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Modelling / Simulation of Series-Parallel Type Hybrid Electric Vehicle using MATLAB

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Abstract: ***This Paper Presents a Modelling and Simulation of series-parallel type hybrid electrical vehicle by using MATLAB/Simulink. Hybrid electric vehicle can save fuel and reduce environmental pollution. Compared with conventional vehicles. Hybrid electric vehicle uses internal combustion engine (ICE) and electrical power, it has the advantages of both. ICE vehicle and electrical vehicle and series-parallel hybrid is the combination of series and parallel structures; thus, it possesses the major features of both and more abundant. A full drivetrain system of a series/parallel Hybrid Electric Vehicle is developed including the Internal Combustion Engine, Motor Generator and Power Split Device along with the vehicle longitudinal dynamics. MATLAB/Simulink Software is used for the simulation of HEV.***
Keywords: Hybrid Vehicle, Series-Parallel Type Hybrid Electric vehicle, Modelling and Simulation, MATLAB/SIMULINK.

I. INTRODUCTION

A mixture vehicle, condensed hybrid electric vehicle, utilizes both an inside burning motor and an electric engine to drive the vehicle. Most half and halves utilize a high voltage battery pack and a blend electric engine and generator to help or help a gas motor. A crossover electric vehicle is a sort of vehicle that utilizes both an electric motor and an ordinary inward burning motor. This kind of vehicle is considered to have better execution and efficiency contrasted with an ordinary one. The restricted fuel reserves are being ceaselessly depleted, each the demand and therefore the production rates are growing speedily. Hybrid electric vehicle has been considered as a short-term solution to not only improve the fuel economy but also reduce its harmful emissions.

It is fiercely realized that HEV consolidates two wellsprings of energy specifically; the ordinary ice and the electric drive frameworks which thus decrease the reliance on petrol fills. The concept of having a dual power source. The concept of having dual power sources enables engine downsizing, load leveling, and range extending. In the modeling of a hybrid electrical vehicle, the electric motor and generator, the size of the battery, level of voltage, and new ice can choose. In this, series-parallel hybrid electric vehicle model built using MATLAB / simulink.

Customarily there are two fundamental classes of HEV, specifically arrangement crossovers and equal half and halves. In arrangement HEV, the ice mechanical yield is first changed over to power utilizing a generator. The change overpowers either to charge the battery or sidesteps the battery to drive the wheels through an electric engine. This electric engine is likewise used to catch the energy during slowing down. An equal HEV, then again, has both the ice and an electric engine coupled to the last drive shaft of the wheels through grasps.

This configuration allows the ice and the electric motor to deliver power to drive the wheels in combined mode, ice modes. The electric engine is likewise utilized for regenerative slowing down and for catching the overabundance energy of the ice during drifting. As of late, arrangement equal and complex HEV has been created to improve the force execution and efficiency. The interaction between all these modules is implemented in the MATLAB / Simulink / simscape block set environment and simulation results testify the effectiveness of HEV model.

II. MODELLING

In Fig 1. the vehicle is a Series-Parallel Hybrid electric vehicle. The series-parallel hybrid powertrain combines the benefits of both these architectures. In the series-parallel architecture, powertrain has two electric machines, where one acts as a motor to drive the wheels and the other acts as a generator to charge the battery and start the engine.

There is a power splitting device which decides the optimal power distribution for all the power sources so that the efficiency is highest at all times. Figure 1 Shows a schematic architecture of the series-parallel hybrid powertrain also known as power-split hybrid powertrain.

