

Modeling and Simulation of Electric Vehicle Drive System using MATLAB/Simulink

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ABSTRACT

This paper presents the modeling and simulation of an Electric Vehicle (EV) drive system using MATLAB/Simulink. The proposed EV model includes a lithium-ion battery, an inverter, a Brushless DC (BLDC) motor, and a vehicle dynamics block. The simulation analyzes motor performance under various conditions such as acceleration, regenerative braking, and variable load. The results demonstrate effective torque-speed response and power efficiency of the system. This model can be a foundation for future development of intelligent control algorithms for electric mobility.

Keywords: Electric Vehicle, MATLAB, BLDC Motor, Simulink, Inverter, Regenerative Braking

1. INTRODUCTION

The global shift towards electric mobility has spurred significant research in the field of Electric Vehicles (EVs). Traditional internal combustion engines are being replaced by electric motors that offer cleaner, efficient, and low-maintenance alternatives. MATLAB/Simulink provides a flexible environment for modeling and analyzing dynamic systems such as EVs. This paper focuses on simulating an EV drive system to understand its dynamic behavior under real-world driving scenarios.

2. SYSTEM COMPONENTS AND MODELING

2.1 Battery Model:

A lithium-ion battery is modeled as the primary energy source. The battery feeds a DC supply to the inverter and is designed with parameters reflecting nominal voltage and capacity.

2.2 Inverter:

The inverter converts DC from the battery into 3-phase AC to drive the BLDC motor. Pulse Width Modulation (PWM) technique is used for switching.

2.3 BLDC Motor:

The BLDC motor is chosen for its high efficiency, torque characteristics, and low maintenance. It is modeled using Simscape Electrical blocks.

2.4 Vehicle Dynamics:

The load on the motor is modeled to simulate vehicle resistance, inertia, and friction. This block also helps analyze the speed and torque behavior of the motor.

3. SIMULATION AND RESULTS

The model was simulated using MATLAB/Simulink R2022a. The drive system was tested under three scenarios:

- Constant acceleration
- Regenerative braking
- Variable load

The outputs analyzed include motor speed, torque, current, and battery State of Charge (SOC).

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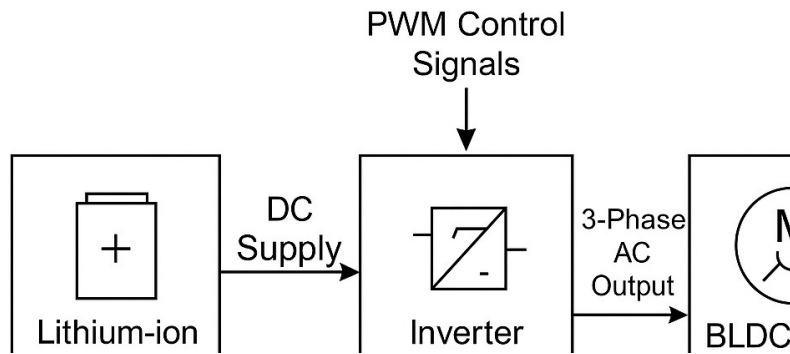


Fig-1: EV Conceptual Diagram

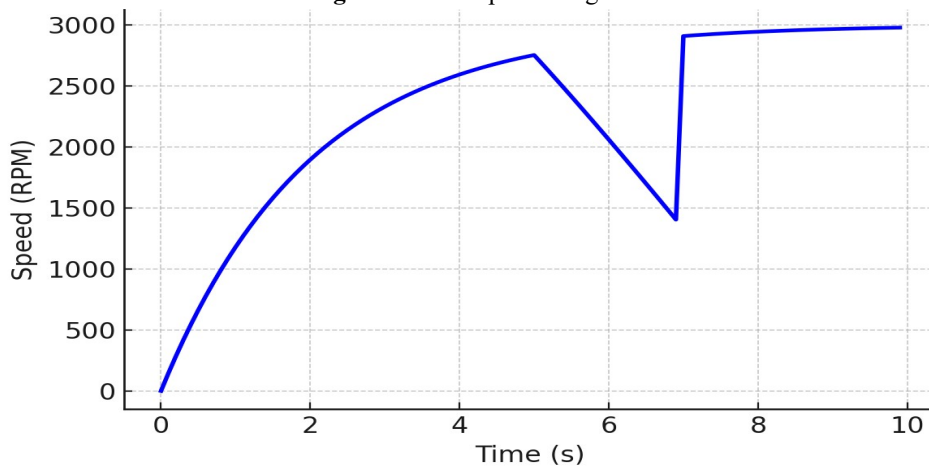


Fig-2: Motor Speed vs. Time

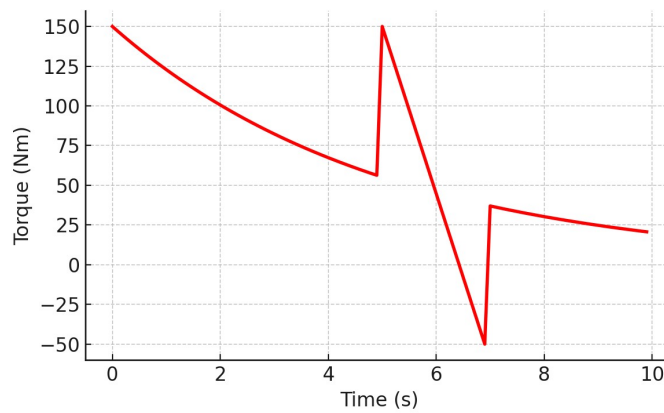


Figure 3: Torque vs. Time

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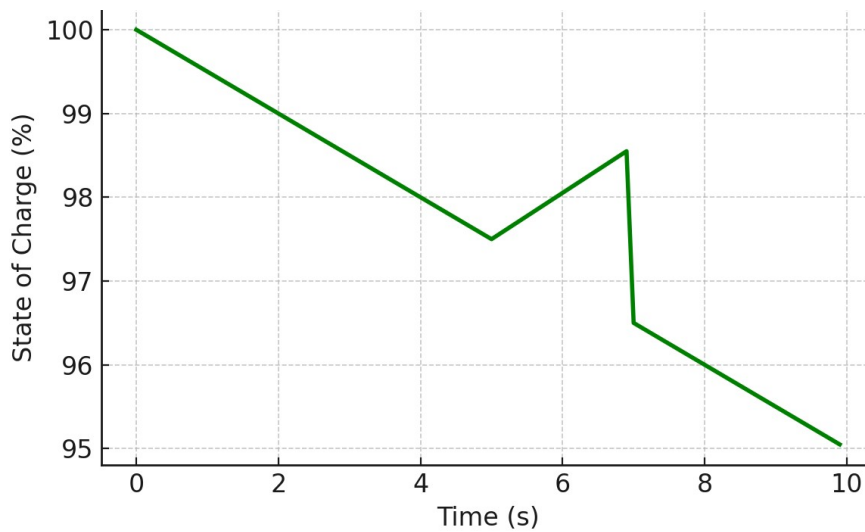


Figure 4: SOC vs. Time

4. CONCLUSION

The simulation of the EV drive system demonstrated successful operation of all major components with efficient energy management and dynamic response. The BLDC motor offered smooth speed control and effective regenerative braking. This model can be extended to test advanced control strategies and hybrid power systems.

5. REFERENCES

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