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Simulation of Hybrid Electric Vehicle Battery by Using MATLAB-Simulink

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ABSTRACT: Electric vehicle's (EVs) are probable to be an choice to be an preferred mode of transportation for the future as it has a excellent capacity to minimize the consumption of petroleum based and different excessive CO2 emitting transportations fuels. In this study, the aspects of the BEVs machine had been mentioned and a mannequin of BEV on the MATLAB-Simulink platform used to be simulated. Moreover, the relevant electrical system components as well as its corresponding equations for verification were identified. Furthermore, all simulation consequences have been considered. This work may gives a basic for greater researches.

I. INTRODUCTION

One of the best challenges that is going through the surroundings in the world is energy conservation. Many difficulties is being facing by our global energy environment. Although no one is aware of precisely the future of the energy, we nevertheless trust that transportation will play a predominant function in saving the future strength.

Today, Electric Vehicles (EVs) are one of the technological development outcomes that have contributed proceed to make contributions in order to make our lives simpler and safer. Because EVs not just use energy, however they additionally produce, store, and transport electricity. That is what makes them an incredible choice for the traditional fuel based vehicles. Moreover, they are greater reasonably priced and eco- pleasant in contrast with the typical motors that use fuel or diesel gas due to the fact they have a reversible electricity storage system .

In this study, MATLAB-Simulink used to be used in order to layout the BEV elements and integrating the complete system. Moreover, it used to simulate the BEV and its equations.

This paper mentioned the simulation of the BEV, its applicable electrical system aspects and its corresponding equation for verification. In addition, it examines all simulation results. The BEV components are Transmission, Battery Charge Controller, Driver Model, Driving Cycle, Electric motor and Longitudinal Vehicle Dynamic Model

II. BATTERY ELECTRIC VEHICLE COMPONENTS

Transmission Model

The Transmission prototype controls the vehicle's moving necessities for the duration of gear change. It shifts torque from motor prototype and braking pressure into the front and rear traction forces from driver model. The inputs of the longitudinal vehicle dynamic prototype are the two forces of the transmission outputs calculations, cell balancing, and State of charge (SoC). Based on IRIZ battery, this prototype covers a easy battery pack. The condition of charge (SOC) is calculated using the following equation :



1. Battery Pack

It is composed of M modules linked in parallel; each module consists of N series-connected smaller factors referred as “cells”.

$$(J + m \times k \times r \times R_{tire}) \frac{d\omega_{MG}}{dt} = T_{MG} + T_{PSD} + T_r \quad (1)$$

$$SOD = \int_0^t \alpha [i(r)] \cdot \beta [T(r)] dt \quad (4)$$

Where J is the rotor inertia of MG, m is the automobile mass, k is the transmission ratio, which is 0.256, τ is equals to 2.72 x 10⁻², R_{tire} tire radius, $\frac{d\omega_{MG}}{dt}$ is the derivative of MG rotation speed, T_{MG} is the torque developed by using MG, T_{PSD} is the torque developed at the output of Power Split Device (PSD), and T_r is the resistant torque with the formula.

Where SOD is the condition of discharge, t is time, T is temperature, and i is current.

2. State of Charge

In percentage, it expresses the lasting capacity of battery that ought to be affected by the temperature, the discharge speed and the battery’s life. As the following equation shows, the ratio between the residual charge present and the nominal volume is the SoC.

B. Electric Motor Model

It has a very important role in BEV. The following equation shows the SoC = Q(t)

$$(5)$$

motor structures are developed based on a DC motor .

1. Motor Speed Control

The speed of the motor can be calculated at different speed techniques voltage. It is an input into the motor manager as shown in the equation below:

$$W_v = \alpha U + b \quad (2)$$

Where U is the representative curve approximates to a line, ω_v the motor speed control instruction voltage, a and b are the equation coefficient additionally varies as the motor load changes.

2. Regenerative Braking

Regenerative braking feature captures the rotating energy reduction of the automobile and then converts it as an electrical power in order to feed it return into the battery source.

$$W_c = \frac{1}{2} (v^2 + mgh) \quad (3)$$

Where W_c is Energy kept in the vehicle’s energy source, m is Total automobile mass, V is automobile speed, h is Maximum altitude change of the BEV, and η_c is Energy effectiveness of the power source.

C. Battery Charge Controller Model

This feature is accountable for the batteries longevity. Its significance is in using an powerful Battery Management System (BMS) in designing the BEV’s electric system. BMS displays battery voltage, current,



Where $Q(t)$ is the ratio between the residual charge available, and Q_{nom} is the nominal volume.

