Simulation of Battery Electric Vehicle by Using MATLAB-Simulink

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Abstract: *As electric vehicles become a more viable option for generating sustainable and greener energy in transportation, academics' interest in modelling and simulation of electric vehicles is growing. The first step in modelling a decent electric car is to choose appropriate electric vehicle parameters and understand their characteristics. This paper focuses on reading vehicle restrictions using an electric vehicle simulation. The simulation's outcome demonstrates the impact of each division's rules on the presentation. All of the work is done in the MATLAB/Simulink environment. Electric vehicles (EVs) are likely to become a substitute energy mode of transportation in the future, as they have demonstrated a high ability to reduce the consumption of petroleum-based and other high CO2 emitting transportation fuels. The components of the BEVs system were reviewed, and a BEV model was stimulated using the MATLAB-Simulink platform. The relevant electrical system components were also identified. Furthermore, all simulation outcomes were quantified. This publication lays the groundwork for future investigation.*

Keywords: Simulink Model, Vehicle Body, Driver Input, Battery Pack, Overall Model, etc.

I. INTRODUCTION

The energy adaptation proficiency the cost of an electric vehicle is more than the cost of electricity adaptation proficiency of a conservative automobile. The battery will be a dependable energy source. The model simulation will provide the battery behaviour, and we will be able to watch how breaking the battery charges it. There are numerous advantages to building a Simulink model. The model simulation will provide the battery behaviour, and we will be able to watch how breaking the battery charges it. The computer model below demonstrates how electric vehicle components work how they're organised, and how we might attain peak performance. MATLAB-Simulink is utilised to plan the BE modules and mix the overall system in this work. It's also used to run simulations of the BEV model and associated equations. For authentication, it has a corresponding equation. It also goes over all of the simulation results. BEV components include transmission, electric motor, battery charge controller, driving cycle, driver model, and longitudinal vehicle dynamic model.

A. Block Diagram of the System

In an electric car, there are several components and a vast network of connecting wires. The conservative IC engine is replaced by a motor in an electric vehicle. The motor is supplied with the battery pack's operational oil. The block diagram below depicts the major components of the electric vehicle setup.
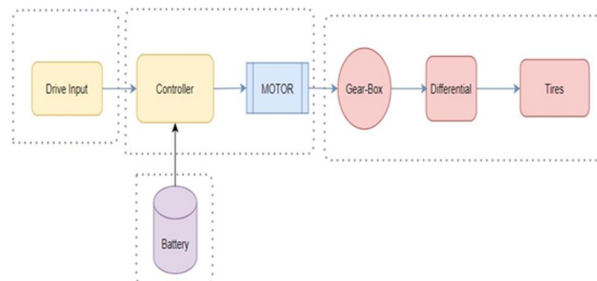
Electric automobiles have four primary components: the motor, the vehicle body, the controller, and the battery pack. There are many different types of motors in electric vehicles. BLDC motors, Brushed DC motors, and AC Induction Motors are all frequently used. The vehicle's body houses the gearbox, differentials, and tyres. We had previously relied only on the batteries to jolt the engine. The battery, on the other hand, is currently being used as a mode of operation. Sections will be arranged to form a unit, and numerous units will practise a battery pack together. To perform activities, the motor demands a power supply from the battery. Assume we connect the battery pack to the motor directly. In that case, the motor will operate at a respectable speed, and a speed governor is out of the question. With the help of the controller, you may control the motor's speed. The controller will work by drawing inspiration from the driver.

1. **Simulink Model**

   Dividing the simulation system into four pieces is a good idea. The primary subsystem is in charge of the vehicle's body. The next subsystem houses the motor and controller circuit. The third subsystem contains the driver input, while the fourth subsystem contains the battery pack.

