Hybrid Technology-Solar Energy Based Electric Vehicle

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Abstract

Nowadays fuel price is increasing because of the increasing supply of the vehicles used domestically. This has, in-turn rose the global emergency for naturally occurring fuel like petrol and natural gas. Hence, there is a starving need to search and develop substitutes for these fuels in order to preserve the natural minerals for a better and sustainable future. The introduction of hybrid electric machines is capable of reducing carbon, sulfur and nitrogen gas emissions emitting from the fuel. Also, the electric (solar) operated vehicle is an upgraded technology of conventional petrol and diesel vehicles. They provide better efficiency as it draws light on the above problem and provides a new approach by substituting the present models. The new design is a multiple-load vehicle which can be laden with both mechanical and solar energy. The solar energy is used to charge electric batteries, hence providing the sufficient voltage essential for the engine to work. Also, it implements the "electric drive technology" for vehicles as it proposes a controlled strategy for better fuel economy. The paper also highlights the work to assess the energy constraints. This paper would serve as a break-through since it will reduce toxic waste and the expenses also will reduce Global Warming.

1. INTRODUCTION

1.1. Problem and Previous Research

The current market of electric bikes faces the difficulty of slow charging time and low top speed due to the insufficiently powered motors as per the load variations. Also, the mass decentralization due to small wheel-base of the current electric scooters makes the vehicle unstable at high speeds. Previous research highlights the point of easy of commute with moderate range and charging time due to economic constraints. Research is carried out to improve the commutation of the Sensor Brushless DC Motor to better the efficiency by providing more steps of PWM Signal and, thus, having a better jerk-free operation. With high-frequency switching power MOSFETs of the driver, output ensures a smooth, hassle-free operation of the motor.

1.2. Purpose and Contribution

For accounting for the above-mentioned problems, the primary idea of the paper is to encounter the slow recharging time of the battery pack by providing an arrangement of a removable battery through a sliding mechanism, and the battery contacts will be held by magnetic connectors. Swapping of the discharged battery with a charged one will consume time the same as a standard motorcycle. To centralize the mass, the concept of converting a standard motorcycle with electric driven one and thus the prolonged wheel-base helps for the stability of the motorcycle, ensuring higher top-speed at low drag co-efficient and thus improving the efficiency and range[1][2]. The PI controller is operating with open-loop feedback control and with the human feedback control, the motor speed is monitored continuously, and the PWM is modified according to the variable input and ensuring better starting of the motor initially.

Photovoltaic cells energy can be used to harness solar energy to generate a voltage to charge the battery. The battery gives the required voltage to the PMDC motor mounted on the back wheel to run the bike. The use of Solar bikes helps in preventing environmental pollution. Two types of solar panels can be generally used, i.e., poly-crystalline and mono-crystalline solar panels. But the poly-crystalline panels have less efficiency compared to mono-crystalline panels. Also, different types of batteries can be used in Electric vehicles such as lead-acid batteries, lithium ions batteries, nickel-cadmium batteries, etc. Different batteries have different advantages for different applications for a solar-based electric vehicle. Lead-acid batteries have lower cost and higher current load capacity but have less life, and they are heavier, while lithium-ion batteries have

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a high energy density, lower weight but have a higher cost, and there are possibilities of the explosion [3].

2. INDENTATIONS AND EQUATIONS

2.1. Range of Mass:

In order to propel the motorcycle, the motor has to overcome the dead weight of the motor, and thus, the range of mass has to be calculated.[4]

To propel the bike on an inclined surface having 6% gradient, the force to be developed by the motor will be,

$F_{wf} = windage\ and\ friction\ drag$,

$F_d = downhill\ force\ from\ gravity = m\ sin\ sin\ x$

$F_p = Propelsion\ Force = F_{wf} + F_d$

$V_b = motorcycle\ speed$

$P_d = F \times V_b$

Thus for attaining higher top speed, a Sensor Brushless DC Motor is selected.