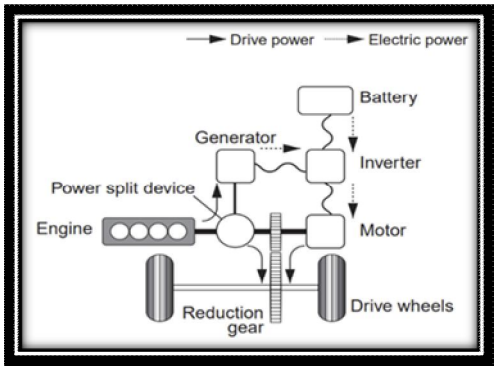

Fig. 1. Series-Parallel Hybrid Electric Vehicle [1]

A. Vehicle Simulation Tools

Recreation place along investigation with regard to vehicle execution is important to the advancement of mixture powertrain since arrange approval utilizing expensive model is unreasonable. thanks to the in accommodation of the numerous isolated demonstrating techniques, incorporated displaying apparatuses are required to accelerate the demonstrating cycle and to enhance the accuracy. Vehicle recreation may be a strategy for fast and organized examinations of varied arrange alternatives (fuel call, battery, transmission, energy element, fuel reformer, and then on) in vehicle arrange and improvement. As of now, many recreation devices obsessed with numerous displaying stages ar accessible, albeit none of them is adequate show all arrange alternatives. These instruments systematically focus on a specific application with focused considerations [1]. Following quite whereas of continuing with upgrades, a quick, actual and all-mains replica equipment is heretofore being worked on. Among the foremost loosely used vehicle displaying and examination stages are MATLAB/SIMULINK.

B. Modes of Operation

Working method of Vehicle appeared in Table 1. This can be found in the table underneath from the battery and help the ICE with motoring the vehicle during four-wheel drive circumstances. The ISA has comparable alternatives during Normal mode. Fundamentally, the 4WD mode is simply a subsidiary of the Normal mode with the EM motoring and the ISA producing the electrical force required (an arrangement/equal mixture blend). The vehicle enters Deceleration mode when the driver utilizes the brakes to moderate the vehicle. Regenerative slowing down includes the way toward utilizing the opposition between the field and armature of the EM to produce ability to renew the battery. As the driver applies the brake, for a set distance of pedal travel, the mechanical stopping mechanism doesn't initiate and the EM retains force off of the back pivot. This mechanical energy is changed over to electrical energy and shipped off the battery [6]. The overall principle is fulfilled during Electric Launch mode when the EM engines (MOT.) the vehicle. After a set the speed, the “ICE" turns on during the Engine Start mode [8]. When the ICE is up to speed, the programmed transmission connects with and the ICE turns into the essential actuator for vehicle drive. Now, the vehicle enters the Normal mode. Between the Electric Launch and Normal mode, the HEV fulfills the requirements of being an equal HEV as recently characterized. Note that during Normal mode, the EM can be utilized to supply regenerative capacity to the battery; besides, the EM can draw power.

MODE	ICE	ISA	EM	TRAN.
Idle	Off	Off	Off	Neutral
ICE, EM, AND, ISA ARE SHUTOFF, ELECTRICAL ACCESSORIES.				
ELECTRIC LAUNCH	OFF	MOT.	OFF	NEUTRAL
VEHICLE STARTED FROM WITH EM.				
ENGINE START	START	MOT.	MOT.	NEUTRAL
ATA CERTAIN VEHICLE, ICE QUICKLY STARTED BY ISA.				
NORMAL	ON	MOT. OR GEN.	MOT. OR GEN.	DRIVE
TORQUE REQUESTS DETERMINED BY PRIMARY CONTROL STRATEGY.				
DECELERATION	ON OR OFF	GEN.	GEN.	DRIVE OR NEUTRAL
REGENERATIVE BRAKING BY EM AND ISA AS BATTERY ALLOWS.				
4WD	ON	GEN. OR OFF	MOT.	DRIVE
EM RECEIVE CONTINUOUS POWER THROUGH DC BUS FROM ISA.				

