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ENHANCEMENT IN THE MODELLING OF BRAKING SYSTEM WITH REGENERATIVE METHOD USING ULTRA CAPACITOR FOR AN ECO VEHICLE

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Abstract:- This paper refers to an useful and effective method of regenerative braking with a bank of supercapacitors in a electric vehicle is proposed. In this method instead of wasting the energy during braking, the energy can be restored with the help of ultracapacitors and can be reused. The present study is focused on braking method of eco vehicle with the sources of energy-battery, BLDC motor, Buck-Boost converter and supercapacitors. The ultracapacitors is racially balanced with the battery in an eco vehicle using Buck-Boost converter to improve the battery life and to increase the dynamic performance of the vehicle. When the brake is applied the rotor rotates in reverse condition and hence the kinetic energy can be converted into electric energy and thus the wasted energy is stored in ultracapacitors and given to the battery with the help of DC-DC converters. The simulation is done with the use of MATLAB/simulink.

Keywords- Electric vehicles, regenerative braking; Brushless DC motor; inverter; battery; ultra capacitor; Buck-Boost converter;

I. Introduction:

Electric vehicles are becoming the need of the hour as the atmospheric pollution caused by the conventional Internal Combustion (IC) engine vehicles is alarming. The use of Electric Vehicles (EV's) has increased widely. Most EV's are driven by energy accumulated in a battery and the main challenge is to use the battery's energy productively. The shortcomings of the battery are limited life-cycle, limited power density and high cost. The Electric double layer capacitors which is also known as supercapacitors, are high capacitance capacitors that has many outstanding features such as high power density, long life-cycle, and it has wide operating range[1].Supercapacitor cannot be used as the main Energy Storage System (ESS) as its energy density is relatively low even though the supercapacitor has many benefits.

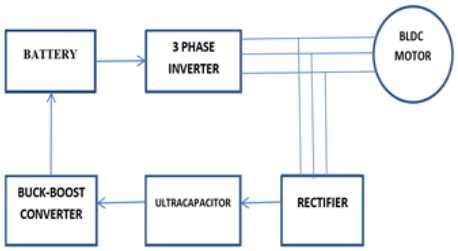
Brushless dc (BLDC) motors have simple structure, high efficiency, high dynamic response, higher speed range, large starting torque, noiseless operation[2], when compared to brushed dc motors and induction motors. Thus BLDC motors have many application in EV's.The energy wasted during braking can be harvested effectively using regenerative braking in EV's than the traditional vehicles with IC engines.

Buck Boost converter is a type of DC to DC converter which has a magnitude of output voltage. The output voltage is more or less than equal to the input voltage magnitude. The buck boost converter is equal to the fly back circuit. There are two types of converter buck converter and boost converter.

II. BRAKING SYSTEM:

In this paper based on stopping time and energy regeneration a new electric braking system is proposed for a brushless DC motor driven electric vehicle(EV) .This new electric braking system is developed by combining various regenerative methods and plugging. The performance measures such as boost ratio, braking torque, and maximum conversion ratio; stopping time and energy recovery for various methods are studied for different running conditions .From the experiment it is observed that the stopping time is less for plugging and increases in the order of two, three and single switch method. In addition to that for single and three switch method energy recovery is better. Based on these performances, all the regenerative braking methods including plugging and switch among themselves based on the brake pedal depression are combined and a new braking strategy is proposed. The important parameter is the range(driving range) of the EV which is the distance travelled by the vehicle per charge .The main objective of the EV manufacturer is improving the range. The range can be improved by increasing the efficiency of the overall components such as motor, power converter, and battery .One of the methods to increase the range is regenerative braking .In regenerative braking the range can be improved by charging the battery from the energy available during braking.

During regenerative braking the energy is send back to the battery by combining the vehicle inertia with power electronic converters which makes the motor to act as the generator .These studies shows that the driving range can be improved by 8–25% using regenerative braking .Various methods are used to achieve regenerative braking in EV .The regenerative braking is achieved using additional DC-DC converter.

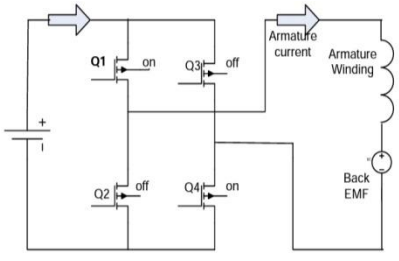


The DC-DC converter which boosts the back electromotive force (back-EMF) to the appropriate level to charge the battery. This method has an extra converter which increases the cost and weight of the system. The regenerative braking is achieved using ultra capacitor connected either in series or parallel with batteries .With the help of additional converters the ultra-capacitor stores the regenerative energy surge and sends it back to the battery. This method also increases the cost and weight of the overall system. Regenerative braking can also be achieved using electronic gear shift technology in which the electronic gear forms different serial and parallel connections of batteries, motor winding, and ultra-capacitor based on vehicle speed to recover regenerative energy. This method requires specially designed motors with multiple switches, multiple windings ,and various battery connections .However, a complex switching topology has to be developed for implementation[3].

