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Electric Vehicle Control Using Pmsm Drive, Pulivendulakadapa district, Andhra Pradesh

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ABSTRACT

This project focuses on the design and implementation of an advanced control strategy for electric vehicles (EVs) using a Permanent Magnet Synchronous Motor (PMSM) drive system. PMSMs are widely preferred in modern EVs due to their high efficiency, power density, and precise torque control capabilities. The proposed control architecture integrates Field-Oriented Control (FOC) for dynamic performance enhancement, ensuring efficient speed and torque response under varying load conditions. The system also incorporates regenerative braking and battery management considerations to optimize energy usage. MATLAB/Simulink simulations validate the effectiveness of the controller, demonstrating fast transient response, high efficiency, and robustness to parameter variations. This work contributes to the development of reliable and energy-efficient EV propulsion systems, supporting the transition toward sustainable transportation.

1.INTRODUCTION

Electric vehicle (EV) control refers to the system and methods used to manage and coordinate the operation of various components in an electric vehicle, primarily focusing on the electric motor, power electronics, and energy storage system. The main objective of EV control is to ensure efficient, smooth, and safe operation of the vehicle under different driving conditions.

At the heart of EV control is the motor controller, which interprets driver inputs like acceleration and braking and adjusts the power delivered to the motor accordingly. It regulates key parameters such as speed, torque, voltage, and current. Advanced control strategies like vector control or field-oriented control (FOC) are often used to achieve high-performance operation, especially with motors like PMSM (Permanent Magnet

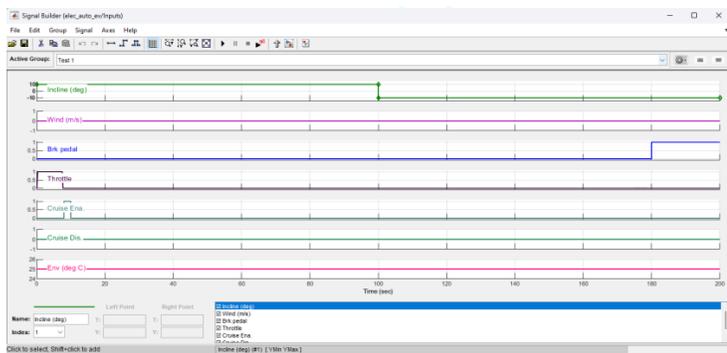
Synchronous Motor) and BLDC (Brushless DC Motor).

OBJECTIVES

1. This control strategy uses feedback from the motor (such as speed, position, or torque) to adjust the input to the motor. It continuously corrects the motor’s operation to maintain the desired performance To evaluate the impact of prolonged standing on musculoskeletal health.
2. FOC, or vector control, is a sophisticated method used in PMSM and BLDC motor control To identify coping mechanisms used by workers to manage pain and discomfort.
3. To achieve High Efficiency, High Power Density, Low Maintenance, Smooth Operation

