NEW TECHNOLOGY FOR ELECTRIC VEHICLES

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ABSTRACT

In world more than 60% petroleum is consumed by vehicles. Global warming, air pollution, rising price of gasoline fuel are the key issue of 21st century. Electric Vehicles (EVs) segment has gained importance in world. Every nation is looking into alternative options of energy efficient transportation solutions. Electric vehicles are the only alternative for clean, efficient and eco friendly urban transport system. Electric vehicles are being popular across the world but they are having some problems associated with driving range, energy storage system and stored energy management. This paper presents a new strategy of energy management between battery and supercapacitors, renewable approaches to generate the electricity, new speed-torque control approach and an energy management system for electric vehicles. The main contribution of this paper is focused on improvement in torque performance and range extension of an electric vehicle.

Keywords: Driving range, Energy storage system, Energy management system, Global warming and Supercapacitor

I INTRODUCTION

Electric vehicle plays a major role to reduce global warming and keeps the people healthy. In many developing countries like India petroleum is imported at very large scale and very high subsidy is provided by government to the people, which cause losses of economical growth. Awareness of electric vehicle among people of such countries can decrease the need of petroleum which will defiantly grow up economy. Electric vehicle are two times more fuel efficient than any gasoline powered vehicle. Even assuming generation is being taken from coal fired plant. Swatch Bharat mission and smart cities projects can't be completed without the EVs. Electric vehicles are mainly used in urban areas and are eco friendly and highly efficient. As the electric vehicle become more popular and they will play very imported role to manage the demand from smart grid. World second large populated country is waiting for efficient electric vehicle opportunities for engineers and scientist to accept the challenge of time and provide a better solution for future shortage of petroleum.

Presently electrical vehicles are having so many problems associated with its battery, speed range, main reason of small driving range is the lack of capabilities of storing sufficient energy to run the vehicle for a long time batteries are used for storage system and energy storage capabilities are very poor of batteries as compare to conventional fuel used in modern vehicle.

- They are only charged by plug in charging methods.
- EVS have very poor torque and speed performance.

- A proper energy management system is needed to control the energy uses, every single watt of stored energy have importance in electric vehicle.

This paper attempts to explain innovative methods of controlling speed and torque and generating clean energy in a fast moving electric cars, electric bus, electric motorcycles and also equally applicable for all type of hybrid electric vehicle. This paper also explains hybrid energy storage system which stores energy which is generated during regenerative breaking. In order to increase the driving range of EV with a fixed amount of saved power, other approaches should be developed to generate power in running vehicles. Electric vehicles (EVs) include electric trains, electric buses, electric aircrafts, electric boats, electric motorcycles or even electric spacecrafts etc. Now a day's electrical vehicle consist simple technology which is shown in following block diagram:-

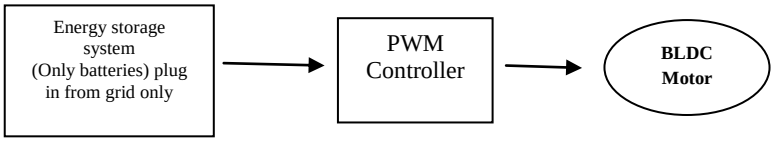


Fig.1 Present Electric Vehicle Technology

Brushless Direct Current (BLDC) motors are one of the motor types rapidly gaining popularity. As the name implies, BLDC motors do not use brushes for commutation; instead, they are electronically commutated. Their linear speed/torque characteristics produce predictable speed regulation. With brushless motors, brush inspection is eliminated, making them ideal for limited access areas and applications where servicing is difficult. BLDC motors operate much more quietly. BLDC motor of the hub type is widely used in the electrical vehicles. Electric Vehicle uses battery as one of its power source for vehicle motion during at low power conditions.. Generally batteries are of two types:

- Primary batteries that are disposable and secondary batteries that are rechargeable.
- Secondary batteries are preferred for vehicles as they can be rechargeable.