2. **Vehicle Body Subsystem**

   First, make a vehicle body subsystem. In the body subsystem of a vehicle. This includes tyres, differential, gearbox, and vehicle body blocks from the Simscape library. We can alter the block parameters to suit our needs. To make the principal subsystem, connect the tyres, differential, gearbox, and vehicle body blocks together.
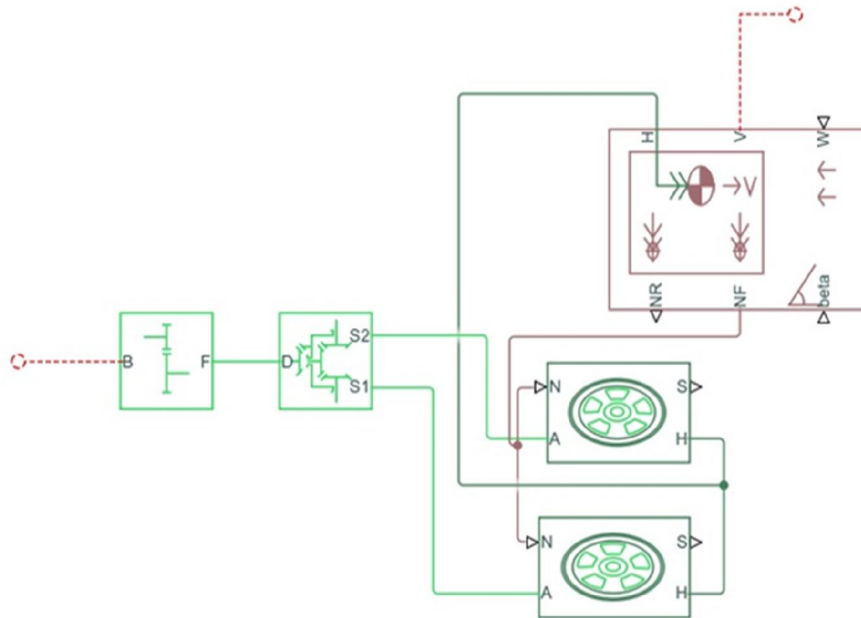

Vehicle Body Subsystem

In a longitudinal signal, the Vehicle Body block represents a two-axle vehicle body. Each axle can have the same number of wheels or a different number of wheels. For example, a front axle with two wheels and a rear axle with one wheel. The size of the vehicle wheels is likely to be similar. The vehicle's centre of gravity (CG) might alternatively be at or below the level of travel Due to acceleration and road profile, the block accounts for body mass, aerodynamic drag, road gradient, and weight dispersal among axles. Include ground and suspension dynamics as an option. The car is not moving at a severe angle to the ground. There is an option to include a visibly defined mass and a visibly defined inertia in the block. In response to system changes, the mass, inertia, and centre of gravity of the vehicle body can alter during simulation.

3. **Driver Input Subsystem**

   Based on condition and response speeds, the longitudinal driver block from the powertrain block collection generates equivalent accelerating and braking orders. The built-in drive arrangement will provide orientation speed, or we can use the signal builder block to make our own indicator. The response time will be calculated

using the actual vehicle speed. A speed fault will be created based on the difference between the mentioned signal and the actual speed. The error will cause acceleration or deceleration, attempting to match the vehicle's real speed to the speed of reference.

The Longitudinal and Signal Builder blocks are used to create the Drive Input Subsystem. The graphic below depicts the interconnections between the blocks.
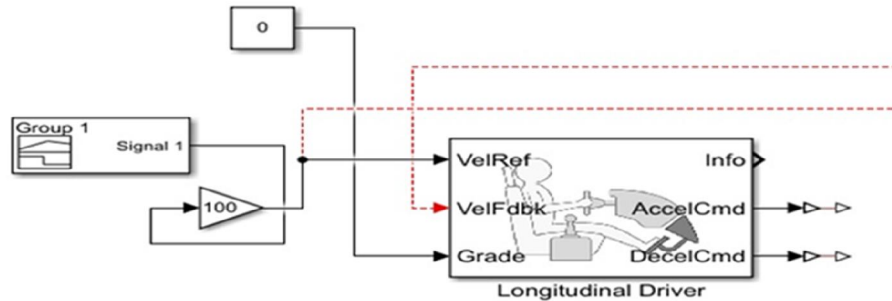
Driver Input Subsystem

4. Battery Pack Subsystem

The battery pack will provide electricity to the engine. Constructing State of Charge (SOC) would provide data on how far we can drive before recharging and how long a specific battery may be used. Using a lithium-ion battery, the SOC % is presented publicly. With the assistance of SOC, we can see how the battery is charging and draining. The graphic below depicts the connections between each block that make up a subsystem.
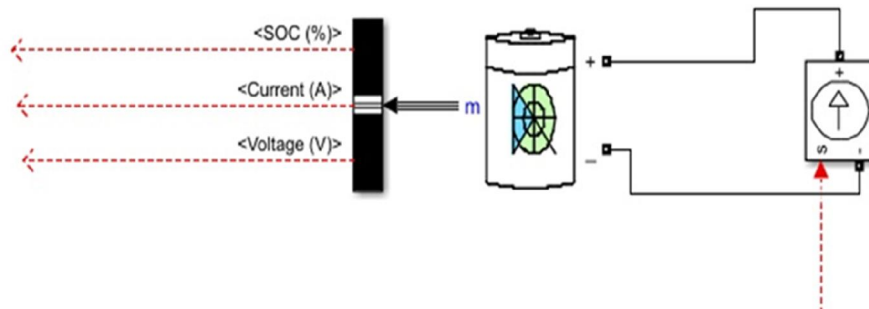
Battery Pack Subsystem

