MODELLING AN ELECTRIC VEHICLE USING MATLAB

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Abstract:
The usage of Electric Vehicles (EVs) has proportionally increased in the recent years due to the positive impacts of the EVs. These positive impacts include their usage their non-dependency on the depleting reserves of the conventional fuels and their environmental friendly emissions as compared to the air pollution caused by the usage of the conventional vehicles .Due to the recent develop-mends of the electrical sources such as Super Capacitors (SCs), Fuel Cells (FCs) and the advancements in the conventional battery systems, the performance of the EVs has reached new heights. Due to their independency from the increasing fuel prices of the conventional fuels and their non-emission of air pollutant characteristics the modeling and control of the EVs has received a major focus in the recent years. The modeling of the EV presents many challenges as it is the combination of the many complex sub systems such as battery management systems, electrical motors and the power electronics interfaces. .in this paper, we developed an EV with driving cycles. The developed model contains a battery source, DC motor, vehicle body, longitudinal driver, tire, simple gear box, driving cycle. simulation was performed using FTP75 drive cycle with time 1874 seconds and wide-open throttle (WOT) with time 60 seconds and we obtain the speed comparison curve and the state of charge of battery after simulation time

Keywords: Batteries, Electric Vehicles, simulation model, Driving cycle.

1-INTRODUCTION

The usage of electric vehicle (EVs) has proportionally increased in the recent years due to the positive impacts of EVs. These positive impacts include their usage their non- dependency on the depleting reserves of the conventional fuels and their environmentally friendly emissions as

compared to the air pollution caused by the usage of the conventional vehicles. Due to the recent developments of the electrical sources such as super capacitors (SCs), fuel cells (FCs) and the advancements in the conventional battery systems, the performance of the EVs has reached new heights. Due to their independency from the increasing fuels prices of the conventional

fuels and them non_ emission of air pollutant characteristics the modeling and control of EVs has received a major focus in the recent years. The modeling of EV presents many challenges as it is the combination of the many complex sub systems such as battery management systems, electrical motors and the power electronics interface. the primary components of an EV system are the motor, controller, power source and transmission. The detailed structure of an EV system and the interaction among its various components are shown in a figure

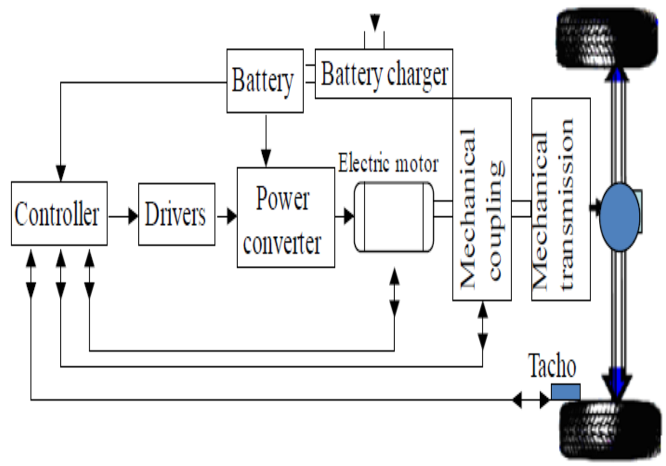


Fig. 1 general block diagram of ev

The module consists of three different systems, control signal represents by driver cycle source and longitudinal driver, electrical signal represents by DC motor and battery, mechanical signal represents by vehicle body, tire and gear box. In this model we use the driving cycle to evaluate the performance of the vehicle and the battery discharging characteristics (SOS). The drive cycle source block generates a standard or user _ specified longitudinal drive cycle. The block output is the specified longitudinal speed. Drive cycles from predefined sources. By default, the block includes the FTP_75 drive cycle which represents a city drive cycle the figure shown the FTP _75 Drive cycle

