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MODELING AND SIMULATION OF ELECTRIC MOTOR DRIVE FOR BATTERY ELECTRIC VEHICLE

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ABSTRACT: Electric vehicles are regarded as the future of e-mobility since they offer tons of benefits. Electric motor is the most important part in order to power an electric car. The performance of such type of vehicle depends on a number of variables, including the motor drives employed, energy storage system , battery management system etc.So it is imperative to study more about these motors in details and find out more about the properties of each of its kind and how suitable it would be to use them in an electric vehicle. In this dissertation, the model of an electric motor drive system for battery powered EVs has been simulated in MATLAB/SIMULINK environment. The simulation result is used to determine the system performance of the vehicle.

Keywords: Electric Vehicles, Simulation of EVs, Selection of Motor, Batter Electric Vehicles, State of charge (SoC)

I. INTRODUCTION

ICE-powered conventional vehicles are also known as ICEV.When an EM or many electric engines are used to power a vehicle's wheels, the vehicle is referred to as an EVs. When both an EM and an internal ICE drive the wheels of a vehicle, the vehicle is referred to as a "half and half electric vehicle" (HEV). Electrical vehicle are just talked about in this thesis.In EVs, the battery is the first energy source and gives electric capacity to electric engine drives and other gear's like lightning gadget. The regular control precise of EVs is portrayed. It very well may be seen that the ordinary control arrangement of EVs incorporates five electrical control unit(ECU), which are the really ECU, motor ECU, battery ECU, break ECU and electric hardware ECU. The super electric control unit control the drive force of electric vehicle by figuring the engine force in light of data, for example, the gas pedal opening and vehicle speed order .The force demand esteem is shipped off the engine Electric control unit. As per the drive yield esteem mentioned by the really electric control unit, the engine electric control unit controls the engine drive to foster the longing force. The engine drive can be utilized to accomplish force direct control. By organizing the breaking exertion the regenerative breaking That is executed by the engine the break electric control unit, for example, a minor that the whole brake force delivered by both the regenerative slowing mechanism and the customary pressure driven slowing mechanism.

II. TYPES OF EVs

There are three types of EVs:-

a) **BATTERY ELECTRIC VEHICLES (BEVS): A** battery electric vehicle is a friendly mode of transportation that is powered by rechargeable batteries only. It eliminates the need for fossil fuels and produces zero tailpipe emissions, making it a sustainable option for the environment. BEVs have gained popularity due to their quiet operation, low maintenance cost and low dependence on conventional fuel sources. With advances in battery technology, BEVs are now able to offer impressive driving ranges and quick capabilities, making them a viable option for daily commuting and longer journeys.

b) **HYBRID ELECTRIC VEHICLES (HEVS):**An internal combustion engine, an electric motor, and a rechargeable battery are all combined in a hybrid battery vehicle. By alternating between the two power sources, it maximizes fuel economy and lowers pollution. During acceleration, the battery boosts the engine's output and stores energy through regenerative braking. When compared to traditional automobiles, hybrids have better fuel efficiency, which saves money and has a smaller negative impact on the environment. For drivers looking for both efficiency and sustainability, hybrid battery vehicles offer a balance between conventional and electric technologies thanks to their dual power system.

c) **PLUG IN HYBRDE ELECTRIC VEHICLES (PHEVS):** Modern cars called plug-in hybrid electric vehicles (PHEVs) combine an internal combustion engine with an electric motor and a rechargeable battery to provide the flexibility of both fuel-powered and electric driving. PHEVs may go greater distances on electric power alone since they can be recharged by connecting them into an external power source. This improves environmental performance by lowering fuel use and exhaust emissions. PHEVs provide drivers the advantages of lower emissions while still allowing them the option to use gasoline when necessary, making them an easy step toward completely electric cars.