Fig. 2. Modes of Operation

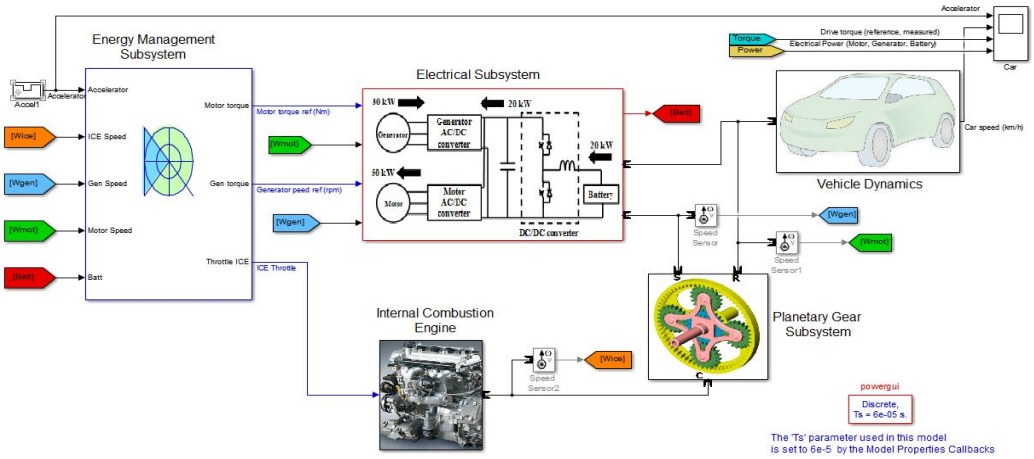

Fig. 3. Simulation Model of Series-Parallel HEV

The Simulation shows a multi-domain simulation of a HEV wheelwork supported Sim Power Systems and Sim Driveline. The HEV wheelwork is of the series-parallel kind. This Hybrid electrical Vehicle has 2 styles of mobility sources: an electrical motor and an indoor combustion engine so as to extend the drive train potency and scale back pollution. It combines blessings| the benefits} of the electrical motor drive (no pollution and high out their power at low speed) and therefore the advantages of an indoor combustion engine (high dynamic performance and low pollution at high speeds).

C. Planetary Gear Subsystem

Planetary Gear system the cogwheel system models the force split device. It utilizes a planetary device, that communicates the mechanical principal power from the motor, the engine and therefore the generator by allotting and consolidating them.

D. Electrical Subsystem

The Electrical Sub-System consists of 4 parts: The electrical motor, the generator, the battery, and also the DC/DC device.
The electrical motor could be a five hundred Vdc, fifty kW interior magnet Synchronous Machine (PMSM) with the associated drive (based on AC6 blocks of the SimPowerSystems electrical Drive's library). This motor has eight pole and also the magnets area unit buried (salient rotor's type). A flux weakening vector management is employed to attain a most motor speed of half-dozen 000 revolutions per minute. The generator could be a five hundred Vdc, 2 pole, thirty kW PMSM with the associated drive (based on AC6 blocks of the Sim Power Systems Electrical Drives library). A vector management is employed to attain a most motor speed of 13000 revolutions per minute.
The battery could be a half-dozen.5 Ah, 200 Vdc, twenty-one kW Nickel-Metal-Hydride battery.
The DC/DC device (boost type) is voltage-regulated. The DC/DC device adapts the low voltage of the battery (200 V) to the DC bus that feeds the AC motor at a voltage of 500 V.

E. Internal Combustion Engine

The ICE models a 57 kW 6000 rpm gasoline fuel engine with speed governor. The throttle signal lies between zero and one and specifies the torsion demanded from the engine as a fraction of the most attainable torsion. This signal conjointly indirectly controls the engine speed. The engine model doesn't embrace air-fuel combustion dynamics.

F. Vehicle Dynamics subsystem

The Vehicle Dynamics system models all the mechanical components of the vehicle:

1) The one gears reduces the motor's speed and will increase the force.
2) The differential splits the input force in 2 equal torques for wheels.
3) The tires dynamics represent the force applied to the bottom.
4) The vehicle dynamics represent the motion influence on the system.
5) The viscous friction models all the losses of the system.