III. MODES OF OPERATION OF REGENERATIVE BRAKING

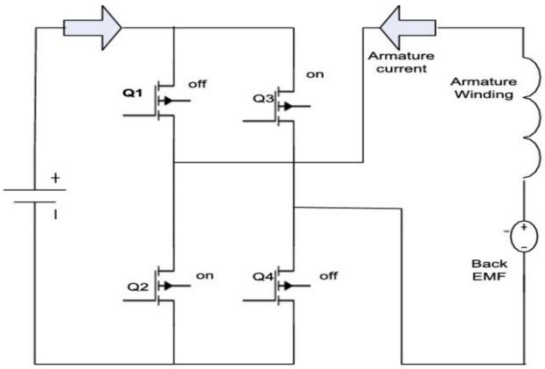
DRIVING MODE:

This figure shows the driving mode of electric vehicles. The armature current flows through the positive side to negative side of source battery. The diode is connected in parallel with every MOSFETs. The diode is used as a freewheling diode such for that PWM can be useful to switch devices, thus the efficiency of system is improved.



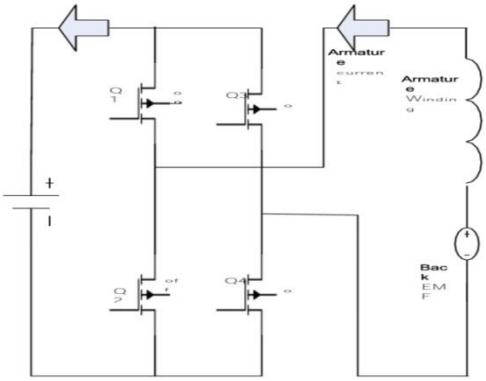
INITIAL BRAKING MODE:

When the vehicle is in motion and when brake is applied it switches to braking mode. The braking mode is converted in two types of conducting stages. During first stage of brake the back emf and battery which goes in series condition. In this type Q2, Q3 are switched on and Q1,Q4 are switched off. This changes the direction of armature current easily.



REGENERATIVE BRAKING MODE:

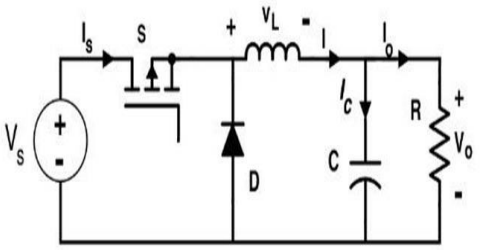
In first stage of initial braking mode, to change the direction of armature current, the back-emf and the battery goes in the series connection as shown in figure. In this mode of initial braking, Q2 and Q3 are switched on and Q1 and Q4 are switched off . Thus the armature current changes its direction automatically. When armature current increases and changes the direction itself, the state of MOSFETs will come back automatically to its position as shown in figure and battery will get charged automatically. This is how regenerative braking get implemented[10].



IV.BUCK BOOST CONVERTER:

In recent years several types of buck boost converters are used. A buck boost converter combining KY and buck converters has a positive output voltage and no right-half plane zero, the voltage gain is low and this converter can be only used in low power systems.A single-switch Buck-Boost converter is discovered

recently which is presented in[5].In new single-switch Buck-Boost DC-DC converter the drawback is float output voltage. In quadratic Buck-Boost converter in which two floating power switches are utilized as a result, two floating gate drivers are required which increases the cost .In a novel quadratic Buck-Boost DC-DC converter without floating gate-driver in which the drawback is output voltage[6].In this paper ,we propose a transformer less Buck-Boost converter with wide conversion ratio. In the proposed converter only one switch is used .In this method, high step- up voltage gain can be obtained without extreme duty cycle.



Figure(2)Block Diagram of Buck-Boost converter

Figure (2) shows the block diagram of the buck boost convertor in this method the transformer is replaced by an inductor.