D. Driving Cycle

It is the automobile operation schedule that explains the terms of the speed and gear selection as a function of time during the simulation. Driving cycles NEDC Mode for small vehicle in the city was designated in order to test fuel economy and vehicle performance of the small automobiles inside cities.

E. Driver Model

Aiming to discover an suitable throttle and brake instructions by PI automobile, driver model considers the objective speed and the real speed. Simulating the function of the driver and the automobile is given by this model. To assure having the specific reference speed monitoring with the aid of the vehicle, a response control loop of a vehicle speed is used. Provided via electric motor the throttle command from the driver prototype is transferred into torque and made an input to the transmission model .

F. Longitudinal Vehicle Dynamic Model

The car, tires, roadway and riding system communication can be defined under the longitudinal vehicle dynamic model theory. There are three variables for the continuous condition of motion dynamics model of an electric car: Wheel slip in the longitudinal direction, speed vehicle center of gravity and wheel circumferential speed. Getting each of the acting forces in a vehicle direction is important in order to control its

$$\lambda_x(t) = \frac{V_v(t) - V_k(t)}{V_v(t)} \tag{6}$$

Where $\lambda_x(t)$ is the longitudinal slip of the driven wheel, V_v , V_k , is the electric automobile speed

III. METHODOLOGY

MATLAB-Simulink used to show the battery electric automobile components and integrating the entire system. Moreover, MATLAB-Simulink used to simulate the battery electric automobile and its respective equation for conformation.

MATLAB is a technical computing language that integrates programming, calculation and visualization in one environment. It has been modified in order to solve engineering and scientific issues and it is used now in many different fields. MATLAB has a powerful and big graphic toolbox that allows the user to work in an easy and easy environment.



TABLE I. Drive train Parameters

Drive train Parameters	
DriveBattery	Lithium-Iron(2.8V)
Modules,cells	3.180
RatedVoltage	200V
RatedCapacity	26.88kWh,120Ah
BatteryWeight	270 kg
RatedLifetime	10years \160,000km
MotorType	PMAC (YASA-400)
MaxOutput	90Kw
MaxTorque	360Nm
Transmission	SingleSpeed 3.37:1

IV. TECHNICAL SPECIFICATIONS

For this study we are using technical structure of PROTON IRIZ Car (BEV). Proton IRIZ is made in Malaysia. Table I shows the configuration.

V. SIMULATION OF BATTERY ELECTRIC VEHICLE

All mathematical equations that apply each part in the battery electric automobile simulation were selected to model the BEV. The simulation model includes six components: the transmission model, the electric motor model, the battery charge controller model, the driving cycle, the driver model and the longitudinal vehicle dynamics model as shown in Fig. 1.