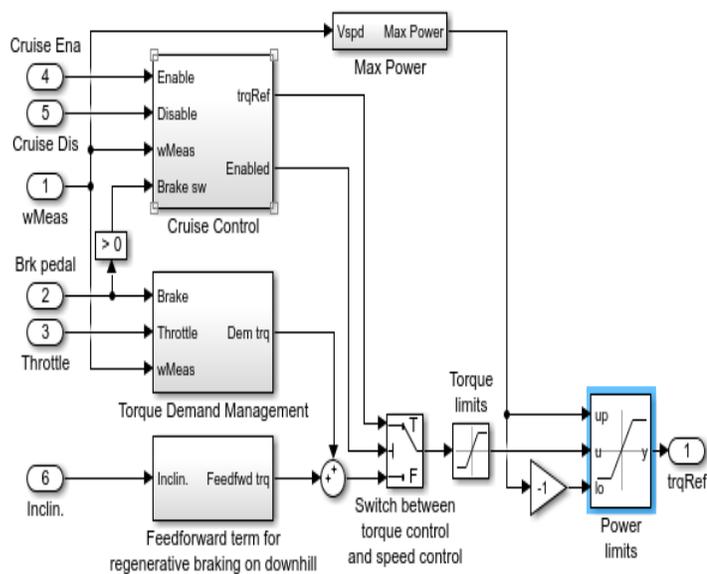
II. METHODOLOGY

1. Electric vehicle inputs



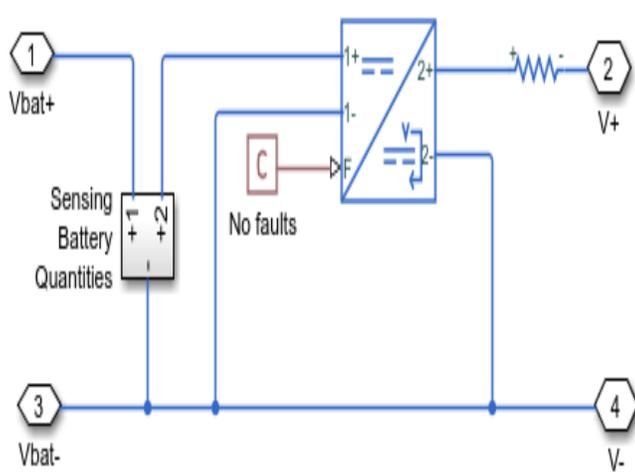
The Signal Builder interface in Simulink, which is used to create and manage time-based input signals for simulation. This particular setup is part of an electric vehicle (EV) model, where various driving and environmental conditions are simulated to test the vehicle's response

2. Vehicle Controls system



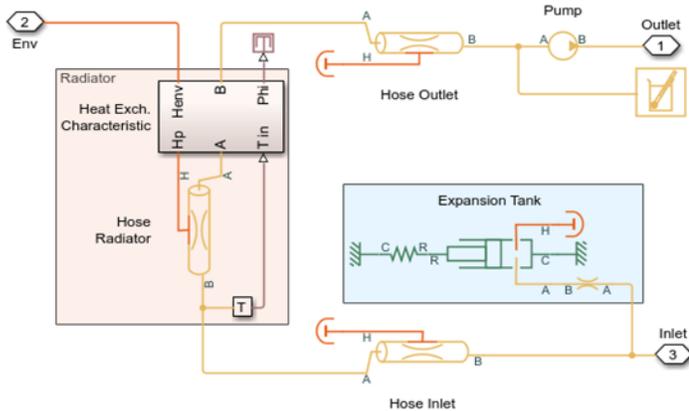
The Vehicle Control Subsystem in a Simulink-based electric vehicle (EV) model. This block is responsible for determining the torque reference (trqRef) that will be sent to the motor controller. The system combines multiple control strategies including Cruise Control, Torque Demand Management, and a Feedforward braking control based on road inclination.

3.DC-DC Converter



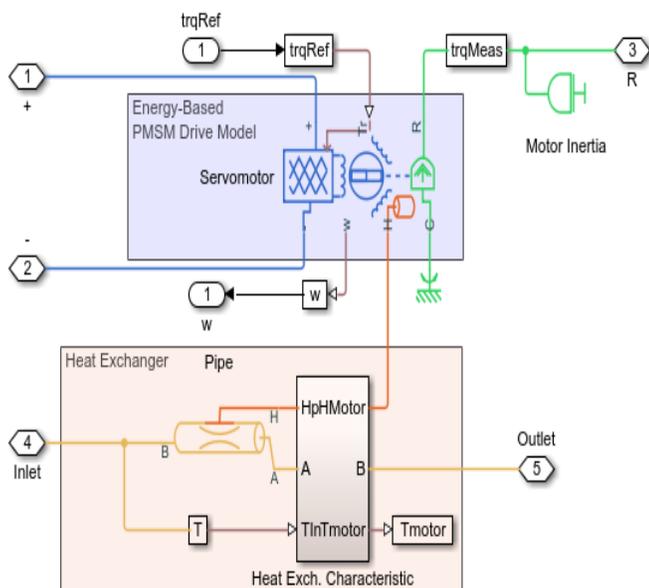
Battery Interface Subsystem in a Simulink model, responsible for connecting the battery to the rest of the electric vehicle's power system. The subsystem receives inputs from the battery terminals: Vbat+ (positive terminal) and Vbat- (negative terminal). A sensing block is used to monitor important battery parameters such as voltage, current, and potentially temperature or state of charge.

