

Electric Vehicle using MATLAB-Simulation

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ABSTRACT

Conventional vehicles utilize petroleum derived fuels to provide good performance and long range which leads to exhaust gas emissions causing environmental pollution & low fuel economy. Electric vehicles (EVs) are likely to be an alternative energy mode of transportation for the future as it has shown a great ability to reduce the consumption of petroleum based and other high CO₂ emitting transportations fuels. The MATLAB vehicle model offers a simulation platform that is modular, flexible, and can be conveniently modified to create different types of vehicle models. In addition, the simulation results clearly demonstrated the fuel economy advantage of the hybrid vehicle over the conventional vehicle model. It is recommended that a more sophisticated power management algorithm be implemented in the model to optimize the efficiencies of the engine and the motor/generator.

Keywords: Electric Vehicle (EV), Matrix Laboratory MATLAB-Simulink, Simulation, Motor, Generator.

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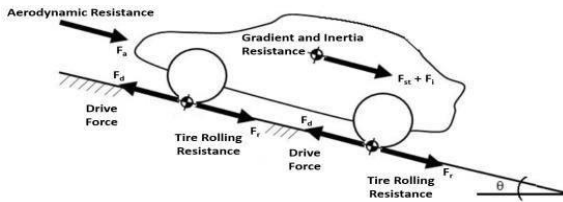
I. INTRODUCTION

One of the greatest challenges that is facing the environment in the world is energy saving. Our global energy environment as well faces many difficulties. Although no one knows accurately the future of the energy, we still believe that transportation will play a major role in saving the future energy. Today, Electric Vehicles (EVs) are one of the technological progress results that have contributed and continue to contribute in order to make our lives easier and safer. Because EVs do not

only consume energy, but they also produce, store, and transport electricity. That is what makes them an excellent alternative for the fuel vehicles. Moreover, they are more economical and ecofriendly compared with the traditional cars that use gasoline or diesel fuel because they have a reversible energy storage device. In this study, MATLAB-Simulink was used in order to design the EV components and integrating the whole system. Moreover, it was used to simulate the EV model and its equations. This paper discussed the simulation of the EV, its relevant electrical system components and its corresponding equation for

verification. In addition, it examines all simulation results. The EV components are Electric Motor, Battery Charge Controller, Power Control Unit, Onboard Charger and Longitudinal Vehicle Dynamic Model.

II. METHODS AND MATERIAL



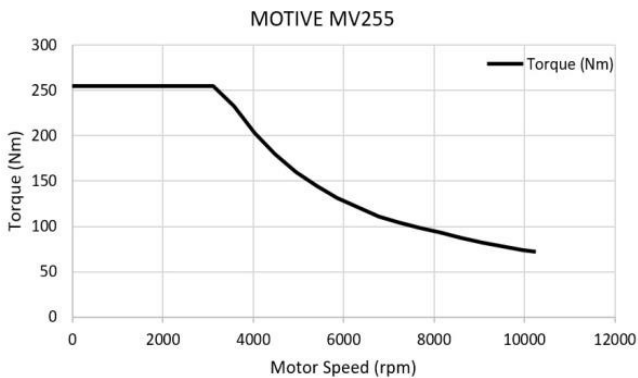
Electric Motor

In electric vehicles, up to

now, 4 different electric motors have been used. These electric motors;

- Direct current motor,
- Asynchronous motor,
- Permanent magnet synchronous motor,
- Switched reluctance motor.

As a result of the evaluation, permanent magnet synchronous motor is considered to be suitable for the model. For this reason, technical specifications of the MOTIVE MV255 electric motor of TM4 have been used in our model.

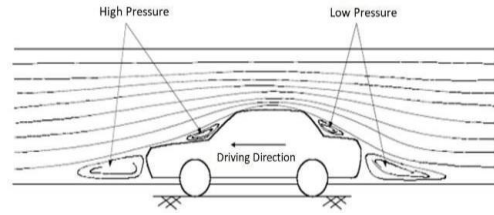


During driving, resistance forces act on the vehicles. These resistance forces;

- Aerodynamic Resistance,
- Tire Rolling Resistance,
- Gradient Resistance,
- Inertia Resistance.

Aerodynamic Resistance

A force acts on objects moving in a fluid opposite to their motions.



This resistance force is called aerodynamic drag resistance. The aerodynamic drag resistance is calculated as follows;

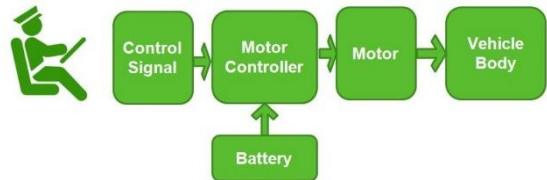
$$F_d = 0.5 \rho C_d A_f (V + V_0)^2 \tag{1}$$

The aerodynamic resistance coefficient is determined experimentally according to Vehicle shape.