III. PARTS OF AN EVs

EVs is a very modern machine and it has different parts in it that all work together to help in the impetus of the vehicle. An ordinary electric vehicle has the accompanying parts:

a) **POWER BATTERY:** This is the wellspring of the entire cycle. It gives the importantpower expected to control up the electrical parts and parts of the vehicle.

b) PORT FOR CHARGING**:** The charging port is a method for empowering the charging of the vehicle. Mixture electric vehicles for the most part don't have a charging port as utilize the gas powered motor present in them and charge the batteries just by means of regenerative slowing down.

c) **DC/DC CONVERTER:**The battery pack that is available in the vehicle is of highlimit and whenever took care of straightforwardly to the electrical parts of the vehicle, the parts tend to come up short. Parts can work securely. This is where DC converters come into the image. A DC converter is a gadget that changes the degree of voltage to suit our application. The primary sorts of DC converters utilized fundamentally are the buck converter, help converter, and the buck-support converter. The buck-support converter can either move forward or step down the Volt.

d) **ELECTRIC TRACTION MOTOR:**This is viewed as the fundamental part of the EV. The EV engine is liable for the impetus of the vehicle and this is finished by the engine utilizing the power took care of in by the battery and changing over it into mechanical energy that is then provided to the wheels to drive the vehicle forward.

e) **TRANSMISSION**:The mechanical power that is created by the engine should be moved to the wheels to impel the vehicle forward the transmission framework moves the mechanical power produced by the engine to the wheels, in this way helping in the impetus. The transmission comprises of the differential and the stuff frameworks alongside the axles and the wheels.

IV. DIFFERENT CONFIGRATION OF DRIVETRAIN SYSTEM

a) **CONVENTIONAL TYPE:**An internal combustion engine that runs on fossil fuels like gasoline or diesel is what is referred to as a "conventional vehicle" in the context of traditional automobiles. To transmit power from the engine to the wheels, these vehicles rely on a complicated drivetrain system that includes a transmission. Conventional cars have been the major mode of transportation for a long time, but they produce exhaust emissions and need frequent maintenance.

b) **TRANSMISSION TYPE:**Since there is no gearbox, the transmission-less drivetrain architecture in EVs operates on the conventional kind.

c) CASCADE TYPE:The transmission less type can be reconfigured into the differential less type, in the case that the differential stuff is removed. This kind, often referred to as the instantaneous drive type, has two engines installed on the body side, with joints set up to convey power to the wheels and perform a function comparable to the differential.

d) **IN WHEELTYPE WITH REDUCTION GEARS:**The transmission-less sort's detachment yields this type. Two engines are installed on either side of the wheels, and reduction gears are included to power the wheels.

e) **IN WHEEL DIRECT DRIVE TYPE**:Back tires and the engine are synchronized so that pivoting may be done naturally without the usage of accessories. This type of wheel**drivetrain architecture has an instantaneous drive.**

f) **FOUR WHEEL DIRECT DRIVE TYPE**: Four in wheels are used to directly operate four wheels independently. It is likely that the EV is driven by an electricmotor.The drivetrain architecture becomes smaller and less intrusive, reducing power transmission losses. The drivetrain plot with the single level reduction gear is a superb choice to fully take advantage of the many result characteristics and small engine size coming from high most extreme speed for electric engine drives.

V. ELECTRIC MOTORS IN EV

Various kinds of engine display various qualities, which makes it critical to assess engines on a few fundamental boundaries for picking a specific sort of engine for an EV. Electric engines utilized in electric vehicle ought to have significant characteristics like straightforward plan, high unambiguous power, low upkeep cost, and great control. Engines that are broadly utilized by electric vehicle producers are DC BM, and BLDC, Acceptance (Offbeat) engine, Simultaneous engine, Exchanged Hesitance engine.

a) BRUSHED MOTOR: Even though they are less frequently utilized in contemporary electric vehicles (EVs), brushed motors offer unique properties and limits. They are made up of a spinning armature and a still magnet, and brushes and a commutator help current flow. Brushed motors are easy to use, inexpensive, and provide a lot of torque at low speeds. Additionally, as the brushes age, they need to be replaced and maintained frequently, which raises the expense of operation. Furthermore, brushed motors produce more heat, making it more difficult for EVs to regulate heat effectively. Due to their superior efficiency, increased dependability, and reduced weight, BL like (PMSMs) and (IMs) are favoured in electric vehicles (EVs).