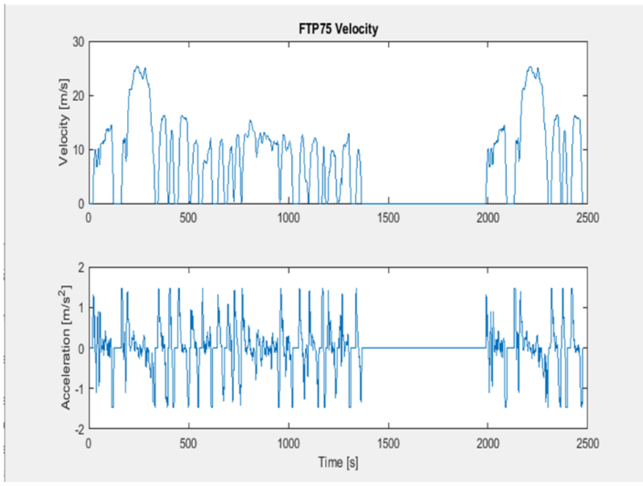
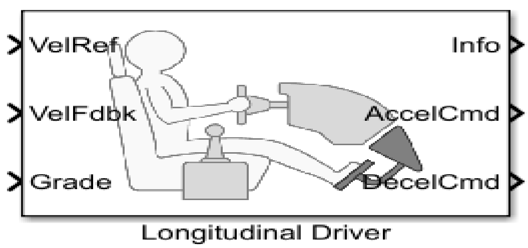


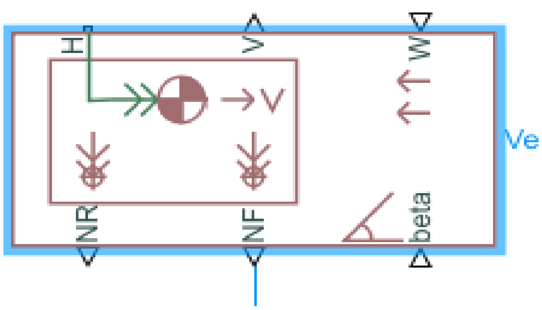
Fig. 2 the velocity and acceleration of ftp_75 drive cycle

The longitudinal Driver



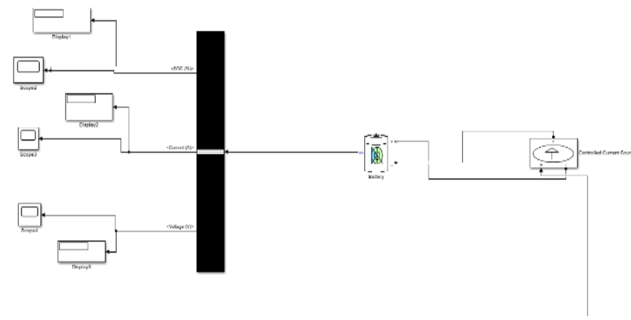
block implements a longitudinal speed _ tracking controller. Based on reference and feedback velocities, the block generates normalized acceleration and braking commands that can vary from 0 through 1. You can use the block to model the dynamic response of driver or to generate the commands necessary to track a longitudinal driver cycle.

Vehicle body



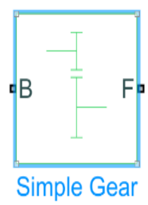
represents a two-axle vehicle body in longitudinal motion. The block accounts for body mass, aerodynamic drag, road incline, and weight distribution between axles due to acceleration and road profile. The vehicle can have the same or a different number of wheels on each axel. Optionally include pitch and suspension dynamics. The vehicle does not move vertically relative to ground

The battery packs



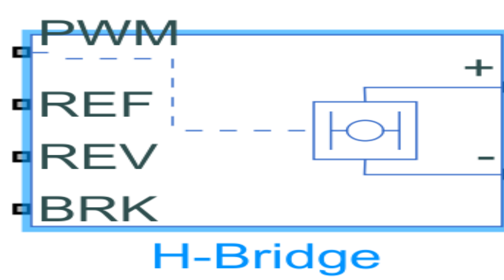
is the powerhouse of the electric vehicle model supplies power to motor and other equipment’s necessary for the efficient operation of the vehicle? power converter convert power from the battery to an optimum level as required by DC motor. Converter is bi_ directional which helps in tacking regenerative energy back to the battery thereby providing charging while deceleration of the vehicle. Used to a model with longitudinal behavior given by equation based on four fitting coefficients, the block can model tire dynamics under constant or variable contact surface conditions

Simple gear



box is used to connect the motor to the rear axle of the vehicle.

H_ Bridge



IS used to represent h-bridge motor driver which controls the power input to the motor according to the load requirements. Controlled PWM voltage produce a pulse width modulated signal to control voltage fed to H_ bridge as per requirement. a solver configuration block specific solver parameter necessary for simulation and is connected to the physical network of the motor controller.