Vehicle Type	CD
Cabriolet	0.5 – 0.7
Car	0.3 – 0.4
Bus	0.6 – 0.7
Truck	0.8 – 1.5
Optimal Design	0.2 – 0.3

Table 1. Vehicle Type & CD

Block Diagram



Tire Rolling Resistance

Due to the elastic structure of the wheel, in front of the wheel contact center, a resistance force against the rotational movement of the tire occurs. The tire rolling resistance is calculated with this equality;

$$F_r = mg C_r \cos \alpha \tag{2}$$

Tire rolling resistance coefficient (Cr) Newton's II. According to the law of motion, during the acceleration and deceleration of an object, an inertial force is generated in the opposite direction to this motion. This force encountered during

positive and negative acceleration of the vehicle is called inertia resistance. This resistance is calculated by this formula

varies according to the road surface.

Road Surface	CR
Concrete or Asphalt	0.013
Small Gravel Ground	0.02
Macadamized Road	0.025
Soil Road	0.1-0.35

Gradient Resistance

The resistance of the vehicle moving on a sloping road. The gradient resistance appears due to the component of gravity. α expresses the gradient of the path in degrees.

$$F_{st} = mg \sin \alpha$$

Inertia Resistance

$$F_i = ma$$

Total resistance force;

$$F_{Load} = F_i + F_a + F_r + F_{st}$$

optimal balance of maximum speed, acceleration performance, and traveling range per charge.

Motor Controller

A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and electrical faults.

Motor controller is a combination of power electronics & embedded micro computing elements which makes the efficient conversion of energy

stored in batteries of an electric vehicle to generate motion.

Battery

The battery is modeled as a voltage source with an internal resistance. The model accounts for internal power loss in the resistance of the battery. There is no time lag component in the model. The battery is assumed to have a constant internal voltage, E_B . The battery terminal voltage, V_B , is equal to the sum of the internal voltage and resistance voltage drop. The battery voltage and battery current are equal to the controller low side voltage and current.

$$\text{Equation 6: } V_B (\text{Volt}) = I_A (\text{Amp}) * R_A (\text{Ohm})$$

+ E_B (Volt). Battery model calculation

$$V_L (\text{Volt}) = I_L (\text{Amp}) * R_A (\text{Ohm}) + E_B (\text{Volt}).$$

Assuming: $V_B = V_L$ and $I_A = I_L$

The battery model uses the current and voltage information from the Motor Controller to calculate the required battery's internal voltage. This voltage is compared with the actual E_B value to create a battery voltage error, BEER, and that error is used by the PI controller model to adjust the loop gain.

$$\text{Equation 7: } BERR = E_B (\text{actual}) - E_B (\text{calculated})$$

Error Voltage Calculation

Motor

The motor controller is assumed to be an ideal controller with no power loss and no time lag. The controller simply raises the battery voltage to meet the higher voltage needs of the motor. The dimensionless constant gain or K ratio of the input and output voltages is determined in order to meet the motor's needs. The same K ratio is used to adjust the current so that input and output power values are equal.

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High side voltage is equal to K times the low side voltage:

Equation 4: $V_H = K \cdot V_L$ Controller High Side Current

High side current is equal to $1/K$ times the low side voltage:

Equation 5: $I_H = (1/K) \cdot I_L$ Controller High Side Voltage

Vehicle Body

Vehicle body is the important part of vehicle, which helps to fix the body part in specified area and to give enhance looks the vehicle. Hence it

the EV business as new business opportunities. In accordance with the implementation of many pilot projects and EV related events, public expectation on EVs is high. However, there is no clear indication for full-fledged diffusion. This is because of high prices of EVs, limited models, lack of charging infrastructure, and lack of trust in the market in terms of life span of EVs and safety. On the other hand, big auto manufacturers have become bolder in EV development, which is seen to address the above-mentioned problems and accelerate EV diffusion.

III. REFERENCES

- [1]. Automotive Engineering Department, Faculty of Technology, Gazi University, Ankara, 06500, Turkey
- [2]. David McDonald , LSSU Sault Ste Marie, MI 49783
- [3]. Karen L. Butler, Member, IEEE, Mehrdad Ehsani, Fellow, IEEE, Preyas Kamath, Member, IEEE
- [4]. Guanhao Du1, Student Member, IEEE, Wenping Cao1, Senior Member, IEEE, Shubo Hu2, Student Member, IEEE, Zhengyu Lin1, Senior Member, IEEE, Jing Yang2, Member, IEEE, Tiejiang Yuan2, Member, IEEE
- [5]. Staubel, Tesla in article "Meeting the technology challenge" AEInt., SAE Sept 2009. 11 . www.doe.gov

is one of the focused part in the upgraded technology. By using the vehicle body parts assembling in correct way, the vehicle gives the comfort that the generation is looking for with the ease of driving.

Conclusion

Both developed and developing countries have become more active in EV introduction and diffusion. In developed countries, the government has led the promotion of next- generation environment-friendly vehicles. In the industrial world, not only conventional auto manufacturers but also large and small enterprises have joined

- [6]. McDonald, Engineering & Technical Education for Electric Vehicle Engr, ASEE AC 2010

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