b) **BLDC MOTOR:**DC brushless engine gives specific benefits over DC brushed motor, as less upkeep and higher productivity. Mechanical recompense as in brushed DC engine is supplanted by comparable electronic replacement (inverter circuit and rotor-position detecting component) circuit in DC brushless engine. Public Electrical Makers Association (NEMA) describes BLDC engines as pivoting coordinated machines with a highly durable magnet rotor andrealized rotor shaft locations for electronic replacement. When compared to other engines, BLDC engines produce more force at the maximum potentials of current and voltage. As a result of these engines' superior performance at greater speeds, blowers, siphons, and ventilation systems increasingly employ them.

c) **ASYNCHRONOUS MOTOR:**3phase IM are broadly utilized in electric vehicles due to high proficiency, great speed guideline and nonattendance of commutator. Three phase AC supply is associated with stator twisting, because of which rotating attractive field is laid out. This spinning attractive field interfaces with fixed rotor guides, and incited current courses through rotor guides. Instigated current lays out its own attractive field. Connection between spinning attractive endlessly field because of incited flows leads to unidirectional force, As speed of rotor is unique (not as much as) speed of rotating field (coordinated speed), these engines are additionally called as current engine.

d) **SYNCHRONOUS MOTOR:** Rotary speed is a synchronous in SM. While the stator is conducted a three phase ac source is powered by a dc supply, stator and rotor initially have opposite polarity. Rotor S-post is now being repelled by stator S-shaft. Currently, rotor S-shaft will be dragged in nearer stator N-post during a subsequent half-cycle when stator posts shift their polarities. Rotor S-post and stator N-shaft are interlocked with the rotor pivoting in a clockwise bearing. The rotor and stator shafts are now linked, allowing the rotor to turn quickly and simultaneously regardless of whether external influences are eliminated. Rotor should be pivoting quickly enough to cover a shaft pitch in half the time required for supply. Synchronous motors find applications in servo, wind turbine, and electric cars because of their great force thickness and efficiency.

e) **SWITCH RELUCTANCE MOTOR (SRM):**Due to its simplicity and dependability, SR Motors (SRMs) are occasionally utilized in electric vehicles (EVs). SRMs work by using the rotor's magnetic reluctance to generate torque. They are appropriate for difficult settings because of their strong and long-lasting design. SRMs are less expensive than other motor types since they do not contain permanent magnets. SRMs can, however, have lower power densities and efficiency, which prevents a wide-scale use in EVs. However, continuing research and technical developments attempt to get beyond these restrictions and improve the performance of SRMs for applications in electric car technology.

Motors	Power Density	Efficiency	Controllability	Reliability	Cost	Points
IM	★★★	★★★	★★★★★	★★★★★	★★	18
PMSM	★★★★★	★★★★★	★★★★	★★★★	★★★★	22
SRM	★★★	★★★	★★★	★★★★★	★★★	17
DC	★★	★★	★★★★★	★★★	★★★	15

We considered parameters like power density, efficiency, controllability, reliability, heat generation and construction for comparison and conclude that PMSM motors best suit our application as above picture.

VI. SIMULATION AND EXPERIMENTAL VEHICAL ENERGY MODEL

The vehicle body was first made and then transformed into a subsystem. A subsystem for DC motors and similar variants was also developed. The final model seen above was created by connecting them with the appropriate building components.