The two operating states of buck-boost converter are,

- ON State
- OFF State

The input voltage supplies current to the inductor and the capacitor supplies current to the output load(resistor) during ON state.The inductor is connected to the resistor and capacitor so energy is transferred from L to C and R during OFF state. The polarity of the output voltage is opposite to that of the input voltage that is either greater than or less than that of the input voltage[4]. Instead of a transformer by using a single inductor it is analogue to the flyback converter. This is the switched mode power supply with a similar circuit topology to the boost converter and the buck converter. The output voltage is based on the duty cycle of the switching transistors. The range of output voltage can vary without interruption from 0 to infinity. Photovoltaics and fuel cells needs power electronic devices as DC-DC converter which are the examples of harvesting renewable energies[7],[8].The responsibility of these converters are highlighted in view of their utilizationin industrial and domestic applications[9].

V. FOREMOST USE OF ULTRA CAPACITOR:

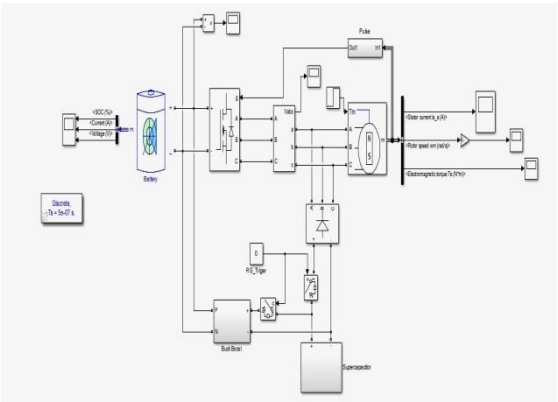
Ultra capacitor plays a indispensable role in entire system, so that new mechanization have such abilities to control them, In super capacitor system, the predominal contents are Buck-Boost conveter, Metal Oxide Semiconductor Field Effect Transistor[MOSFET], Smoothing aluminium inductor Ls, ultra capacitor and battery pack. During acceleration, the capacitor voltage of super capacitor officially allows to set free from packed rate charge to one-third its ceremonial voltage. During deceleration, the vivacity of capacitor which is liberated during acceleration period is upgraded back and charge up the super capacitor. Super capacitor is mainly used because it stores upto 20-80 times higher energy as assess to electrolytic capacitor as shown in figure (1). Ultra capacitor also develops the transient performance in electric vehicle which correspondingly increases the lifespan of batteries. Ultra capacitors improve the load balancing when used in parallel with battery. It also provides a peak power and a backup power supply to the electric vehicles which also enlarges the distance.

VI. PROPOSED WORK:

The system and block diagram of ultra capacitor based regenerative braking is shown. The matlab simulation of eco vehicle consists of different blocks. In this technique the battery and the ultra capacitor are connected in parallel. At first the vehicle is at running condition. When the driver applies the brake at that time some of the kinetic energy produced is stored in the battery and remaining charges are stored in the ultra capacitor. For controlling this a dc-dc controller is designed. The controller decides whether the battery is fully charged or partially charged. Thus the boost converter is to increase the speed while the buck converter is used to decrease the speed which will help in charging the capacitor.

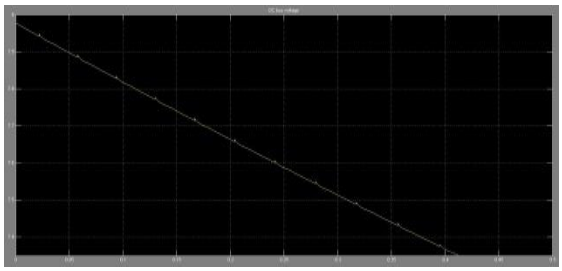
VII. SIMULATION RESULTS:

The MATLAB Simulink model for regenerative braking of brushless dc motor is exhibited in the figure.

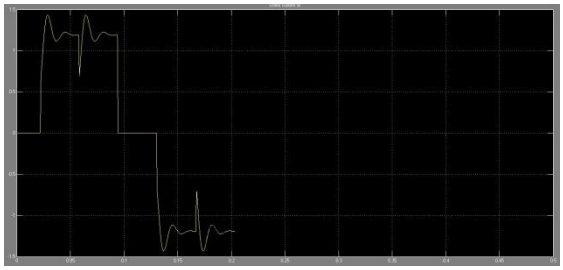


The supercapacitor voltage,current and State of charge(SoC) waveforms can be come to the conclusion that till the brake is applied.Upto 15sec simulation time