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III. SIMULATION RESULTS

Start the simulation. It will run concerning one minute after you use the accelerator mode. you'll see that the HEV speed starts from zero km/h and reaches 73 km/h at 14 s, and at last decreases to 61 km/h at 16 s. This result obtained by maintaining the accelerator constant to seventieth for the primary four s, and to 100 percent for successive four s once the pedal is discharged, then to eighty fifth once the pedal is pushed once more for five s and at last sets to -70% (braking) till the tip of the simulation.

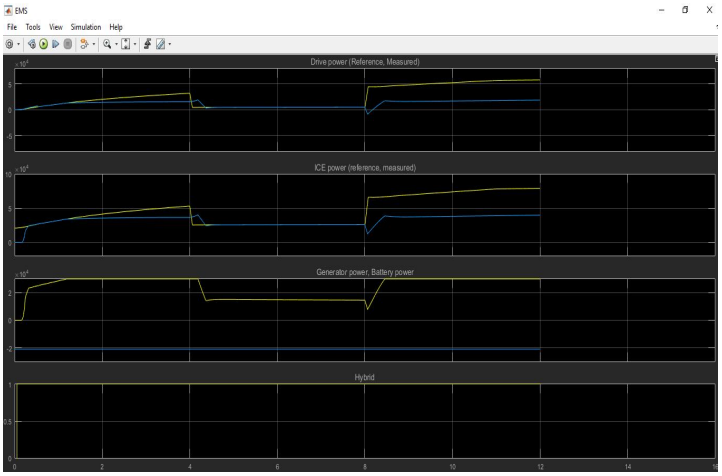


Fig. 4. Electrical Subsystem result.