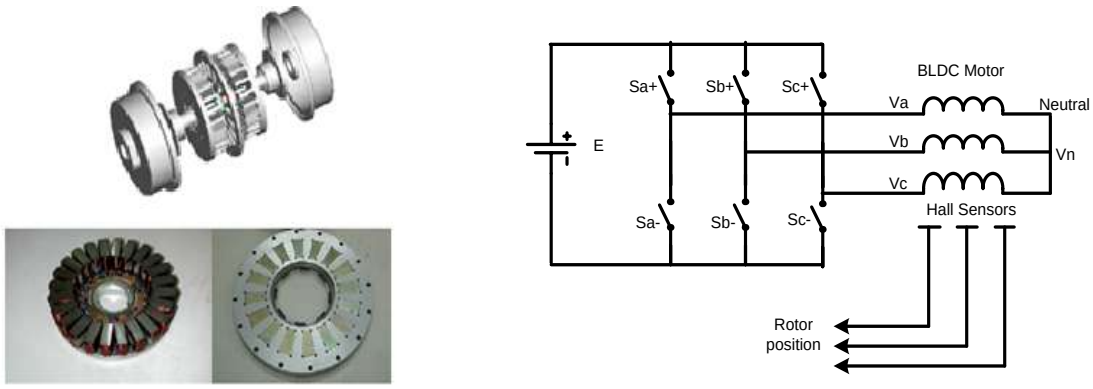


Fig. 2 Wheel motor assembly and typical structure of a BLDC motor connected to an inverter.

The first section gives the introductory idea about the paper. The second section of the paper gives ideas about the different approaches to generate electricity in electric vehicles. Third section deals with speed and torque control.

Fourth section gives idea of energy management system. Results of the experiment are discussed in the third section. The final section presents the conclusion.

II. ENERGY STORAGE SYSTEM

In order to increase the driving range of EV with a fixed amount of saved power, other approaches should be developed to generate power in running vehicles. Electric vehicles (EVs) include electric trains, electric buses, electric aircrafts, electric boats, electric motorcycles or even electric spacecrafts etc. This paper attempts to explain innovative methods of generating clean energy in a fast moving electric cars, electric bus, electric motorcycles and also equally applicable for all type of hybrid electric vehicle.

If other sources are found to support the charging of batteries to run any of above mention electrical system by some other source it will improve the range of EVs. It can significantly observe that the instantaneous power required is highly vary during uphill and downhill path or vehicle going through speed breaker or improper road [2].

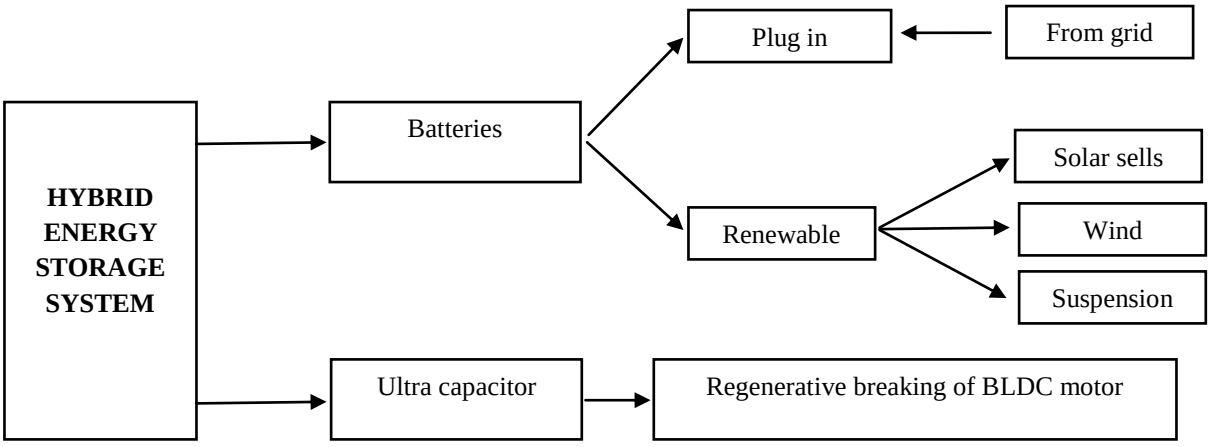


Fig.3 Energy storage system and charging structure

There are various methods to generate the electricity in running EVs. Condition for implementing any technology to generate electricity in EV is addition of initial cost and maintenance cost always should be less then cost saved after implementing technology.

2.1 Solar Powered Electric Vehicle

Designing a Solar Powered BLDC Motor Driven Electric Vehicle is one of the solutions for the improving range of an electric vehicle. The integrated system consisting of the solar module, boost converter, charge controllers, batteries and BLDC motor drive. In order to achieve the required voltage for charging the batteries, the Photo voltaic (PV) Module may be connected either in parallel or series. Thus to make it cost effective; power converters and batteries are been used. The electrical charge is consolidated from the PV panel and directed to the output terminals

to produce low voltage (Direct Current). By implementing enough pv cells large amount of energy can be generated which will help for outdoor charging of vehicle.

2.2 Wind Alternator

If this wind energy is used to extract some power in such a way that it does not create any component of force or thrust opposite to the direction of the propulsion of the vehicle, then this gained energy can be used to produce electricity to charge up the battery of the electric vehicle itself. In three-wheelers, four wheelers we can use it very easily.

