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Integrated Vehicle Health Monitoring and Predictive Maintenance System for Hybrid Electric Vehicles

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Abstract--Integrated vehicle health management is a rapidly booming market globally. This aims on advanced technology for monitoring health and working conditions of a hybrid electric vehicle in real time working conditions. This growing trend allows us to introduce new electric vehicles in market with powerful motors, better driving range and better battery capacity. This makes people too complicated to choose electric cars and predict the health and working conditions of vehicle. In this paper a simulation modelling package of an electric vehicle with factors like motor ratings, Gear ratio, mass etc we can check any working condition of vehicle in real time with torque and speed, distance curves and we designed a vehicle which covers more distance is same time by reducing speed due to safety purpose for this we compared our vehicle with the BMW i4 vehicle.

Index Terms—Electric vehicle, Electric motors, Internal Combustion engine, batteries, Vehicle Simulation, Simulink.

I. INTRODUCTION

NASA first unveiled IVHM in 1992 as a system to gather information, identify, forecast, and minimize malfunctions while supporting operational choices and post-operational maintenance tasks for spacecraft.

Electric vehicles are expected to become the standard soon due to their high efficiency, quietness, absence of local pollution, and grid operator-friendly power management features. To evaluate the performance of an electric car, it is essential to have the appropriate model.

The electric car model contains a lot of different pieces, which makes it intricate. To prevent making the wrong inferences, each component must be modeled accurately.

II. BLOCK DIAGRAM

Creating a vehicle model with the fewest possible moving parts by utilizing separate component models. to evaluate the performance metrics using different drive automobiles, such as speed, distance, torque observing the operation under load and without load. understanding MATLAB models and how to configure them to correspond with real vehicles

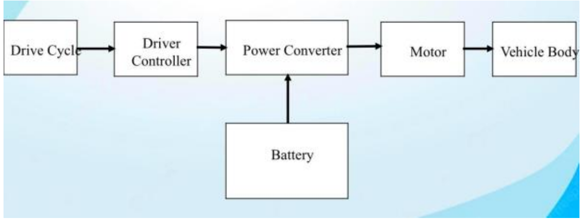

Fig. 1. Functional Block Diagram

This EV simulation model analyzes key vehicle parameters, including drivetrain, motor power, battery capacity, and vehicle mass. Three main portions have been identified in the simulation file. The first is the reference velocity generator, which oversees providing a reference velocity for corresponding result comparison and incorporates the Simulink block. The following portion contains the DC motor and controller, which control the motor's speed and the output power produced by pulse width modulation (PWM). The last component is responsible for the vehicle's gearbox and gear ratio in addition to the wheel configuration data such as the vehicle's mass and drag coefficient.

III DESCRIPTION

A. Drive Cycle and Driver Controller

Inputs for vehicle acceleration and deceleration are produced by the drive cycle source, which also provides longitudinal drive cycles. The longitudinal driver produces commands for acceleration and deceleration based on a comparison between the reference and actual velocities. Because the driver controller regulates the vehicle's acceleration and deceleration in accordance with the reference velocity, it is essential to achieving realistic simulation results. Accurate simulation is necessary to assess EV performance in different driving situations and conditions. The simulation model's accurate depiction of vehicle dynamics is facilitated by the drive cycle source and driver controller.

B. Power Converter and Battery

PWM and Averaged simulation models are its two available simulation modes. A PWM port input signal determines the controlled voltage that the H-bridge output produces. The electric power for the electric vehicle's drive train and other parts comes from a DC battery.

C. DC Motor and Vehicle Body

An electric car's wheels are propelled by a DC motor that draws energy from a DC battery. The motor is ideal for a variety of traction applications due to its high beginning torque. These devices can withstand sudden, heavy loads with ease. This vehicle body, which has two axles, has drag characteristics as well as changing vehicle mass, road inclination, and road profile. It features a dynamic suspension system and pitch system as options.

III. SIMULATION MODEL

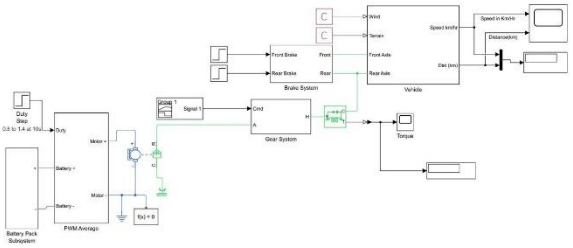

Fig. 2. Simulation Model of Electric Vehicle

- Simulation model contains several parameters which enhance vehicle performance in it like
- Vehicle Body

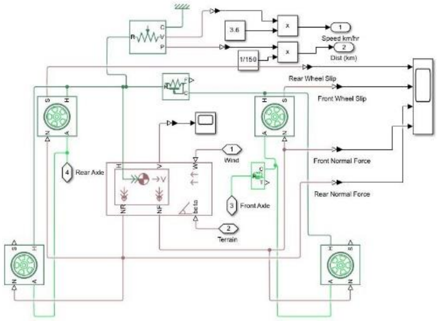

Fig. 3. Vehicle Body Subsystem

- Simple Gear

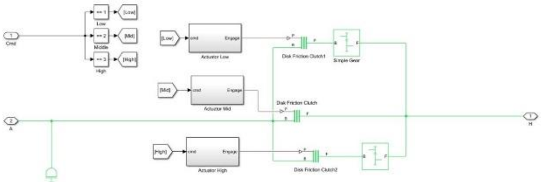

Fig. 4. Gear Subsystem

- Controlled PWM Voltage
- Controlled Voltage Source
- Magic Formula
- Longitudinal Driver
- Motor
- Power Converter
- Battery
- Driver Cycle