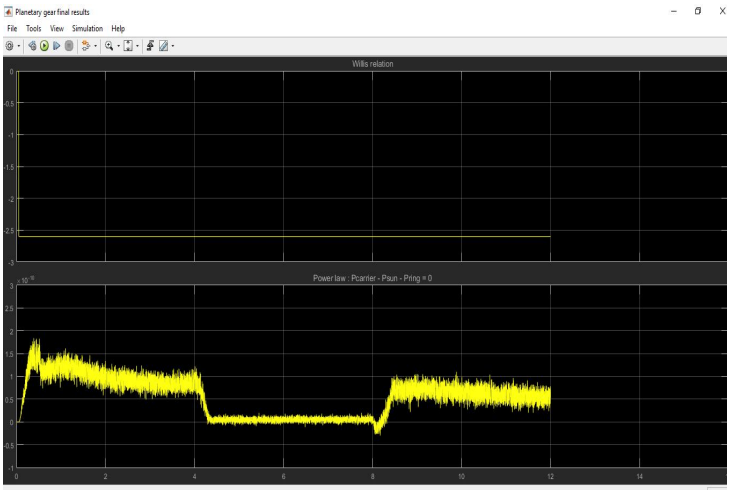


Fig. 5. Planetary Gear Subsystem result

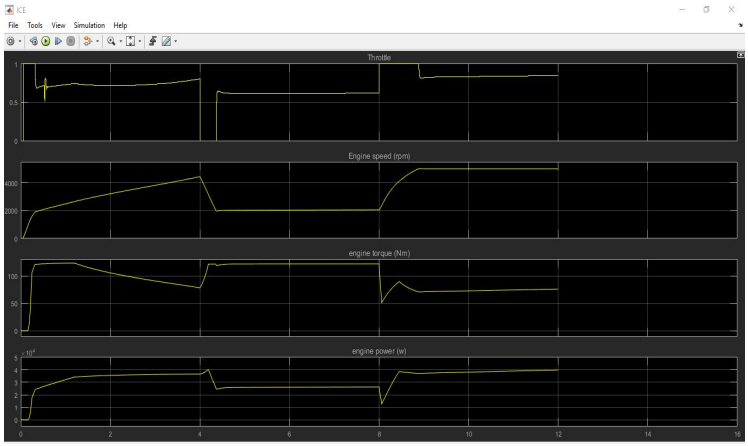


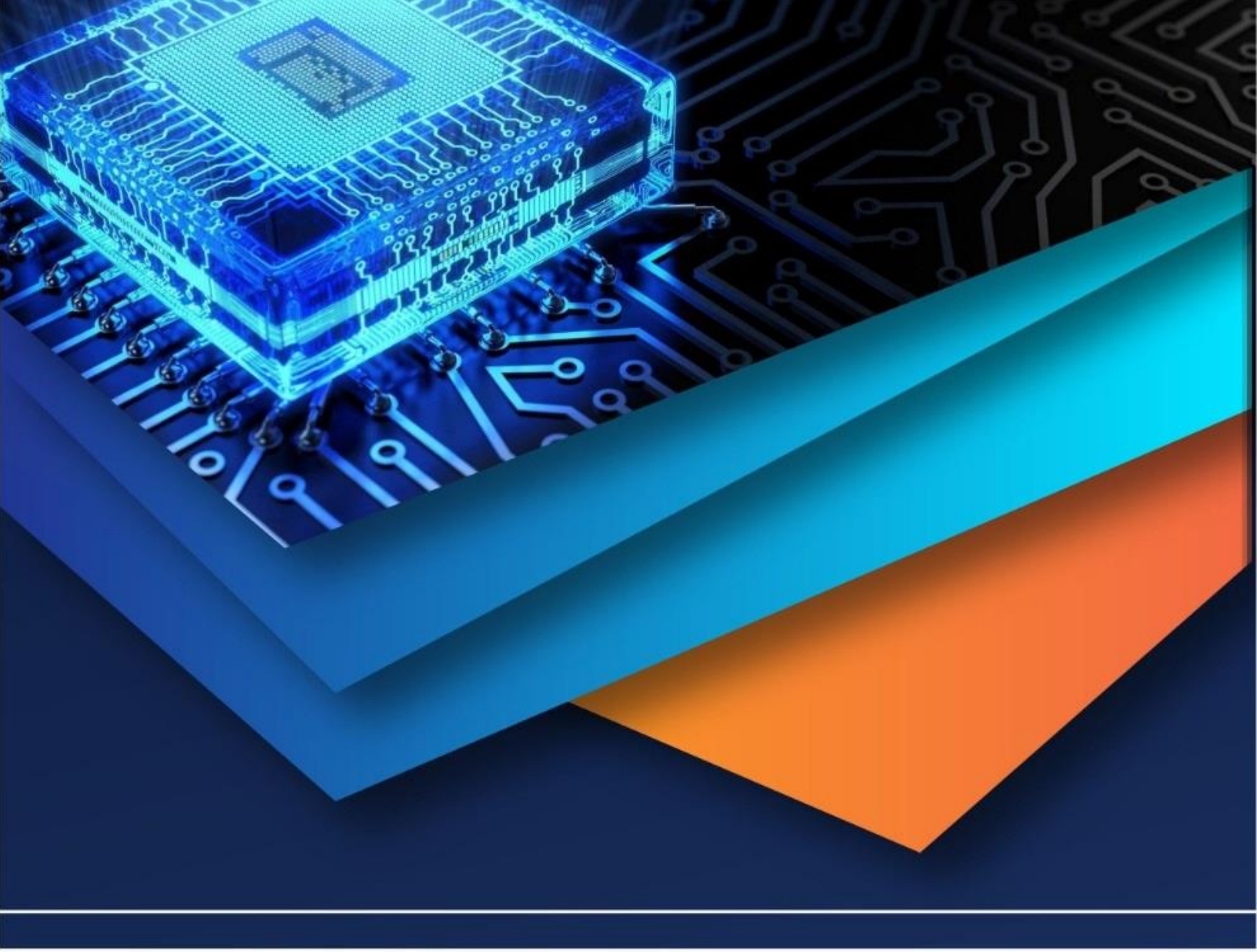
Fig.6. Engine speed, engine power, engine torque and throttle valve