2.2. Motor Specifications:

The motor is a sensor brushless DC motor will require following specification data

- Power
- Rated Voltage
- Peak current
- Rated Current
- Rated Speed
- No. of stator poles
- Rated Torque
- Peak Torque

$$T_L = T_{em} - \omega B - J_m \frac{d\omega}{dt}$$

$$T_{em} = k_t i_a$$

Where,

$T_{em} = developed\ electromagnetic\ torque\ (Nm)$

$\omega = rotor\ angular\ velocity\ \left(\frac{rad}{sec}\right)$

$B = viscous\ friction\ constant\ \left(\frac{\frac{Nm}{rad}}{sec}\right)$

$J_m = Rotor\ moment\ of\ inertia\ (kg - m^2)$

$T_L = load\ torque\ (Nm)$,

2.3. Battery Specifications:

Powering the motor the low manufacturing cost and ease of replacement draws attention on the use of lead-acid battery.

2.4. Controller Specifications:

The motor commutation in the BLDC motor is implemented by an electronic controller and determines the rotor position and to know when to commutate; the hall sensors are used.

2.5. Solar Panel:

Solar cells are used for the conversion of the power of sunlight proportional to its electrical value by using the PVC effect. The photovoltaic (PVC) effect engages the generation of voltage in electromagnetic (EM) radiation. The photoelectric and photovoltaic (PVC) effects are both associated with the sunlight, but they are different in that the electrons are expelled from the surface of a substance when exposed to the radiation of sufficient energy in the photoelectric, and the electrons generated are shifted to different valence bands—the accumulation of voltage between two electrodes in photovoltaic.

2.6. Voltage Controller:

It is indispensable to normalize the voltage output of the panel of solar plates prior it is applied to the battery. The output of the solar panel is not always stable due to change in the intensity of sunlight, angular changes with respect to the direction of sunlight, as well as other environmental factors. The output power of the voltage regulator is higher than the input power[5]. The amount produced of the solar panel is input to the elevator converter, which would then passes to the battery for charging.

2.7. Charge Controller:

A solar charge controller manages the energy that enters the battery bank from the solar panel. Ensures that deep cycle batteries do not overload during the day and that energy does not run back to the solar panels at night and drain the batteries. Some charge controllers are available with additional capabilities, such as lighting and charge control, but energy management is your main task.

3. FIGURES AND TABLES

Here, the feedback is provided by the human as to increase or decrease the throttle similar to a conventional vehicle.

Considering the motor direction in Counter Clockwise, the commutation sequence of the three phases is given as.

The stepped PWM signal helps in achieving three phase controlled input to the stator terminals of the motor and thus, by feeding the hall sensor data to the controller,

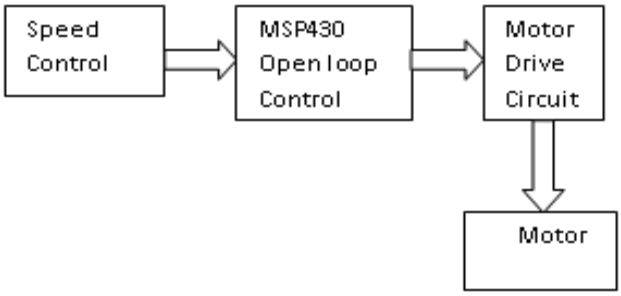

Fig. 1: Block Diagram for Open Loop Control of Sensor Brushless DC Motor.

