controller and the output power is changed from the chopper. This output signal from the chopper is sent back to the motor. Thus studying the performance of the output power from the chopper the speed of the motor can be controlled by the motor controller.

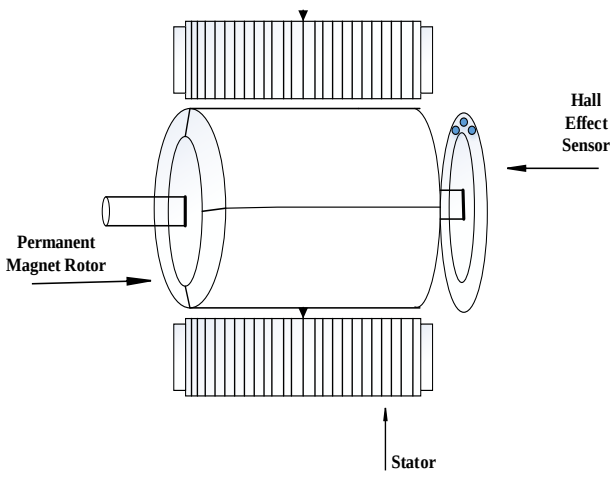

Fig-1 : Construction of BLDC Motor

4. MOTOR CONTROLLER

Motor controller helps to control the various properties of the motor to obtain sufficient current and voltage applied to the motor. Electric motor contains brushes and commutator for its commutation. In most of the electric vehicles Brushless DC motor is used which is far better than brushed DC motor, permanent magnet DC motor, AC induction motor and switched reluctance motor in many aspects. But since brushless DC motor does not have brushes and commutator, the electric vehicle which would use brushless DC motor has to use motor controller which would promote its commutation. Power is taken from the batteries and supplied to the motor controller. The accelerating pedal is linked to variable resistors which gives signal to the motor controller to adjust the speed of the vehicle as per needs.

The controller delivers zero power when the vehicle is at rest. When the driver presses the pedal, the controller delivers full power by which the vehicle is accelerated. As the driver presses the pedal the speed of the vehicle can be varied as per the acceleration. This is done with the help of the motor controller. Power is applied from the variable resistor to the motor controller from a single variable resistor.

But in most of the electric vehicles, two variable resistors are used for safety purpose. In case one variable resistor fails to operate, the other variable resistor can be brought into work. The signal provided by the variable resistor is delivered to the motor controller. In case of two variable resistors, the motor controller reads both the variable resistors and takes the further operation into account. If the signals provided by both the variable resistors are not same, Then the motor controller does not operate.

5. DESIGN OF SOLAR VEHICLE

Solar electric car is to provide immense riding pleasure to the user who wishes to ride solo. A light weight, smooth and fast to ride vehicle should provide an ultimate eco-friendly and economical cruising experience to end users. The chassis is the backbone of your vehicle. The design of chassis should be simple and straightforward as possible. While weight is a prevalent concern, it is only one of several factors that contribute to a successful vehicle design. In a straight line, the solar vehicle must fit inside a cuboid of 100 inches (2540 mm) long, 60inches (1524 mm) wide and 60 inches (1524 mm) high, with the base coincident with the ground.

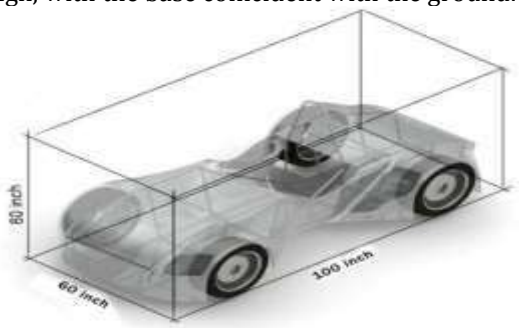

Fig-2: Design Of Vehicle

a) **Ground Clearance:** The fully-laden solar car must have a minimum of **6 inches** of ground clearance which will be measured between the ground and the lowermost part of the vehicle.
b) **Weight of EV:** the weight of the vehicle should not exceed the limit of **180 kg**, without the driver.
c) **Wheel Size:** The wheel diameter should be **minimum** of **12 inches** or **maximum** of **14 inches**.
- **Tyre Size**: Tires used by teams should have the following specification:
- **Tread Width**: Maximum 6.5 inches (165.1 mm) and minimum 3.54 inches (90 mm).
- **Load rating**: Greater than the load on wheels.
- **Speed rating**: Greater than the maximum speed of the vehicle.

d) **CHASIS MATERIAL:** The tube/rectangular pipe used in the fabrication of the chassis or the other frames/supports maybe seam or seamless.
e) **STEERING SYSTEM:** Good steering geometry is very important for control at any speed. Determining the length and position of all the elements is probably best determined by trial and error, so build in as many extra mounting holes as you can. Allowable total steering system free play (inclusive of play in all the steering linkages) is limited to 10 degrees, measured at the steering wheel.

5.1 BRAKING SYSTEM

The brakes are one of the most important control components of vehicle. In our vehicle, two disc brakes are used on the front axle to be more effective and drum brake on rear axle assisting to slow or stop the vehicle instantly after applying the brakes. Tandem master cylinder is used as a master cylinder in our vehicle because the tandem master cylinder transforms applied brake force into hydraulic pressure which is transferred to the wheel units through two separate circuits.

