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ENERGY-REGENERATIVE BRAKING OF BLDC MOTOR BY USING SUPER CAPACITOR

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ABSTRACT:

The electric vehicles are the only future of the sustainable development goal of the world. The pollution in the metro cities has become very severe problem now a day. The pollution is affecting the human health very severely. The global warming despite of very serious issue is increasing continuously. The number of vehicles in countries like India has increased so rapidly in last decade. The pollution due to vehicles has also increased to unavoidable level. The government is taking very positive steps to control the air pollution. Delhi state government has proven the reduction in the air pollution with implementation of the even-odd system. We may not always control the number of vehicles on road but we may reduce the pollution by improving the performance of the vehicles. The electric vehicles are found very suitable with improved performance.

KEYWORDS: Electric vehicle, brushless dc motor, super capacitor, BLDC motor, etc.

INTRODUCTION:

Air pollution being direct affecting on the human health is very severe problem to overcome. Reducing the number of vehicles needs a very strong alternative of the public transport. In coming future the conventional transportation must be replaced by the effective electric vehicle transportation.

Electric vehicles even though have not proven to be very popular, have great future. The factors affecting the popularity of the E-vehicles are the cost and the performance. The major issue with the E-vehicles is the capacity of the batteries to store the energy. The challenge is to control the time required for the charging of the battery. Authors have proposed the charging if battery with the concept of the regenerative braking. The use of the super-capacitors is proposed to achieve the task. The system upon implementation is found fuel saving. Authors have implemented the system with the help of prototype and the results expected were the reduced level of fuel consumption.

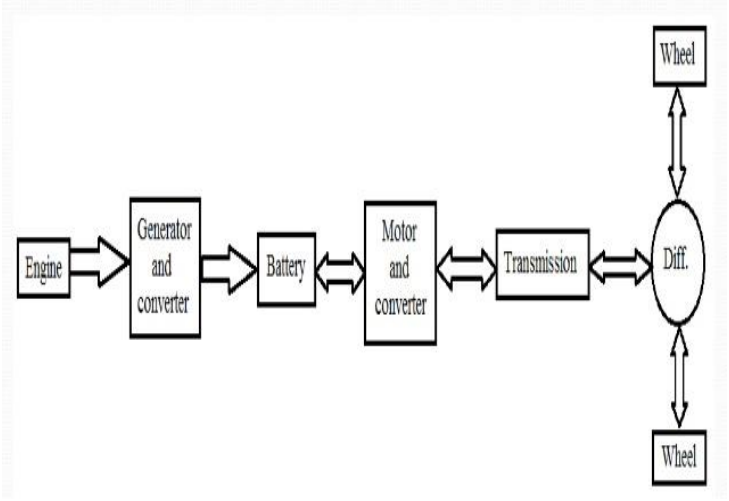

Fig. 1: Basic Block Diagram of E-Vehicle

IMPLEMENTED SYSTEM:

The implemented system is as shown in Fig. 2 below. The BLDC motor is used and controlled with arduino. The system is supplied from the solar energy. Other components such as the converters, battery and super-capacitor are used to build the system. The operation of the motor is controlled with the relays. First relay is switch ON when motor running in motoring mode and at the time of regenerative braking first relay is switched OFF and second relay is switched ON to charge the battery.