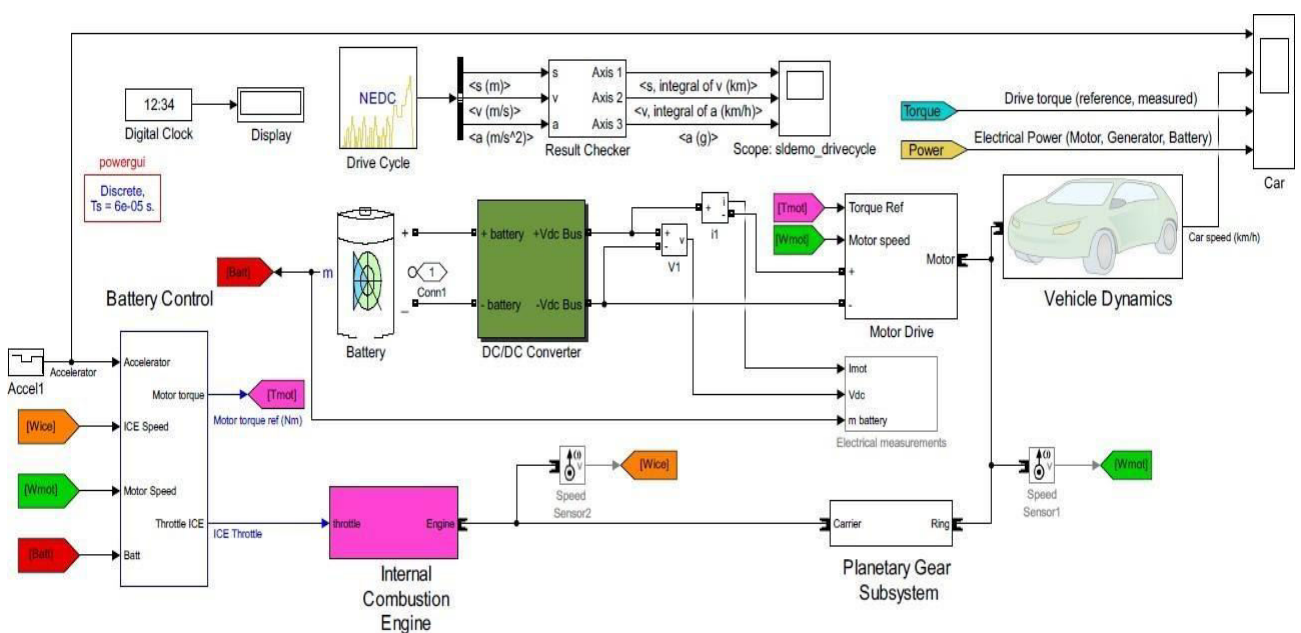


FIG 1.Simulation of Battery Electric Vehicle



VI. RESULT AND DISCUSSION

As shown in Fig. 1 the BEV simulation model has been designed by the mathematical equations that are applied by all subsystem blocks. Furthermore, the output shown in Fig. 2 and Fig. 3 represent the battery current, battery voltage, battery state of charge and battery power.

Apparently, all the output visuals showed that the simulation is working in a good condition and also , New European Driving Cycle (NEDC) was selected with the purpose of calculate the level of the fuel economy inside city and also engine emission

In Fig. 2, the current, power and voltage of the battery are visible. As shown in the figure the curve of the battery current follows the motor current dimension and the required torque graphs. Due to the increase in torque demand, we can notice the increase of the battery current. Moreover, from the battery power graphs, power is drained from the battery to the load while motoring then it returns to the battery during regeneration. The motor can run in a regular motoring mode when the polarity of the voltage and the current are same. However, when the motor converted to regenerative braking mode (generator), the current changes to negative and the power flows in the opposite direction. Battery state of charge (SOC) is the ratio of the residual volume to the maximum volume. SOC for NEDC has a low dead charge, which is best for fuel economy as shown in the Fig. 3.