4.Electric Vehicle cooling system

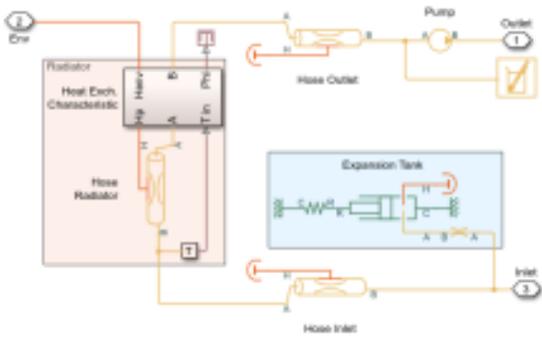


A thermal management subsystem used in an electric vehicle (EV), focusing on the cooling circuit for components such as the motor or power electronics. This system helps maintain optimal operating temperatures and prevent overheating. The loop begins with a pump that drives coolant through the system, directing flow from the inlet to the outlet.

5.PMSM Drive

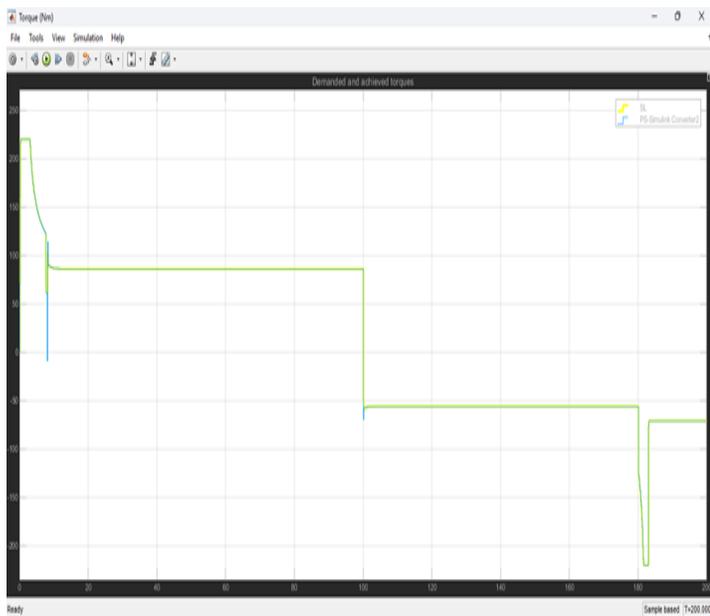


Permanent Magnet Synchronous Motor (PMSM) drive system with a thermal management subsystem, commonly used in electric vehicle applications. At the core of the system is the energy-based PMSM drive model, represented by the servomotor block. This block receives a torque reference signal (trqRef) and simulates the electrical and mechanical behavior of the motor, producing outputs such as measured torque and angular speed (w). The model is connected to a motor inertia component that represents the physical load and reflects the motor's rotational response.