5. Simulink Model of Battery Electric Vehicle

To Simulation, add a powerful block. To see the outputs and behaviour of the Electric Vehicle model, add a scope and display block. The signal builder block is used to construct a reference signal. The feedback loop will be explained using the reference signal and real speed on the same graph. We may also calculate the electric vehicle's average speed. We can study battery charging and discharge during deacceleration and acceleration commands, respectively, with the use of the SOC graph. The General Electric Model utilised to observe the vehicle's SOC percentage and average velocity is depicted in the diagram below.
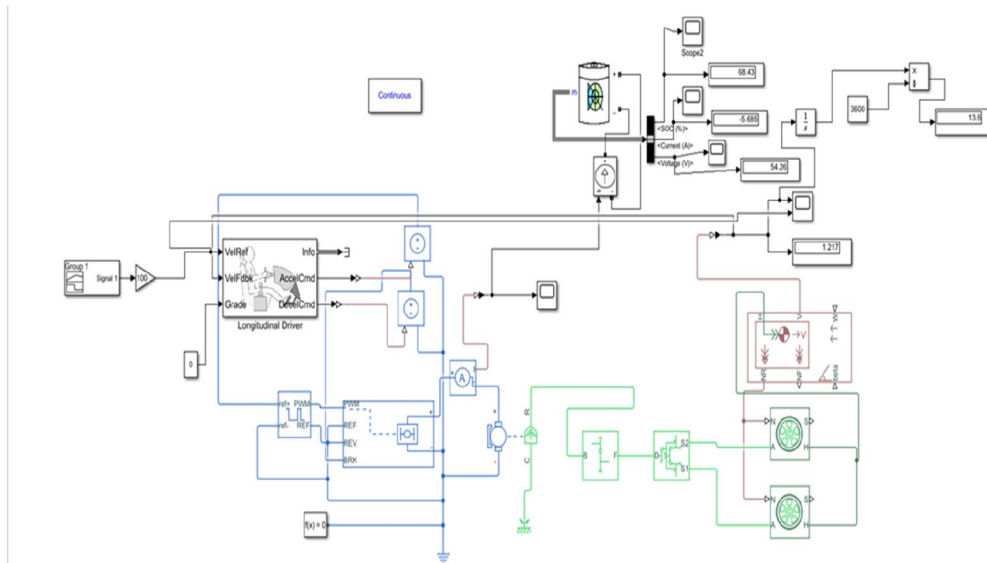
Simulation of Battery Electrical Vehicle

II. RESULTS

The reference speed is generated initially using the signal builder block. It has been determined to go at a peak speed of 100 km/h. Simulate the model for 1,000 seconds. The speed rises for the first 400 seconds. The speed remains steady for the next 200 seconds, then progressively slows for the final 400 seconds. The image below shows the reference signal created with the aid of the signal builder block.
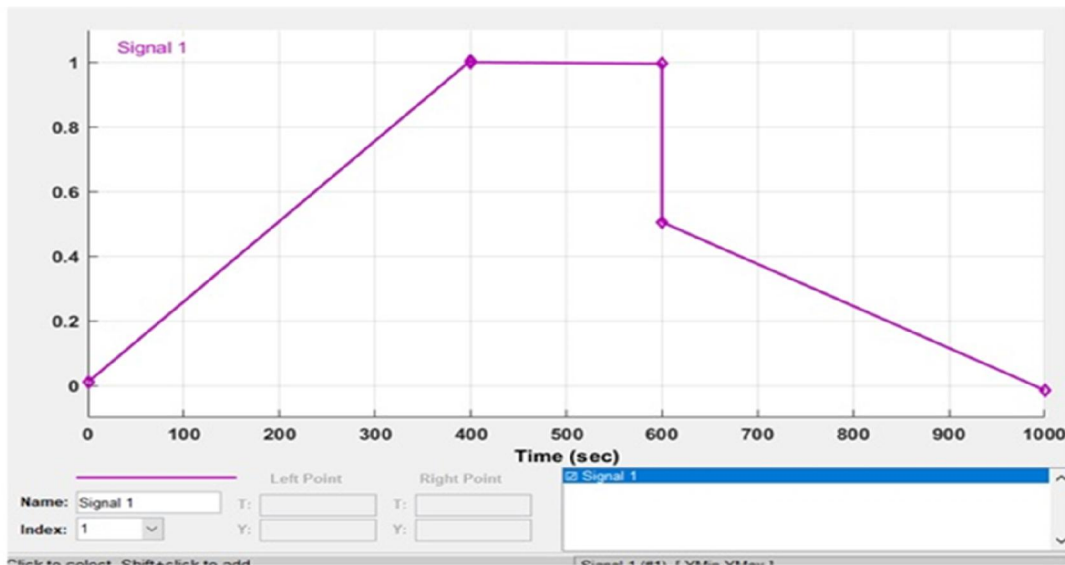