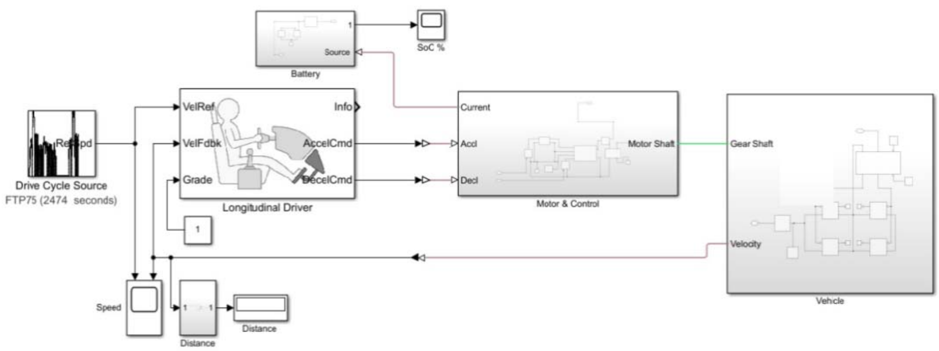


Figure 1SIMULINK Model of Electrical Vehicle Motor Drive

a) **Drive cycle:** A standard or customized longitudinal drive cycle is produced by the Drive Cycle Source block. The provided vehicle longitudinal speed is the block output, which you may use to: Calculate the amount of gasoline and engine torque a vehicle will need to run at the required speed and acceleration for the supplied gear shift reference. Create accurate velocity and shift references for closed-loop braking and accelerating orders for vehicle control and plant models. Over several driving cycles, analyze, tweak, and improve system performance and resilience, as well as vehicle control.

b) **Vehicle block:**

Vehicle body and tires:

The four tire and vehicle body are connected by gear and wheel in order to form the four-wheel design for an electric vehicle. This four-wheel tire connection is utilized with the NR and NF. W is the vehicle's body, and beta is the body's angel.

As a long-distance vehicle that operates with a four-fitting connection, the tire is the key factor in determining the vehicle's speed to shift to a variable surface speed to affect the tire's performance for an electric car. Input and output ports of function utilise a variety of ports.

OUTPUT is the S slip value, while INPUT is the N normal force action. The connected port are H represents the wheel hub and A represents the axis.

Gear: Gear is a function of the S and O that is used to control a vehicle's speed. S is the speed accelerator for the input, while O controls the function of the output shaft.

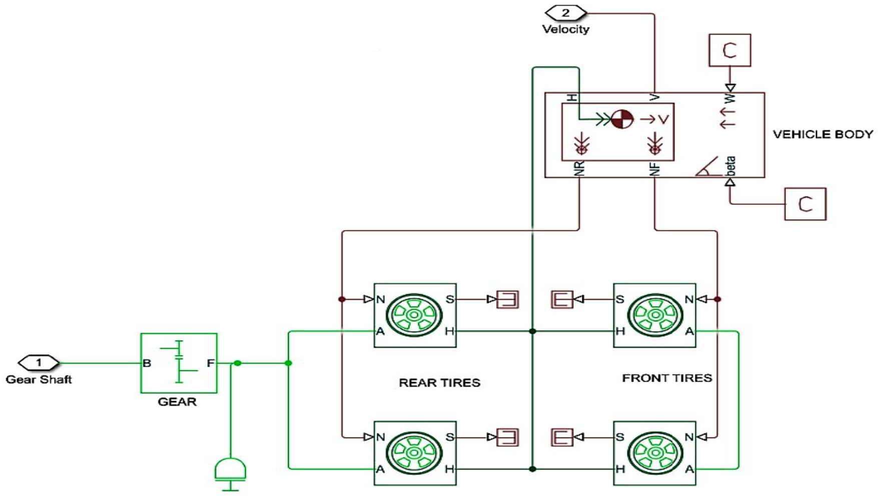


Figure 2 Vehicle block

c) **Motor and Power control:**The battery, PWM, H-bridge, and DC motor are all components of the motor control block, which is used to regulate the motor of a vehicle.The voltage signal that was received and used to produce the pulse signal for the PWM block's voltage controller is known as the PWM block's input, and the PWM block's REF output is known as the PWM block's pulse signal. To make the H-bridge operational, PWM and REF are used.