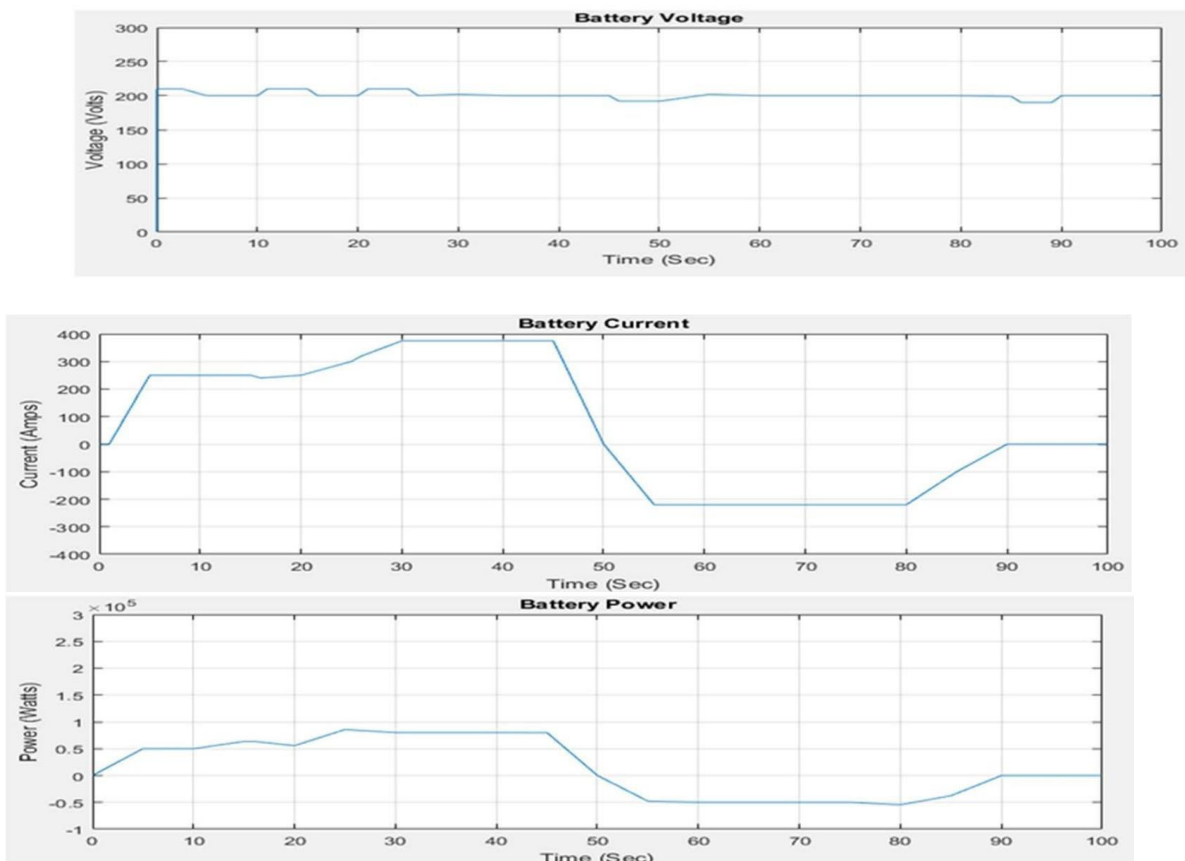


FIG. 2 Battery Voltage, Current, and Power

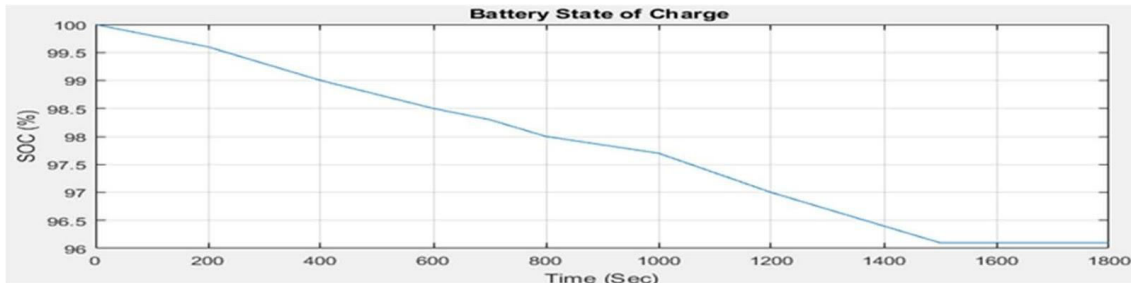


FIG. 3 Battery State of Charge

VII. CONCLUSIONS

In this study, BEV and its components have been simulated with the intention of study the energy flow, efficiency and performance. Best results for Battery current, power, State of charge, and voltage were shown in MATLAB-Simulink. A lot of chances still ahead in order to create better BEV model that will be the basis for next future researches. With the intension of finding the current, power, State of charge, and voltage for the battery and the exact component size, and to minimize the use of energy, modeling and simulation are very important for automotive designers.

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REFERENCES

1. J. Y. Yong, V. K. Ramachandaramurthy, K. M. Tan, and N. Mithulananthan, "A review on the state-of-the-art technologies of electric vehicle, its impacts and prospects," *Renew. Sustain. Energy Rev.*, vol. 49, pp. 365–385, 2015.
2. Z. Chen, R. Xiong, and J. Cao, "Particle swarm optimization-based optimal power management of plug-in hybrid electric vehicles considering uncertain driving conditions," *Energy*, vol. 96, pp. 197–208, 2016.
4. K. K., & Hat, M. K. (2015). SIMULATION BASED STUDY OF ELECTRIC VEHICLE PARAMETERS, 10(19), 8541–8546.
5. Mohd, T. A. T., Hassan, M. K., & A. Aziz, W. (2015). Mathematical Modeling and Simulation of an Electric Vehicle. *Journal of Mechanical Engineering and Sciences*, 8(June), 1312– 1321. <https://doi.org/10.15282jmes.8.2015.6.0128>.
6. Meradji, M., Cecati, C., Wang, G., & Xu, D. (2016). Dynamic modeling and optimal control for hybrid electric vehicle drivetrain. In 2016 IEEE International Conference on Industrial Technology (ICIT) (pp. 1424–1429). IEEE. <https://doi.org/10.1109/ICIT.2016.7474967>.
7. Houcque, "Introduction to MATLAB for Engineering Students," Northwest. Univ. Version, no. August, pp. 3–43, 2005.
8. Reddy, G.N. 2012. A MATLAB-based tool for EV design. In: 2012 International Conference on Education and e-Learning Innovations (ICEELI).
9. L. Buccolini, A. Ricci, C. Scavongelli, G. DeMaso-Gentile, S. Orcioni, and M. Conti, "Battery Management System (BMS) simulation environment for electric vehicles," in 2016 IEEE 16th International Conference on Environment and Electrical Engineering (EEEIC), 2016, pp. 1–6.
10. Zhou Bing, Jiang Qinghua, Yang Yi, & Wang Jisheng. (2010). Analysis of energy consumption and powertrain parameters



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