2.3 Regenerative Breaking

The brushless DC motor has been widely used in EVs. Conventional EVs use mechanical brakes to increase the friction of the wheel for deceleration purposes. Thus, the braking kinetic energy is wasted.

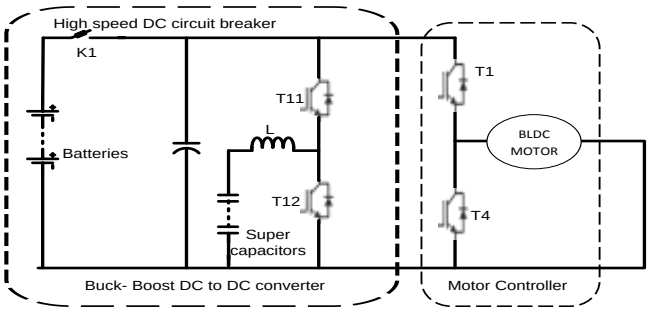


Fig.4: Regenerative Breaking in brushless DC motor

With this problem in mind, this paper will discuss how to convert the kinetic energy into electrical energy that can be recharged to the supercapacitors. As a result, regenerative braking can realize both electric braking and energy savings.

Vehicle + driver mass = Total weight

Kinetic Energy: KE = ½ mv2 (m is mass in kg, v is velocity in m/s)

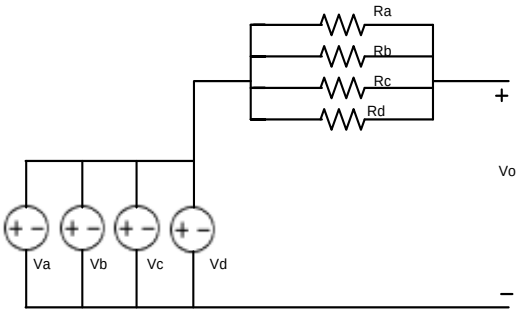
Capacitor Energy: ECAP = ½ CV2 (C is capacitance in Farads, V is capacitor voltage in Volts)

Capacitor Charge: QCAP = CV (C is in Farads, V is in Volts, Q is in Coulombs)

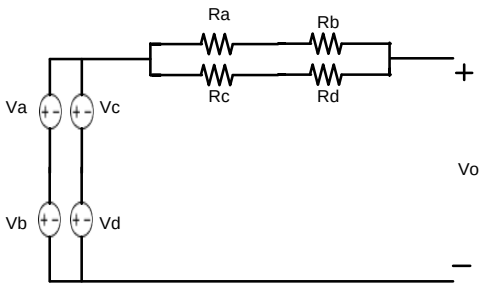
III. SPEED AND TORQUE CONTROL CIRCUIT

Electric vehicles are composed of batteries, a wheel motor and its electronic drive. has been invented in this research which will be similar to the multi-gear transmission of conventional ICE vehicles. These speed and torque control is formed by various combinations of batteries and stator windings connected in serial and/or parallel configurations. From electrical circuit law, when the BLDC motor operates at the stage of low-speed and high-torque (during starting of vehicle), all four batteries are connected in parallel and the stator windings are connected in serial so that the partial voltage on windings is low, allowing a higher current which will produce a higher torque. When the

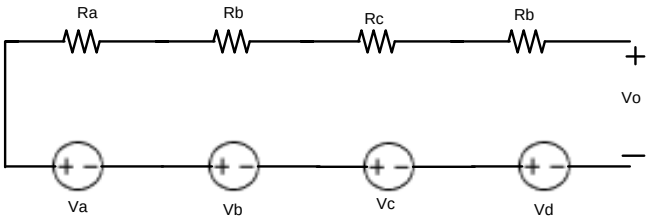
motor operates at the stage of high-speed and low-torque (normal running), the batteries are then connected in serial to achieve high voltage and the stator windings are connected in parallel to distribute the main current into branches. A novel electronic gearing is proposed in the propulsion system for an electric vehicle driven directly by a wheel motor. This electronic gearing assembles the parallel and serial connections of batteries and motor windings into three modes to accommodate various driving patterns in the permissible range of speed and torque.