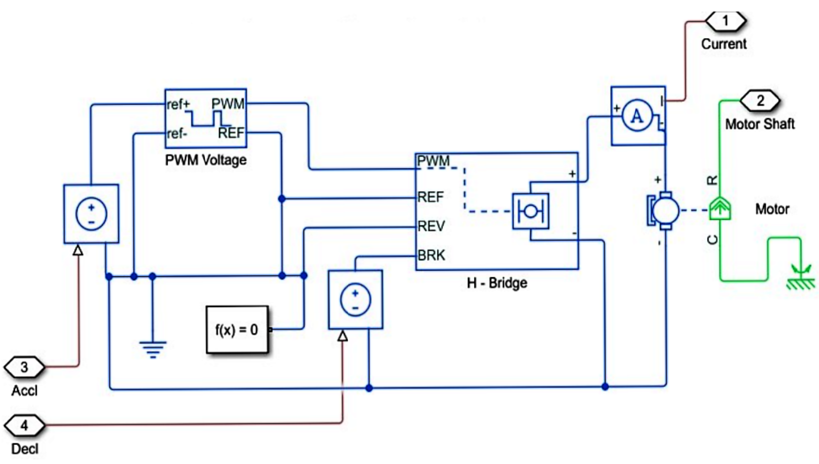
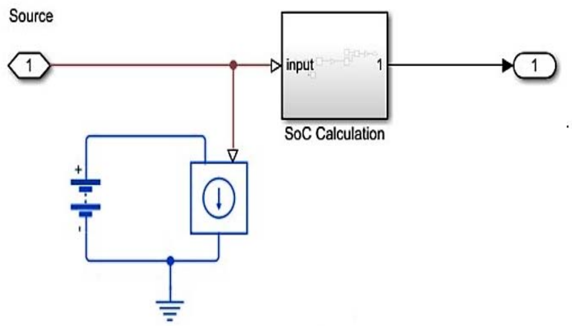


Figure 3 Motor and power control block

d) **Battery:**The battery, which has two terminals and is connected to the vehicle's (+,-) positive and negative terminals, is the source of power for the motor controller circuit. By doing so, the motor is linked as well as the source of current control.

e) **State of charge (SoC):**The following figure shows the subsystem to calculate the SOC given by the prepared Electric vehicle model.



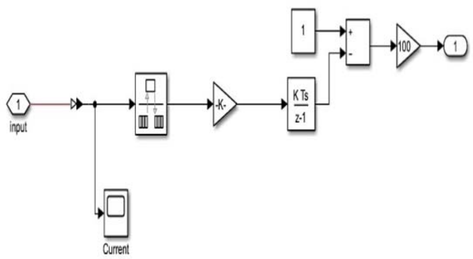
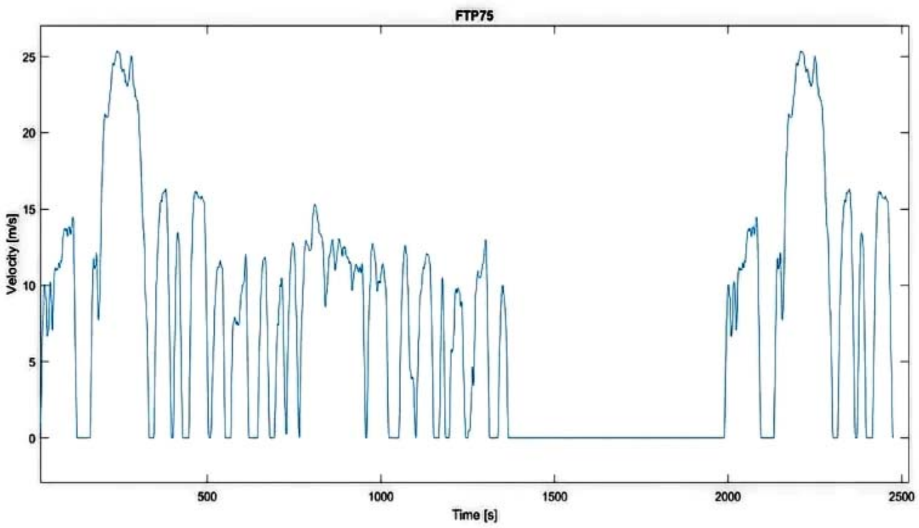