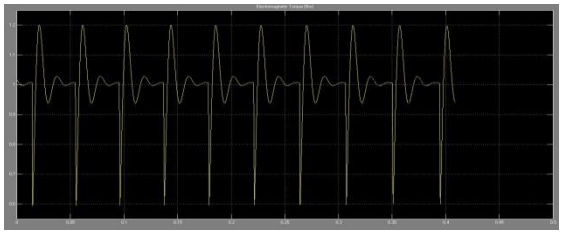
the supercapacitor current is zero and the voltage,SoC said to be in constant.The voltage and SoC increases and also current is negative during the regenerative braking mode which indicates the charging of supercapacitor.During normal mode of operation the current flow in the circuit is towards the load and after regeneration the current flow is towards the battery-supercapacitor energy storage.(i)The graphical representation for DC bus voltage is shown below



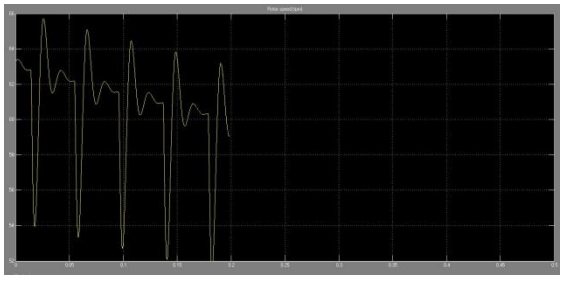
(ii)The graphical representation of stator current, ia is shown below



(iii) The graphical representation of Electromagnetic torque(Nm) is shown below



(iv) For the rotor speed(rpm) the graphical representation is shown.



The ratings and specifications is shown in the table(1)

Table(1):Specifications

Components	Specification
Capacitance	6800 microfarad
Voltage	100V
Connection	Parallel

VIII. RESULT:

Thus the enhancement in the modelling of braking system with regenerative method using ultracapacitor for an eco vehicle is obtained.

IX. CONCLUSION:

The ultra capacitor based regenerative braking is one of the most important system in eco vehicles. The regenerative braking has the capacity of saving the dissipated energy upto the range of 8-25%. The regenerative braking system has been improved by the latest technologies of power semiconducting devices, are ultra capacitor, Buck-Boost converter. The research says that the regenerative brakes are already implemented in most of the electric vehicles. Due to the rise in petrol cost progess in energy conservation is required hence this method is implemented which improves the fuel consumption by 33%.

REFERENCES:

[1] E.R.Aswathi, P.K.Prathibha, Jayasri R.Nair. "Regenerative braking of BLDC Motor using fuzzy control for electric vehicles",2018 second International Conference on Inventive Communication and Computational Technologies(ICICCT),2018.

[2] Y N Wang, X Z Zhang, X F Yuan. "Hybrid non-singular terminal sliding-mode controller design for an electric vehicle system with a brushless d.c.motor", Proceedings of the Institution of Mechanical Engineers, Part I:Journal of Systems and Control Engineering,2010.

[3] A.Joseph Godfrey, V.Sankaranarayan. "A new electric braking system with regeneration for a BLDC motor driven electric vehicle", Engineering Science and Technology an International Journal,2018

[4] D.Mahalakshmi, V.S.Archana, J.Komathi. "Reactive power control in microgrid by using Photovoltaic generators",2016 International Conference on Computation of Power, Energy Information and Communication(ICCPEIC),2016.

[5] Ajami, H. Ardi and A. Farakhor, "Design, analysis and implementation of a buck-boost DC/DC converter", IET Power Electronics, vol. 7, no. 12, pp. 2902-2913, 12 2014.

[6] S. Miao, F. Wang and X. Ma, "A New Transformerless

Buck-Boost Converter With Positive Output Voltage", IEEE Transactions on Industrial Electronics, vol. 63, no. 5, pp. 2965-2975, May 2016.

[7] C.T. Pan and C. M. Lai, "A High-Efficiency High Step-Up Converter with Low Switch Voltage Stress for Fuel-Cell System Applications," IEEE Transactions on Industrial Electronics, vol. 57, no. 6, pp. 1998-2006, June 2010.

[8] S. K. Changchien, T. J. Liang, J. F. Chen and L. S. Yang, "Novel High Step-Up DC-DC Converter for Fuel Cell Energy Conversion System,"IEEE Transactions on Industrial Electronics, vol. 57, no. 6, pp. 2007-2017, June 2010.

[9] T. LaBella, W. Yu, J. S. (. Lai, M. Senesky and D. Anderson, "A Bidirectional-Switch-Based Wide-Input Range High-Efficiency Isolated Resonant Converter for Photovoltaic Applications", IEEE Transactions on Power Electronics, vol. 29, no. 7, pp. 3473-3484, July 2014.

[10] Y. Xiao, M. Nemec, L. J. Borle V. Sreeram, H.H.C IU, "Regenerative Braking of series- Wound Brushed DC Electric Motors for Electric Vehicles" IEEE, 2011.