Mode I



Mode II



Mode III

Fig.5 Battery connection modes

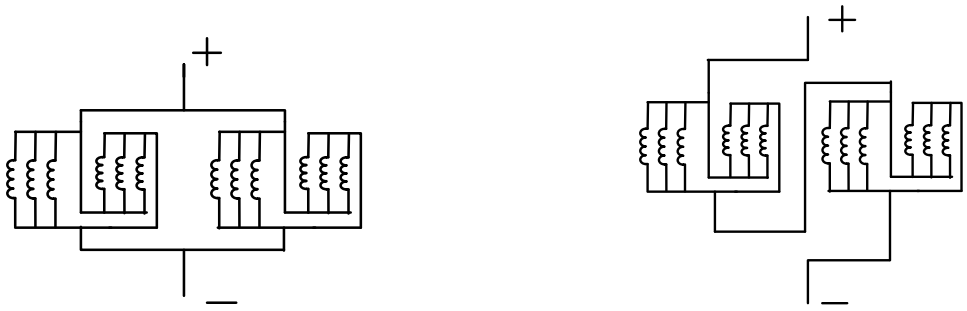


Fig.6 Serial (right) and parallel (left) winding

The objectives of this invention are to extend the speed range of constant power, as well as to improve the driving performance and efficiency of the vehicle. Fig shows the configuration of a four battery connection consists of three modes: 4-in-parallel, parallel of 2-in-series, and 4-in-series, as shown in Fig. The internal resistances, capacities and terminal voltages are respectively denoted by Ri, Ai and Vi, where i = a ,b ,c ,d . The series and parallel connection of battery have been successfully invented and implemented on electric vehicle extending the range of constant and improving the efficiency of the propulsion system. Each mode of battery connection has its best range of speed, torque and efficiency that determine a proper shift point between two adjacent modes.

Voltage and current in all modes are given in the table:-

Modes	Voltage	Current
I	Vo=Va=Vb=Vc=Vd	A=Aa+Ab+Ac+Ad
II	Vo=Va+Vb=Vc+Vd	A=Aa+Ac=Ab+Ad
III	Vo=Va+Vb+Vc+Vd	A=Aa=Ab=Ac=Ad.

Table.1 Modes voltage and current

IV. ENERGY MANAGEMENT SYSTEM

Energy source models and a new control EMS is introduced for light electric vehicles for next-generation transportation. The logic sequences of the vehicle's EMS under the operating control strategy directly influences the energy harvesting of the light electric vehicle from the three renewable sources and energy saving as much as possible. The EMS controls all of the energy sources that have different tasks in delivering power to the load. The battery is the main energy source of electric vehicle.

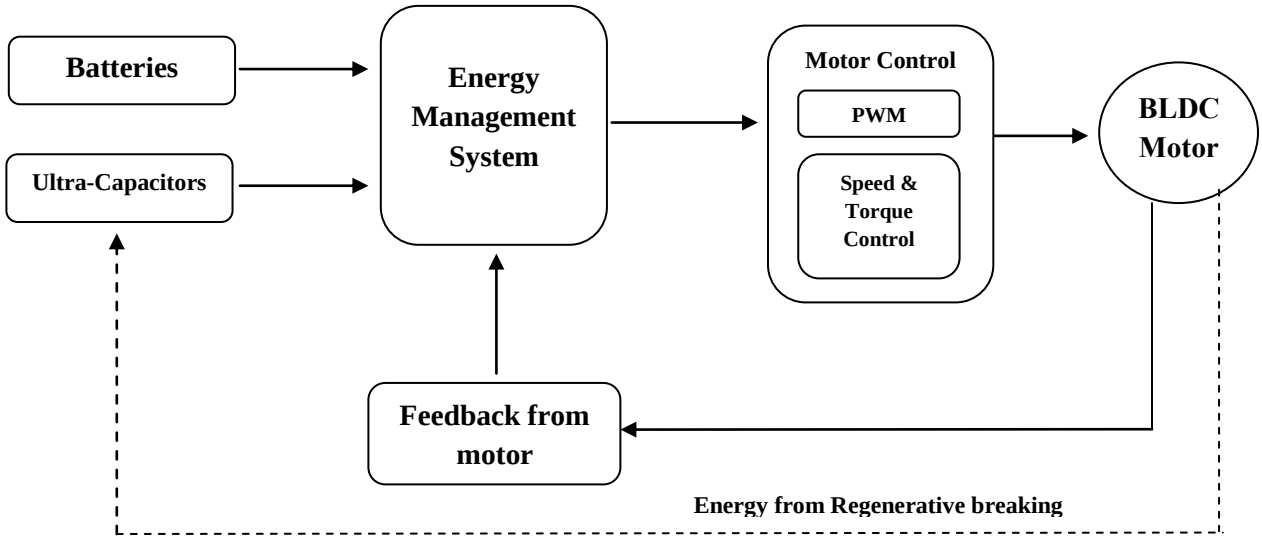


Fig.6 Energy Management System

Once the vehicle is started, processors determine the battery capacity, supercapacitor voltage level and load. Then, based on the control algorithm, the EMS determines which energy sources should be activated. The battery also functions as a storage device that receives charges from the renewable or through plug-in.