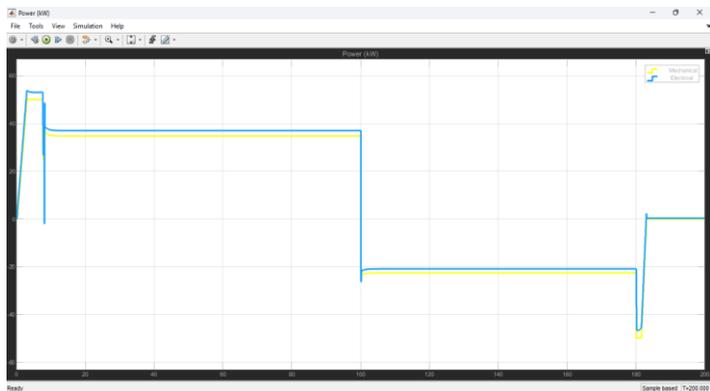
III. RESULTS AND DISCUSSION

1. Comparison between Demanded torque and achieved torque output



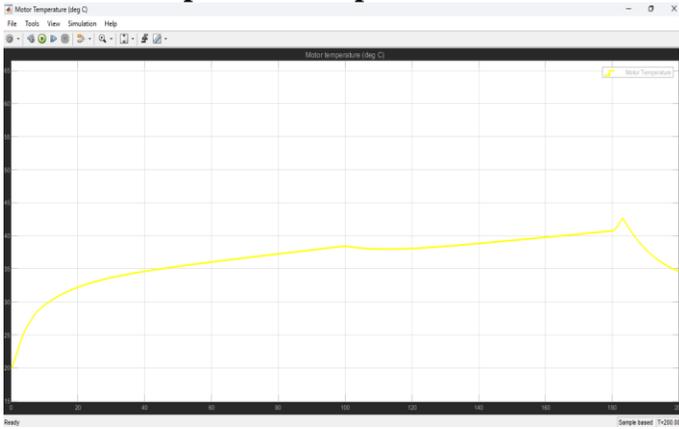
The comparison between demanded and achieved braking torques in a vehicle simulation, At the beginning, the torque demand is high, possibly due to a strong brake pedal input or a need for sudden deceleration. Over time, the demanded torque steps through different levels, simulating varying braking intensities. The achieved torque closely follows the demanded values, indicating that the system responds well to input changes. Slight delays or deviations between the two lines may highlight physical constraints, system lag, or control limitations

2. Comparison between mechanical power and electrical power



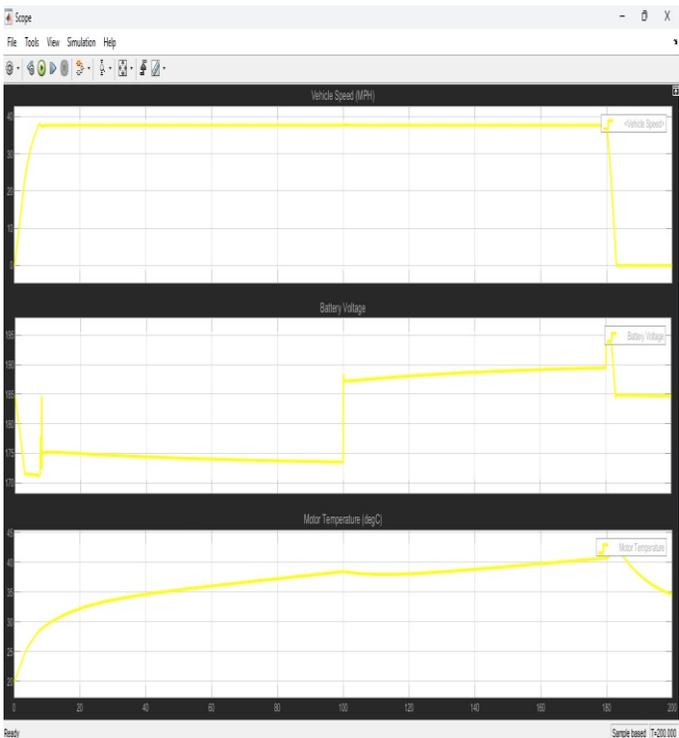
The comparison between mechanical power and electrical power over time in a vehicle system simulation, likely involving an electric or hybrid electric powertrain. The y-axis represents power in kilowatts (kW), while the x-axis represents simulation time in seconds

3. Motor Temperature output



The thermal behavior of an electric motor in response to changing operational conditions. The x-axis indicates simulation time (in seconds), while the y-axis represents the temperature of the motor. Initially, the motor temperature starts at around 20°C and rises gradually due to increasing power demand and heat generation during operation

4. Analysis



The simulation results displayed in the scope provide a comprehensive overview of the dynamic behavior of an electric vehicle over a 200-second drive cycle. The top graph illustrates the vehicle speed, which rapidly increases to 38 MPH and remains constant for the majority of the duration. This indicates a stable cruising phase until around 180 seconds, where a sharp drop to 0 MPH suggests a sudden braking or shutdown event. The middle graph shows the battery voltage, which initially starts near 185V and briefly dips before stabilizing around 175V

IV CONCLUSION

For estimating position and speed relies on Hall-effect sensors and is specifically tailored for Electric Vehicle applications. The typical challenge of initiating motion in such systems is effectively overcome by employing Hall-effect pulses to start the motor in BLDC mode. Following this, a Back-EMF-based estimator, working alongside the Hall-effect sensors, provides precise rotor position and speed estimation, enabling sensorless vector control in PMSM mode. Consequently, there is no need for a dedicated method to detect the initial position or a special startup procedure.

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