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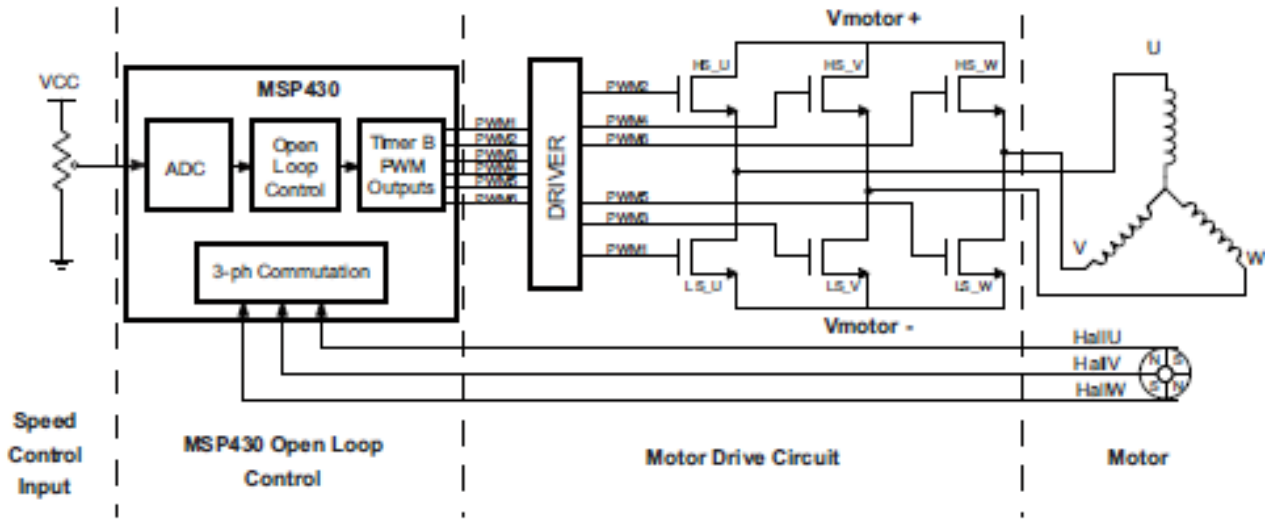

Fig 2: Block Diagram for open loop control implementation.

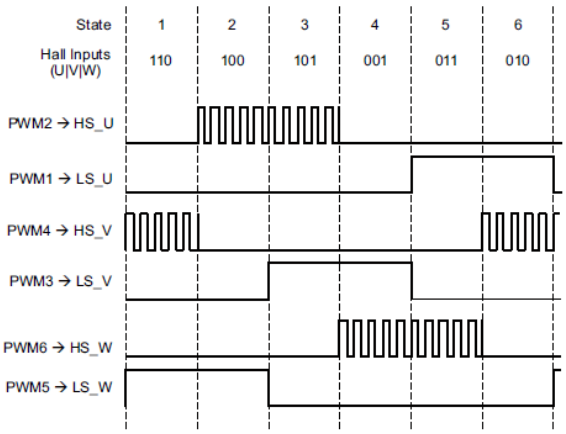

Fig 3: Hall Sensor based commutation for one electrical cycle.

the motor operates as a conventional three phase ac synchronous motor.

By considering the average load of 195 Kg, the acceleration by the motor by giving 100% throttle is given.

4. CONCLUSION

In this paper, the components for hardware testing have been selected for the making of an electric motorcycle as the BLDC motor has 80% of its rated torque initially, which translates into rapid acceleration. Electric bike are particularly useful in city riding because they don't blench smoke into the city air. There is no use of fuel; hence it has low maintenance as well as it is eco-friendly in nature. Limitations of an electric bike are as follows: Power delivery is so linear that there is no 'surge' feeling, which many riders experience in conventional fuel-powered engines. Sometimes, the battery has a short life and long charging time. But this problem is solved with the adaption

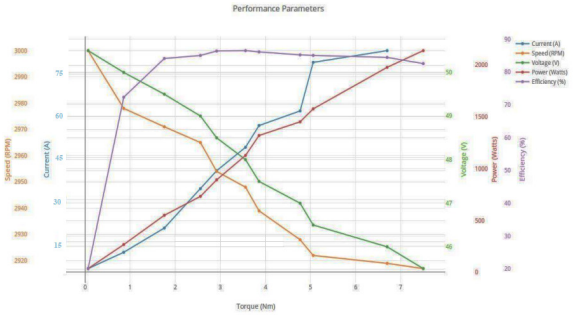

Fig 4:. Performance Parameters of BLDC Motor

of the modular battery pack concept. It can be used by any urban citizen. An electric bike requires no license so anyone can travel a long distance in a short period of time.

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