IV. IMPLEMENTATION

In MATLAB The simulation tools used in this work are Simulink and Simscape. For design and iterative analysis, Simulink offers a desktop environment, and Simscape lets users build physical systems inside the Simulink platform. Schematic diagrams of basic components can be put together to construct systems like refrigeration frames, hydraulic cylinders, and electric machines. More products with a large variety of intricate parts and improved analytical tools are available from Simscape for more intricate simulations. Simulink and Simscape integration make it easier to develop and analyze EVs thoroughly. System voltage, battery rating, drag coefficient, gear ratio, and motor specs are some of the chosen EV parameters for simulation. The Simulink model's integration of these factors allows for the simulation of driving cycles and vehicle performance. Precise simulation results and significant performance evaluation depend on accurate vehicle specification representation. Analyzing the effects of various parameters on EV performance is made easier by having a clear understanding of the significance of each parameter. A thorough evaluation of EV traits and behavior is made easier by the simulation model's parameter implementation.

V. VEHICLE DATA

Vehicle Data

Rider mass = 80 kg
Vehicle mass = 2125 kg
CG height = 254 mm
Drag coefficient = 0.24
Front axle = 1520 mm
Rear axle = 1400 mm
Front area = 2.31 m
Air density= 1.1 kg/m^3

Tire Parameters

Tire b = 10
Tire c = 1.9
Tire d = 1
Tire e = 0.97
Tire diameter = 18 inch
Tire inertia = 1e-3 kg*m^2
Initial Velocity=500 rad/s
Velocity threshold for rolling resistance=0.001m/s
Roll resistance = 0.005

VI. SIMULATION RESULTS

The simulation results section contains a thorough review of EV performance. Important components of the analysis include the assessment and comparison of vehicle acceleration, battery capacity, and actual vs. reference velocity. Accurately interpreting simulation results requires an understanding of how specific vehicle factors affect the findings. The results of the simulation provide important insights into how EVs operate in various driving scenarios and conditions. The suggested methodology's future iterations and implementations could improve EV performance analysis and evaluation even more.

Here BMW i4 covers speed to 146.7 km/hr which covers 6.626 km in 100 s with torque165.4

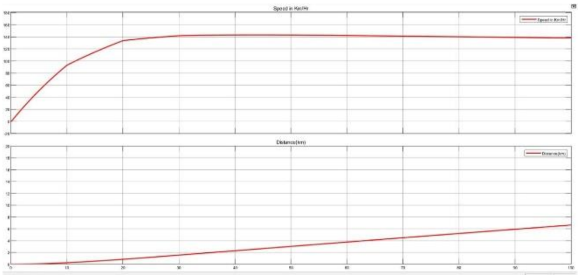

Fig. 5 Speed and Distance

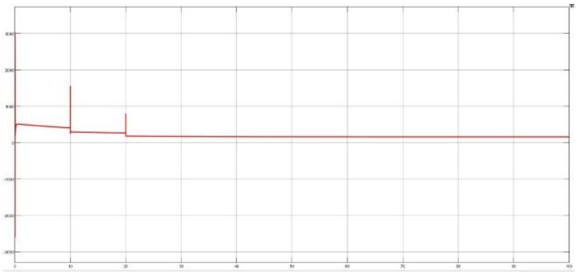

Fig. 6. TORQUE

Our enhanced vehicle travels 138 km/hr with safety measures and covers more distance than that 6.633 in 100 sec with torque of 157.6 efficient than above.

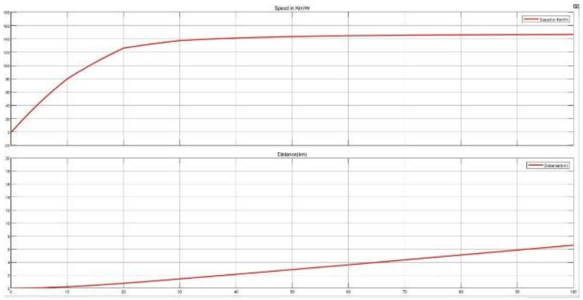

Fig. 5 Speed and Distance

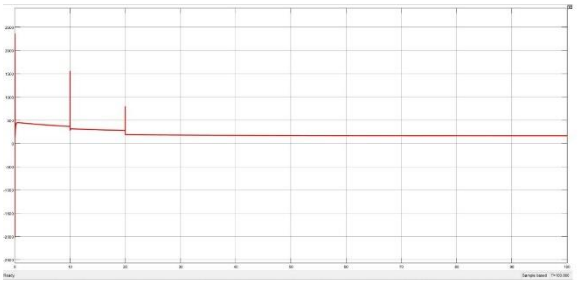

Fig. 6. TORQUE

This can be achieved by decreasing motor rated from 5000 to 3000 and gear ratio from 1.3 to 1.66 Mileage only depends on rated motor speed and gear ratio it is also possible with decreasing the weight of vehicle but not suggestible it effects build quality. By this results our vehicle safe and efficient.

VII. CONCLUSION

Electric vehicle performance in real-world circumstances can be accurately predicted and measured with the aid of reference velocity profiles and correlations between them. An electric vehicle's performance is determined in large part by variables including system voltage, battery capacity, and motor rating.

Every year, more and better types of electric vehicles enter the market as they continue to dominate the automotive industry. The comparative performance research of automobiles using simulation will provide purchasers more insight into the engineering process. The techniques presented in this study provide consumers with a straightforward and efficient means of comparing electric automobiles to determine which best meet their demands.

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