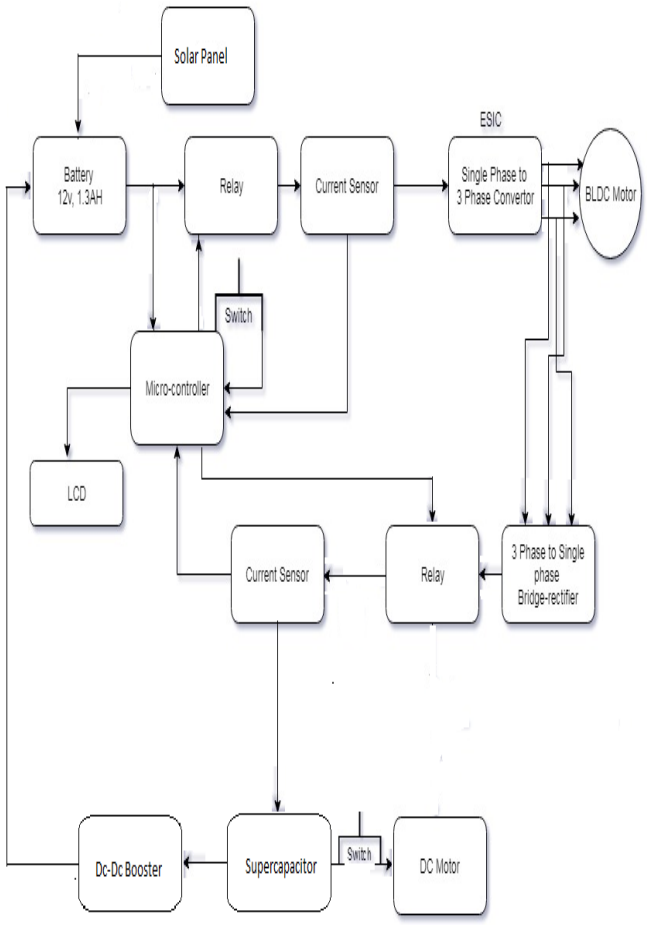

Fig. 2: Block Diagram of the Implemented System

MOTORING MODE:

Motor rotates with the speed near to 14000 rmp. The current sensors are used to sense the current. The energy is supplied by the battery to the motor.

BRAKING MODE:

During braking mode supply to BLDC is switched OFF. But due to inertia motor continues to rotate at high speed at these instant motor works as a generator and generates voltage spikes. These generated voltage spikes are stored in super-capacitor through single phase to three phase bridge rectifier. The stored energy in super-capacitor is used to charge battery through DC-DC Booster. Also DC motor as a load is connected across super-capacitor to check whether charge is stored in capacitor or not.

TOTAL TIME REQUIRED FOR BATTERY CHARGING:

Battery voltage=12v
Battery current=1.3AH
So we need to charge full battery.
Solar panel rating=
Solar panel voltage=16.4V
Solar panel power =10W
so, solar panel Amp=solar panel watt/solar panel voltage
=10/16.4
=0.60A
Therefore solar panel give 0.60A per hour and our battery is needed 1.3A,
Time for charging full battery is=2.16hrs.

MOTOR RATINGS:

BLDC motor voltage=12V BLDC motor has required less current and high voltage. So, its speed is very large but torque is less.
BLDC motor=1400kv It's not an voltage related term but it's an rpm. 1V=1400rpm

12V=12*1400 =16800rpm

SUPER CAPACITOR RATINGS:

E=1/2*c*v*v
Our each capacitor is 100F.
C=100/3 =33.33F
V=2.7V
E=0.5*33.3*2.7*2.7 =121.37J

OBSERVATIONS:

Battery of 12 V was used to connect to the motor. Every motor need high starting voltage and power. But at the end when motor off that initial energy required to start motor is waste. It means the motor is working as a generator. This energy is used to charge the batteries.
Let see it from calculation: Initial voltage=12V
Initial current=1.3A (assume for only 1sec)
So, total power given to motor=V*I
=12*1.3
P1=15.6Watt
After regeneration, how many power store in super capacitor
Super capacitor voltage after motor off=2.9V
Current=6.9
So, total power=2.9*6.9
P2=17.69Watt
So, it is prove that P1<P2.
From that we conclude that after regeneration we get power which use for starting the motor

CONCLUSION:

The conventional braking of the vehicles is based on the friction. This energy during the brake implementation is naturally wasted and hence the regenerative braking system has great potential to save

the energy. This paper presents the overview and basic calculations of the regenerative system implemented for the prototype of the electric vehicle. The proposed system is very useful for improving the performance of the electric vehicles.

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