Figure 4 Battery BlockFigure 5 SoC Calculation

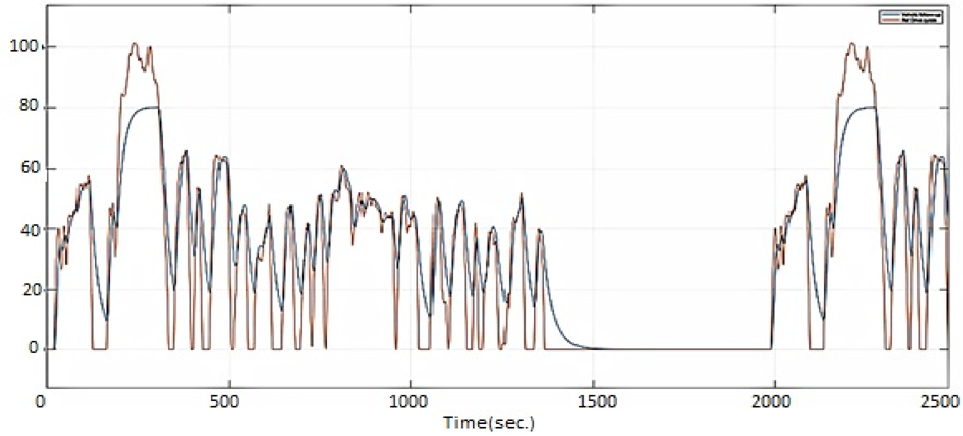
f). SIMULATION RESULTS

FTP75 Driver Cycle: One driving cycle source make up this system. We may choose one of these blocks since they are each linked to a multiport switch. Standard longitudinal drive cycles are produced by drive cycle source blocks. The vehicle longitudinal speed is the block output. The simulation in this case uses the FTP75, UDDS, and WOT Drive cycles. The following is the plot for the FTP75 cycle**.**



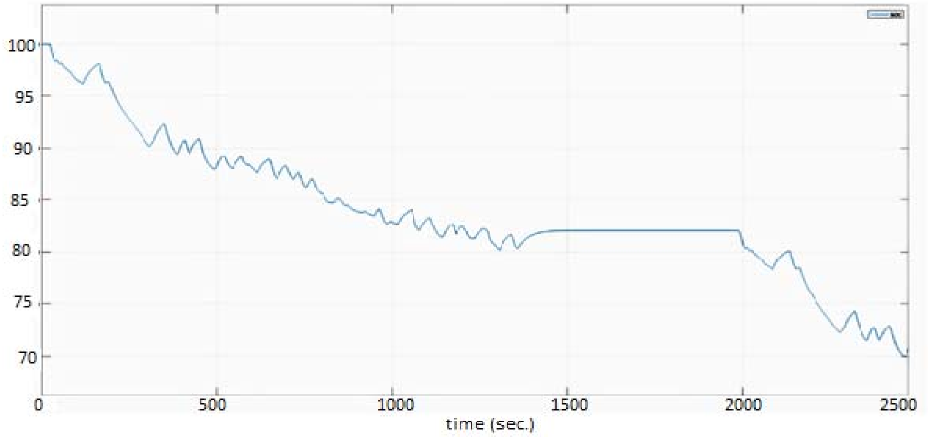
Velocity

The vehicle's velocity plot is seen in the plot below. Blue line represents vehicle velocity, while red represents the reference driving cycle.



We can tell from the map that the car followed our driving cycle as it travelled. The vehicle's top speed and the distance it travelled were both in accordance with the driving cycle.

State of charge of battery (SoC): Now that the vehicle's performance has been examined, we can examine the plot.



VII. CONCLUSION AND SCOPE OF FUTURE WORK

In this work, we successfully simulate an electric car for students using FTP74 drive cycle. Using the gathered data, we chose an appropriate motor and created an appropriate battery pack. Simulink was used to create a simple electric vehicle model, and reproduction tests were carried out at completely open choke using the FTP75 driving cycle. The model's effort to express the necessary execution levels to comply with the directions for speed increases and decelerations can be seen in the speed correlation bend, which can be separated from the little variation in the actual drive cycle and speed criticism bend. A detailed and comprehensive characterization of the engine control and vehicle block factors would enable the model to closely track the reference speed signal, improving the framework's visual representation. Changes in battery block factors may also be helpful in reducing the depth of release rate. It will boost the mileage of the car in just one charge-discharge cycle.

a) SCOPE OF FUTURE WORK:

- The model's block variables were parameterized in great detail in order to minimize that which separates the output speed signal from the reference speed signal.

- Optimizing the battery pack for maximum efficiency and performance
- Simulating in detail is preferred to simulating in average mode

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