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A REVIEW ON STUDY AND ANALYSIS OF HYBRID ENERGY STORAGE SYSTEM

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Abstract: Significant distance perseverance and guarantee the minimization of a cost work for electric vehicles, another cross breed energy stockpiling framework for electric vehicle is planned in this paper. For the hybrid energy store system, the paper proposes an ideal control calculation planned utilizing a Li-particle battery power dynamic restriction rule-put together control based with respect to the SOC of the super-capacitor. Simultaneously, the attractive reconciliation innovation including a second-request Bessel low-pass channel is acquainted with DC-DC converters of electric vehicles. Therefore, the size of battery is decreased, and the force nature of the cross breed energy stockpiling framework is improved. At long last, the viability of the proposed strategy is approved by recreation and examination.

Keywords: Hybrid energy storage system, electric vehicles, DC-DC converter, power dynamic limitation.

I. INTRODUCTION

Because of the contamination brought about by petroleum product, new energy sources have been persistently developed[1-2]. These days, implanted energy stockpiling frameworks in current age electric vehicles are generally founded on the Li-particle batteries which, with high energy thickness, can give significant distance perseverance to electric vehicles. While contrasted with the super capacitor, the reaction of Li-particle batteries is more slow than that of super capacitors[3-4]. Thusly, so as to make electric vehicles practically identical to fuel vehicles concerning quick transient quickening, energy, and significant distance perseverance, a half breed energy stockpiling system(HESS) comprising of Li-particle batteries and super-capacitors is applied to electric vehicles[5]. For the improvement of electric vehicles, upgrading the energy stockpiling gadget is basic, and it is important to consider expanding the limit of the battery, while lessening the size and weight of the battery to build the charging rate[6-8]. DC-DC converters which assume a significant part in cross breed energy stockpiling framework have been created quickly throughout the long term. Through a progression of developments, a assortment of DC-DC converters are proposed. Another zero Voltage Switch (ZVS) bidirectional DC-DC converter is proposed in [9], which has great controllability to improve change effectiveness, however isn't appropriate for electric vehicles because of the unpredictable control and higher cost. It has been demonstrated a segregated bi-directional DC-DC converter[10] with complex structure can convert an enormous force transmission. Another zero-swell changing DC-to-DC converter with the coordinated attractive innovations is first proposed in [11-12] by S.Cuk, and the application is fruitful.

II. TOPOLOGY OF HYBRID ENERGY STORAGE SYSTEM

Made out of DC/DC converter, super capacitors and the Li-particle battery. DC/DC converters comprise of four IGBT switches T1~T4 and its relating diode (included battery) tube D1~D4, and a coordinated attractive structure — self inductance L1 、 L2 and common inductance M, which share a center inductors. The battery pack gives capacity to the smooth DC engine. The super capacitor manages the immediate condition of pinnacle power gracefully. The force the executives arrangement of electric vehicles decides the electrical energy stream as per the heap request. The converter has five fundamental working modes (mode because of the extra battery pack change). Table 1 shows the particular activity method of half breed energy

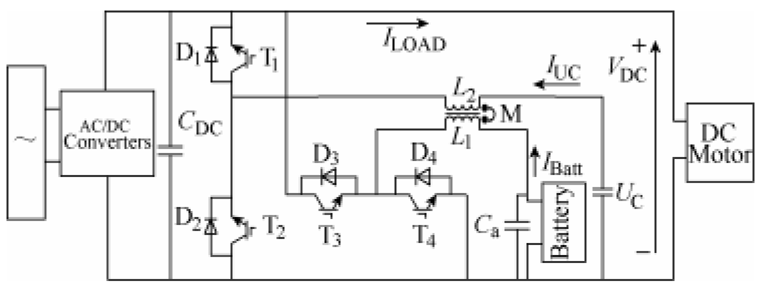


Fig.1 Topology of the hybrid energy storage system

III. DESIGN OF THE DC/DC CONVERTER WITH INTEGRATED MAGNETIC STRUCTURE

Magnetic elements such as inductors, are the main components of energy conversion, filtering, electrical isolation and energy storage. The size of the magnetic element is a major factor in determining the size and weight of the converter. To achieve the integration of magnetic elements, an E-type magnetic core is used in this paper. Herein, a coupling inductance (L1 and L2) is used. As shown in Fig.2, L2 as the output filter inductor, L1 as the external inductance, and Ca as additional capacitance. In the

Table 1 The operation mode of hybrid energy storage system

Working mode	Power source	Power flow	Operation mode
Parking charging mode	AC power	Battery and super capacitor	Buck
Constant speed mode	Battery	DC	Boost
Acceleration mode	Super capacitor	DC motor	Boost
Braking mode	Braking energy	Battery and super capacitor	Buck
Super-capacitor charging mode	Battery	Super capacitors and DC motors	Boost or buck