The flowing figure shown the final model

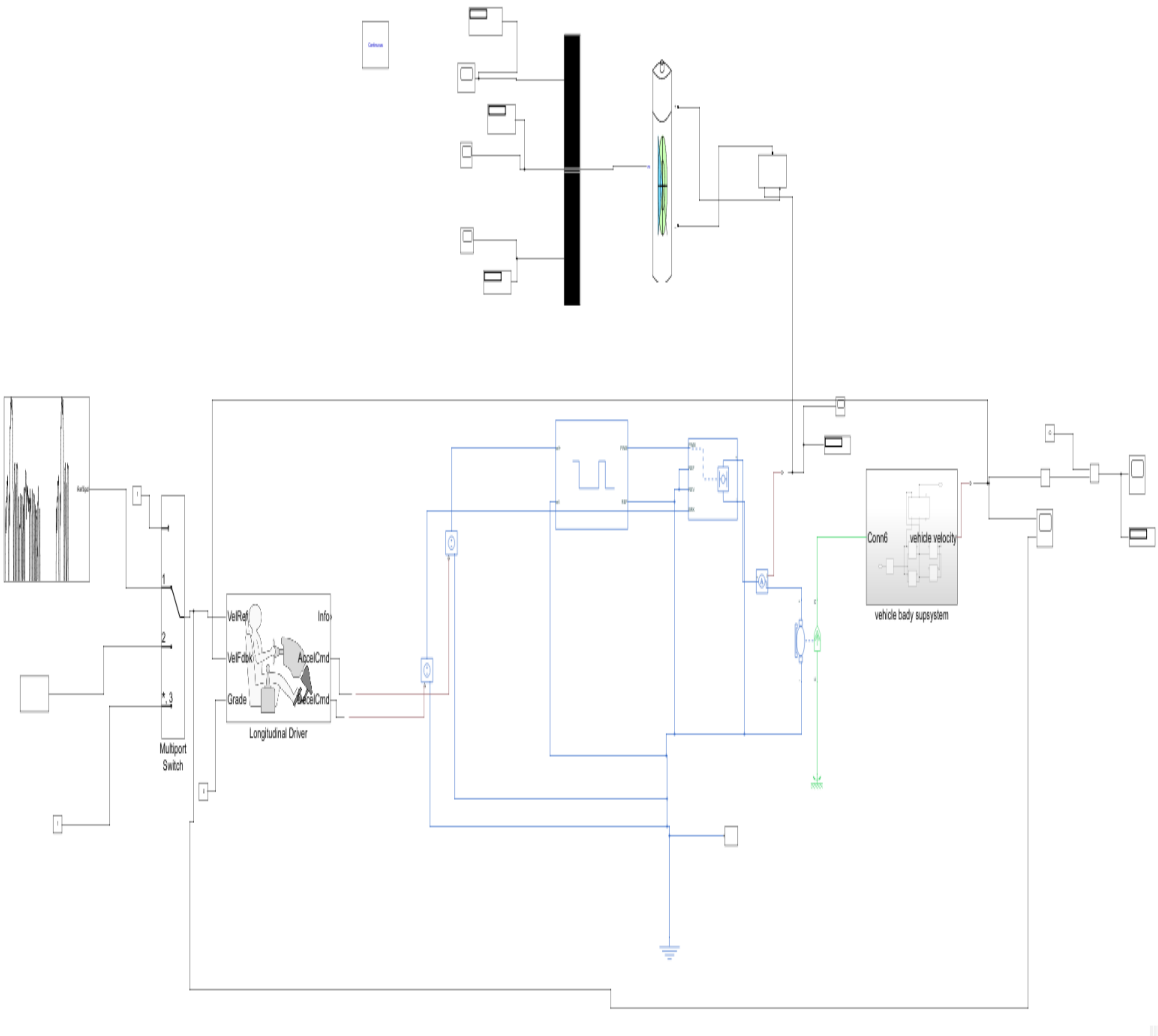


Fig. 3 the final MODEL

The simulation results with FTP75 drive cycle

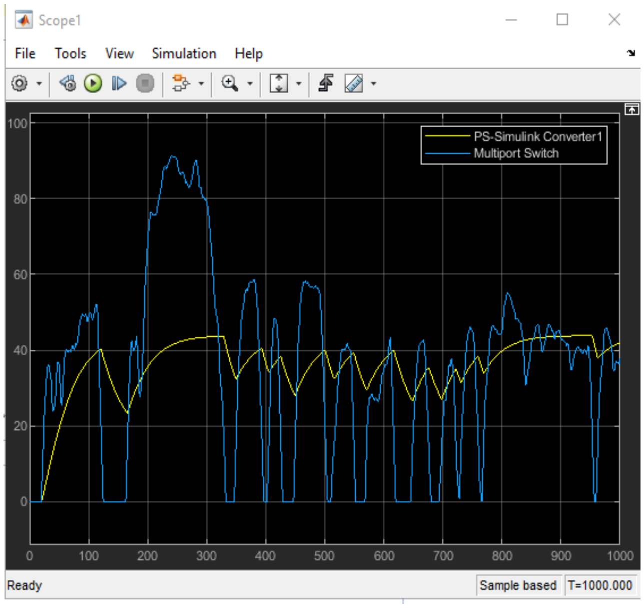


Fig. 4 the first comparison BETWEEN VEHICLE speed and the driving cycle speed

-The results after change the parameters of the longitudinal driver

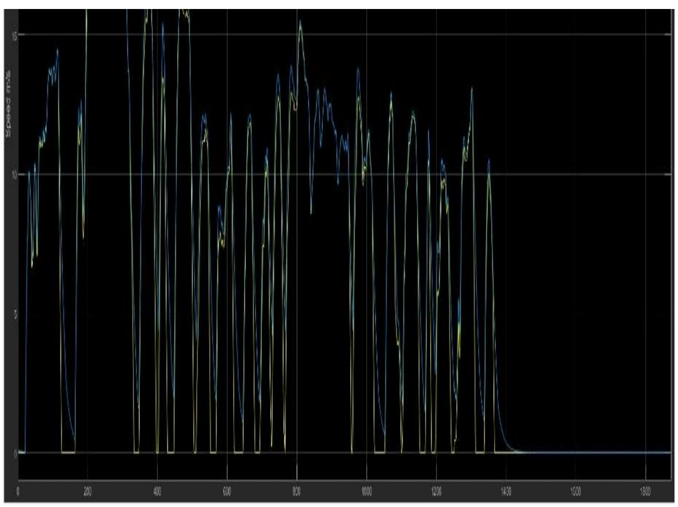
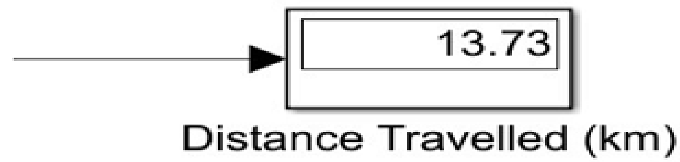


Fig. 5 the result after change the longitudinal driver parameters

the speed (m/s) from the driver cycle and speed feedback from the vehicle body is plotted to understand the response of model according to drive cycle data. the FTP75 drive cycle is used to perform the simulation with simulation time of 1875 seconds. Speed comparison curve shows that the actual vehicle speed (blue curve) almost follow the reference curve (yellow curve) through the simulation. During peak deceleration, speed comparison curve shows a difference in velocity which is encountered due to inertia effect of the vehicle and instantaneous drops in reference curve. In reference curve the distance covered in 1875 seconds is around 17.77 km average speed 34.1 km/h, from the simulation the distance covered by actual vehicle speed at the end of simulation at time 1875 seconds 13.6 km



The is due to instantaneous velocity variation in the drive cycle data which is not exactly followed by the vehicle in actual scenario.

the state- of _ charge of battery

the FTP75 drive cycle is having several acceleration and deceleration profiles that varies randomly which depicts a real-life driving scenario which help to track the natural of the battery discharge while different acceleration profiles and regenerative charging effect and different decoration profiles. The soc scope bloc helps in keeping track of the remaining battery capacity