The feedback control system regulates the vehicle system to follow the control strategy in the EMS. Two feedback measurements, the battery and the vehicle speed, are used to calculate the demand of the system and calculated demand is supplied to the motor. The battery is the main source, supercapacitor is used as supportive source which is

used during high speed/torque demand. The main function of the developed control strategies is to support the EMS of the battery and Supercapacitor under different load conditions. The optimal use of the EMS is energy saving with pure electric driving and motor-assistance and the battery charging cost, which counterbalances the use of electric energy. The logic sequences of the vehicle EMS under the operating control strategy directly influences the energy harvesting of the light electric vehicle from the three renewable sources. In this paper, an overview of different energy sources and a new EMS is introduced for light electric vehicles for next-generation transportation.

V. FULL OPERATION

Full operation of vehicle is as given below:

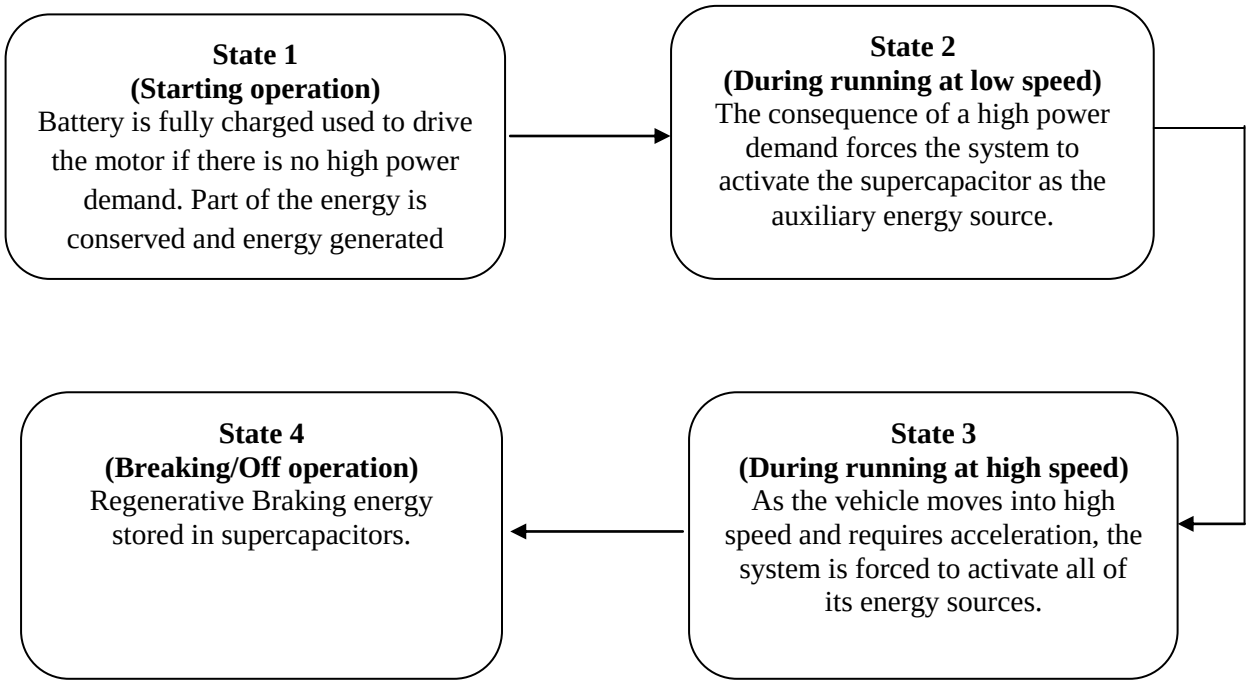


Fig.7:- Load and EMS

VI. CONCLUTION

Torque and speed control circuit and energy management system has been introduced and implemented on the electric vehicle which extending the driving range and improving the efficiency of the propulsion system. Each mode of battery connection has its best range of speed, torque and efficiency. At the same time operation of electric vehicles will become like ICE vehicles driving smoothness and comfort. The test result shows that the driving range is increased by 30% over the same vehicle without torque and speed control circuit, energy management system. In the field of automobile sector, this kind of experiment is new. By implementing this system on an automobile, the fuel efficiency of an automobile increases without hampering environment. More research may be necessary for the determination of the number of modes, shift points and the real road test on the driving range.

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BIOGRAPHICAL NOTES

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