Generated Input Signal

Take a look at the graph of SOC percent. In this situation, the battery will be depleted non-linearly for the first 400 seconds before being reduced linearly for the next 200 seconds. During the remaining 400 seconds, the battery will be charged and drained, resulting in the answer.
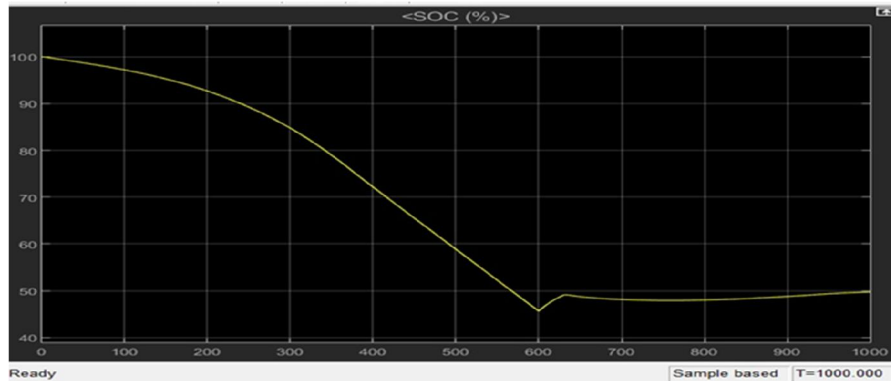
Graph of SOC%

The graph below demonstrates how the vehicle's real speed follows the reference speed of the input drive cycle.
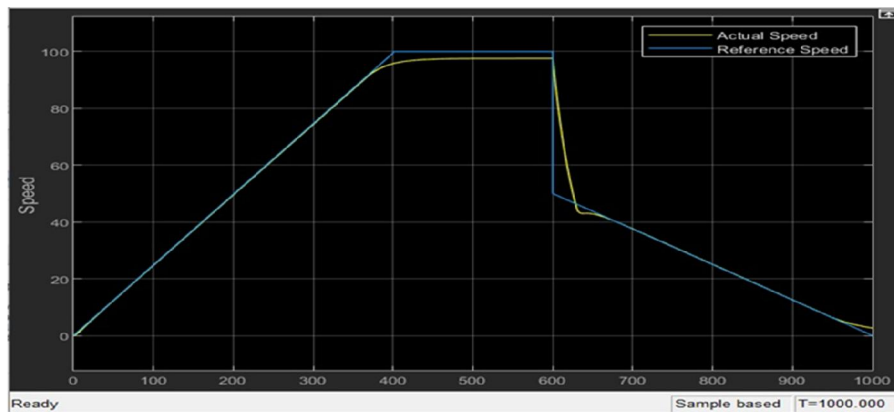
Actual Speed and Reference Speed on the Same Graph

Assume we're looking at a 1,000-second average speed. It's nearly the same as the average speed indicated on the graph in this case.

III. CONCLUSION

The percentage of SOC as well as the speed graph are displayed. When an acceleration command is sent, the battery is depleted, according to the SOC % graph. When a deceleration command is issued, the battery gets charged. The Speed graph displays how the real speed tries to match the reference speed while taking input into account. According to the model, the electric vehicle travelled about 14 kilometres in 1,000 seconds. The vehicle will move almost 50 kilometres per hour if we measure the average speed. The measured average speed and the graphed average speed are virtually similar. Listed below are a few examples: It would be a high-potential, high-efficiency technology.

IV. FUTURE SCOPE

- In the future, we may be able to create solar-powered electric automobiles.
- It would be extremely beneficial to the environment if we could replace current fuel-based transportation with electrified transportation.
- Ultra-charging stations and battery-treatment equipment will have numerous advantages. It will have a significant impact on the growth of electric vehicles as well.
- Unlike batteries, conservative oil has a high calorific value. Nonetheless, the battery conversion process is more than just a matter of conserving fuel.

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