IV. CONCLUSIONS

The modelling and simulation of hybrid electrical vehicle (HEV) completely different modelling ways area unit bestowed with powertrain part and system modelling examples. This simulation tool is supposed as a facilitate within the style and analysis of the hybrid electrical vehicle. parts within the driveline may be varied and also the result on the hybrid electrical vehicle fuel potency may be investigated. each simulation tools area unit consisting of a Simulink vehicle model, wherever the driveline parts area unit painted as interconnected blocks that area unit human action physical signals between one another within the level of seconds. The simulation input could be a vector containing the vehicle reference speed as a operate of your time. The output may be any desired simulated signal. Some attention-grabbing observations may be created in every scope. throughout the total simulation, you'll observe the DC bus voltage of the electrical system well-regulated at 500 V. within the planet gear scheme, you'll observe that the Willis relation is adequate to -2.6 and also the Stevens' power law of the planet gear is adequate to zero throughout the total simulation.

REFERENCES

[1] Li Yaohua, Wang Ying, Zhao Xuan, 2015 “Modelling and Simulation Study on a Series-parallel Hybrid Electric Vehicle” World Electric Vehicle Journal Vol. 7 - ISSN 2032-6653 - ©2015 WEVA
[2] T. Prius, Toyota Hybrid Systems, THS-II: Next-generation hybrid technology by Toyota, August 2011.
[3] Modelling and Simulation of a Hybrid Electric Vehicle for the Challenge X Competition, Giorgio Rizzoni, the Ohio State University , Columbus, OH 43210, Advisor May 20, 2005.
[4] P. Chapman and M. Aston, “A generic battery model for electric and hybrid vehicle simulation performance prediction,” International Journal of Vehicle Design, pp. 82–95, September 1982.
[5] Liu C, Gao XH and Guo JH. Optimal torque distribution strategy of hybrid electric bus based on genetic algorithms. Appl Mech Mater 2014; 494–495: 219–222
[6] X. He and J. W. Hotion for Hybrid Electric Vehicles t II: S E Transactions on Intelligent Transpo Syst pp. 244-251, 2002.
[7] C. C. Chan, The state of the art of electric and hybrid vehicles, Proc. IEEE, vol. 90, no. 2, pp. 247–275, Feb. 2002.
[8] F. Ohlem r, G. R iman, ―Challenge X 2005 Report #3: Control System Har e Development‖, submitted to the Challenge organize
[9] Languang Lu, Xuebing Han, Jianqiu Li, Jianfeng Hua and Minggao Ouyang, "A review on the key issues for lithium-ion battery management in electric vehicles", Journal of Power Sources, vol. 226, no. 15, pp. 272-288, March 2013.
[10] V. H. Johnson, “Battery performance models in ADVISOR,” Journal of Power Sources, vol. 110, no. 2, pp. 321 – 329, 2002.
[11] J. P. Gao, G. M. G. Zhu, E. G. Strangas, and F. C. Sun, “Equivalent fuel consumption optimal control of a series hybrid electric vehicle,” Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering 2009, vol. 223, pp. 1003–1018, April 2009.
[12] Anon., “History of battery invention and development,” March 2012.
[13] M. Stephen and M. Eshani, “An empirically based electrosource horizon leadacid battery model,” SAE Journal, pp. 135–138, February 1996
[14] W. B. Gu, C. Y. Wang, and B. Y. Liaw, “The use of computer simulation in the evaluation of electric vehicle batteries,” Journal of Power Sources, vol. 75, no. 1, pp. 151–161, 1998.
[15] Yuliang Leon Zhou, “Modelling and Simulation of Hybrid Electric Vehicles” B. Eng., University of Science & Tech. Beijing, 2005, Yuliang Leon Zhou, 2007.



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