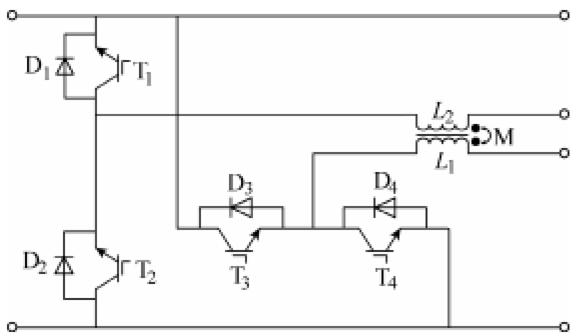


Fig.2 Topology of DC/DC converter with integrated magnetic structure

IV. CONTROL STRATEGY OF HYBRID ENERGY STORAGE SYSTEM

4.1 Super capacitor

A cascade voltage and current controller is selected to provide a stable load voltage. When the DC side voltage has a significant increase during braking, Super-capacitors can make a more rapid response and recycle the braking energy. Fig.3 is the control block diagram of the super capacitor controller. Where Vdc and Vdc-sen are respectively the actual voltage and rated voltage of DC motor; * UC i and * –UC sen i are respectively the per unit of super-capacitor actual current and rated current; fs is the switching frequency; G1,2 are the switching signal of T1 and T2. In boost mode, the duty cycle of the inductor current transfer function can be expressed as:

$$\frac{I_{L2(s)}}{D_{(s)}} = \frac{V_{dc}R_{Load}C_{dc}s+2V_{dc}}{R_{Load}L_2C_{dc}s^2+L_2s+R_{Load}(1-D)^2}$$

Table2 Comparison of two structures of DC/DC converter

Feature	Discrete inductors structure/cm^2	Integrated magnetic structure/cm^2	Effect(%)
Surface area	79.15	60	–24.20
Core volume	104.19	79.60	–23.60
Core weight/kg	0.31	0.23	–25.80
Wire weight/kg	0.21	0.21	–0

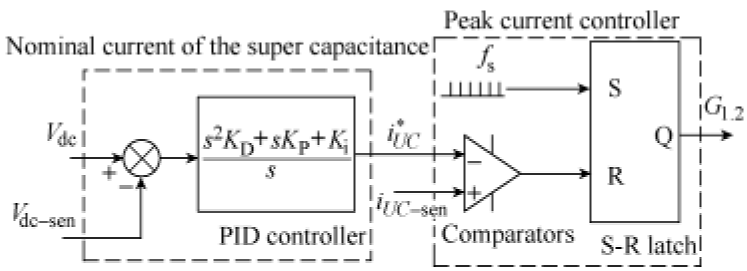


Fig.3 Block diagram of the super-capacitor voltage and current controller

V. SIMULATION

5.1 Simulation of proposed HESS

In the part, a simulation model of the proposed HESS is built on Matlab/Simulink.

Table 3 The parameters of HESS

Parameters	Value
$N_{SB}.N_{PB}$	185
$N_{P\_sc}.N_{S\_sc}$	570
Li-ion battery η_{DOD}	80%
Li-ion battery initial SOC	1
Super-capacitor initial SOC	0.94
Li-ion battery En/(kW·h), P_{max}/W	10, 200
Super-capacitor En/(kW·h), P_{max}/W	0.25, 200

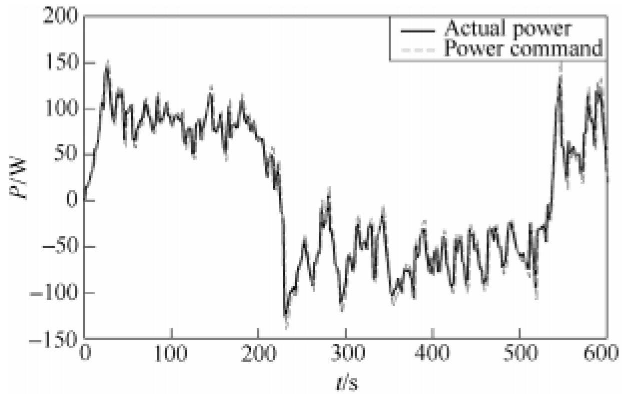
Table 4 Control parameters of HESS

Parameters	Value
$P_{disch\_high\_limit}(x_1)$	$N_{SB}.N_{PB}.C_{cellbat}.I^D_{cel\_bat}$
$P_{disch\_low\_limit}(x_2)$	0
$Q_{sc\_disch\_high}(x_3)$	0.81
$Q_{sc\_disch\_low}(x_4)$	0.42
$P_{char\_high\_limit}(x_5)$	$0.05N_{SB}.N_{PB}.C_{cellbat}.I^C_{cel\_bat}$
$P_{char\_low\_limit}(x_6)$	0
$Q_{sc\_char\_high}(x_7)$	0.97
$Q_{sc\_char\_low}(x_8)$	0.94
$K_{p1}(x_9)$	0.08
$T_{i1}(x_{10})$	0.02