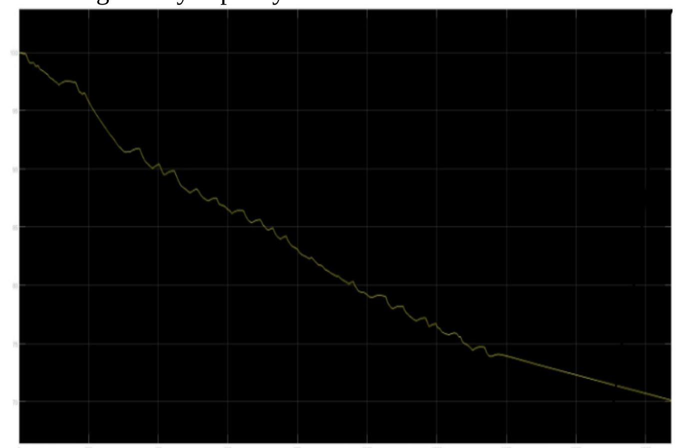


Fig. 6 the state of discharge of battery after simulation using ftp_75 driving cycle

Starting from 100% after traveling distance 13.73 km/h in about 30 minutes the state of charge of battery reaches around 70%

The simulation results with wide open throttle

Speed comparison curve

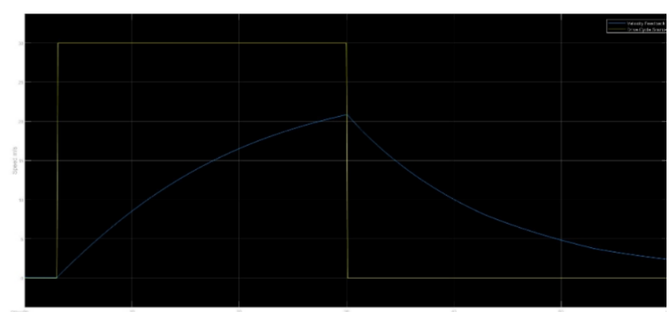
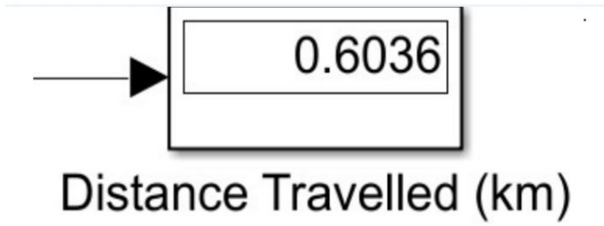


Fig. 7 the compression between the vehicle speed and WIDE-OPEN throttle

In WOT condition, the vehicle is accelerated with full throttle in reference to 30 m/s and reaches a value of 22 m/s in 30 seconds and decelerates with reference speed of 0 m/s after 30 seconds

Distance travelled by WOT in reference velocity is 0.8 km, while distance covered by actual vehicle speed is 0.6 km



State of charge of battery

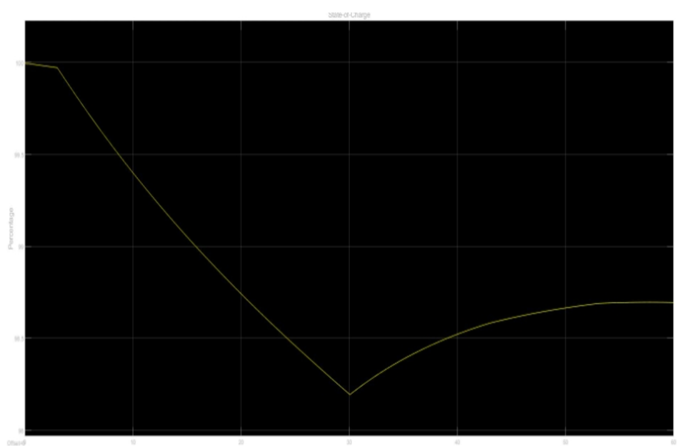


Fig. 8 the state of discharge of battery after simulation using wide open throttle

During the peak acceleration command in the start of WOT condition from t=3 second to t=30 second, the battery SOC
Drops from 100% to 98.2% in 27 seconds time. During deceleration after 30 seconds a regenerative voltage produced
By motor helps the regenerative recharge of battery charging the Battery from 98.2% to 98.6% in next 30 seconds time.

Conclusion

a basic electric vehicle model was created with Simulink and simulation was performed using FTP75 drive cycle with time 1874 seconds and WOT with time 60 seconds and we obtain the speed comparison curve and the state of charge of battery after simulation time

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