5.2 SELECTION OF DISC BRAKES ON FRONT

- Heating of the Brake rotor increases its thickness thereby causing no loss in brake fluid volume.
- Better stability than Drum Brake.
- Increase in temperature does not affect the disc pads.
- The braking design is simple.
- drum brakes. has better anti fade properties than drum brakes.
- The major advantage of the disc brake is its ability to operate with little fade at high temperatures of up to 1073 to 1173 K, while drum brakes are highly temperature sensitive.
- A maximum temperature of 673 to 700 K should not be exceeded.
- Water and dirt resistant. Better cooling, Friction surfaces are directly exposed to air in disc brake while in drum the friction surfaces are not directly exposed to air.
- disc brakes is very less as compared with the conventional drum type brakes, the approximate ratio being 1:4.
- This means that in disc brakes, the pressure intensity must be considerably greater than in the drum type

5.3 DISC BRAKES

Disc brakes are fairly simple to work with, once you know the parts and their functions. The main components of a disc brake are:

A. Rotor

B. Caliper, which contains a piston

C. Brake pads

Friction between the pads and disc slows the disc down.

a) **Rotor:** Brake rotors are metal discs. It is an important component in the braking system. The caliper clamp on to them to slow their rotation, and then slow or stop the car. The discs of the brake have been conventionally made of pearlitic gray cast iron. It is cheap and has good anti wear properties, cast steel discs also used but drawback in their cases are less uniform friction behavior. Recently ceramics and carbon fiber also used. There are two types of disc brakes:

1. Solid type
2. Ventilated type

b) **Caliper:** Calipers are the housing that contains the pistons and the brake pads. The Calipers are connected to the Hydraulic system, and hold the brake pads to the Rotor. There are two main types of calipers.

- Floating (or sliding) calipers
- Fixed calipers

c) **BRAKE PADS**: Brake pads are a key brake part because they are the component that contacts and applies pressure and friction to a vehicles brake rotors. Brake pads are designed for high friction.

5.4 BRAKE CIRCUIT: In our Brake circuit, the two independent line from the tandem master cylinder is actuated by single pedal for locking the two wheels on front effectively. And also provide another one pedal for locking the rear wheel with drum brake.

6. BATTERY

EVs can be categorised depending on the power source, they are Battery powered electric vehicles(BEVs), Hybrid electric vehicles(HEVs), Plug-in hybrid electric vehicles(PHEVs), Photovoltaic electric vehicles(PEVs) and Fuel cell

vehicles(VCVs). Due to the advancing technology, the rechargeable batteries are been widely used as the major energy sources in EVs. The different types of batteries along with their characteristics are shown in table I.

Table-1: Types of batteries and their characteristics

Battery type	Lead – Acid	Ni – Cd	Ni - Mh	Lithium - ion
Power density	180	150	250-1000	1800
Nominal voltage	2V	1.25V	1.25	3.6
Energy Density	30-50	45-80	60-120	110-160
Overcharge Tolerance	High	Moderate	LOW	Very low
Life cycle	200-300	1500	300-500	500-1000
Operating temperature	-20-60℃	-40-6-℃	-20-60℃	-20-60℃
Self discharge	Low	Moderate	High	Very Low

For the development of the new generation of EVs, the most promising candidate among all the existing battery technologies is the Lithium ion battery. As compared to all other batteries, Lithium ion batteries are superior in terms of high energy efficiency and power design, which makes the EV lighter and smaller in size. Lithium ion batteries also advances in broad temperature range of operation, rapid charge capability, low self discharge rate, long life cycle and no memory effects. Due to these promising features, the lithium ion batteries are already adopted in for commercial purposes in consumer electronics like cell phones, laptops, computers, video cameras, digital cameras, power tools and many other portable devices.

There are different types of Lithium ion batteries which have different energy apacity, which helps in determining the suitability and potentiality in applications. The Lithium ion batteries can be further classified into four types, they are Lthium Cobalt Oxide(LCO), Lithium Manganese Oxide(LMO), Lithium Iron Phosphate(LFP) and Lithium Mixed Nickel-Manganese-Cobalt Oxide(NMC).

Table II shows the classification of Lithium ion batteries along with their specifications.

Table-2: Classification of Lithium ion batteries.

Specification	LCO	LMO	LFP	NMC
Specific energy(Wh/hr)	155	100-120	160	200
Specific Power	1C	10C,40C	35C	10C
Nominal Voltage	3.90V	3.70V	3.40V	3.60-3.70V
Thermal runaway(℃)	150	250	270	210
Operating temprature	Average	Average	Good	Good
Charge limit	4.20V	4.20V	3.60V	4.20V
Life cycle	500	500-1000	1000-2000	1000-2000
Cost	High	Low	Moderate	
Safety	Poor	Average	Very good	Good

7. CONCLUSION

A preliminary design of the electric drive system, which involves estimation of the required battery capacity and motor power, is carried out. It shows that a 700 W motor will be able to drive the car while 48 V batteries with capacity 40 Ah. Thus by using such technologies as presented in this paper will helpful to automotive industry towards electric vehicles.

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