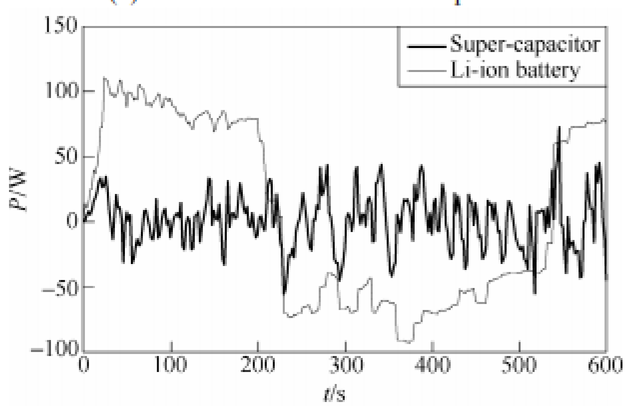
5.2 Simulation and experiment of proposed HESS applied to electric vehicles

5.2.1 Simulation

The simulation model of the proposed HESS applied to a typical car driving cycle is built on Matlab/ Simulink to test the dynamic performance of the system. The parameters of simulation system are presented in Table 5. The simulation of cars during the acceleration mode, constant speed mode, braking mode and parking charging mode are built on Matlab/Simulink, and the stability of the load side and load side voltage, battery, super capacitor current ripple are observed.



(a) Power command and actual power



(b) Power of the super-capacitor and Li-ion battery

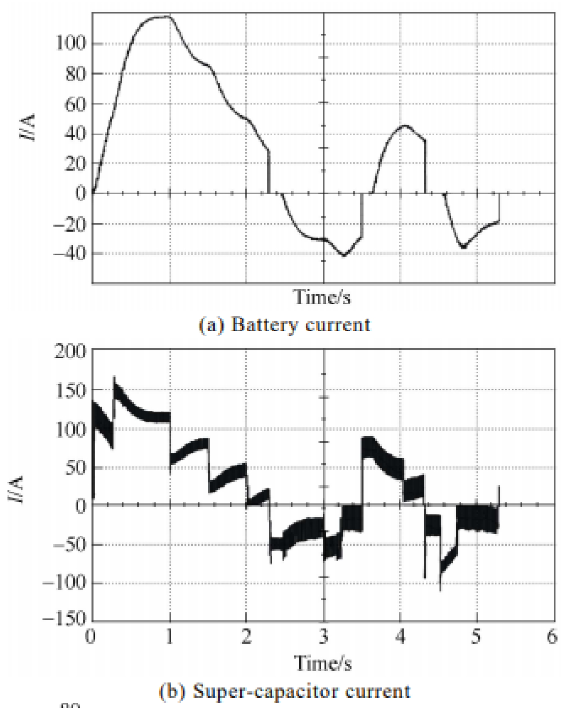


Fig.4 Simulation results of the proposed HESS

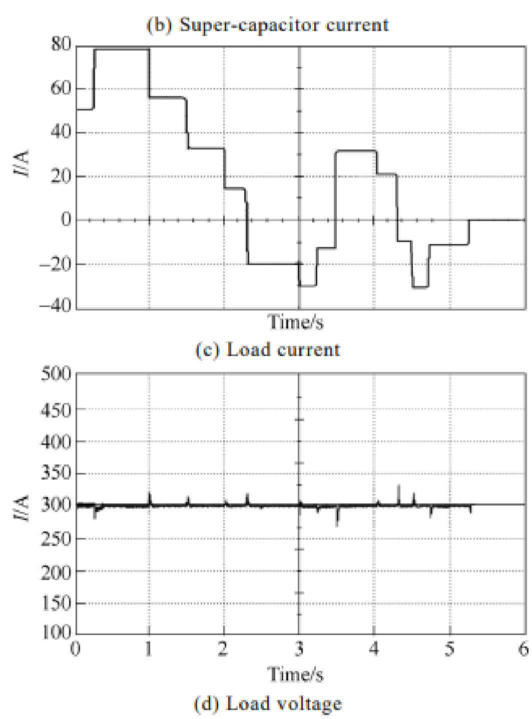


Fig.5 Simulation results of the proposed HESS applied on electric vehicles

VI. CONCLUSIONS

In this paper, a new hybrid energy storage system for electric vehicles is designed based on a Li-ion battery power dynamic limitation rule-based HESS energy management and a new bi-directional

Experimental data	
DC side voltage/V	$V_{dc}=20$
Battery/V	$V_{batt}=12$ the initial charge state 80% lead-acid battery
Super Capacitor	6 Maxwell Boostcap PC2500 series connection 450F, the initial state of charge 12V
Switching frequency/kHz	$f_s=20$
Sampling time/μs	$T_{st}=20$
DSP model	TI-TMS320F2812
L_1, L_2/μH	1.938 mH, 54.5687
M/μH	52.7866
Switch model	HGTG 30 N 60 A 4 D IGBT
Voltage sensor	*LV* 20-*P*
Current sensor	*LA* 100-*P*

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