Assignment Report: Simulation of Electric Vehicle Powertrain in Simulink

Title:

Design and Simulation of an Electric Vehicle (EV) Powertrain using MATLAB Simulink

Aim:

To model and simulate an electric vehicle (EV) powertrain using MATLAB Simulink in order to understand the energy flow from the battery to the wheels. The simulation will help in analyzing the performance of various subsystems such as the electric motor, inverter, and battery, as well as evaluating key performance metrics like efficiency, speed, and energy consumption.

Model Used:

The EV powertrain model consists of the following subsystems:

- **Battery Pack**: Provides electrical energy to the motor.
- **DC-DC Converter**: Regulates the voltage from the battery to an appropriate level for motor control.
- **Inverter**: Converts DC voltage to AC to drive the electric motor.
- **Electric Motor (typically PMSM or Induction Motor)**: Converts electrical energy into mechanical power.
- **Transmission**: Transfers motor output to the wheels.
- **Vehicle Dynamics**: Models mass, road load forces, and calculates vehicle motion.
- **Driver Controller**: Determines throttle and braking commands based on a drive cycle.
- **Feedback Sensors**: Monitor speed, torque, voltage, current, and SoC (State of Charge).

Toolboxes Used:

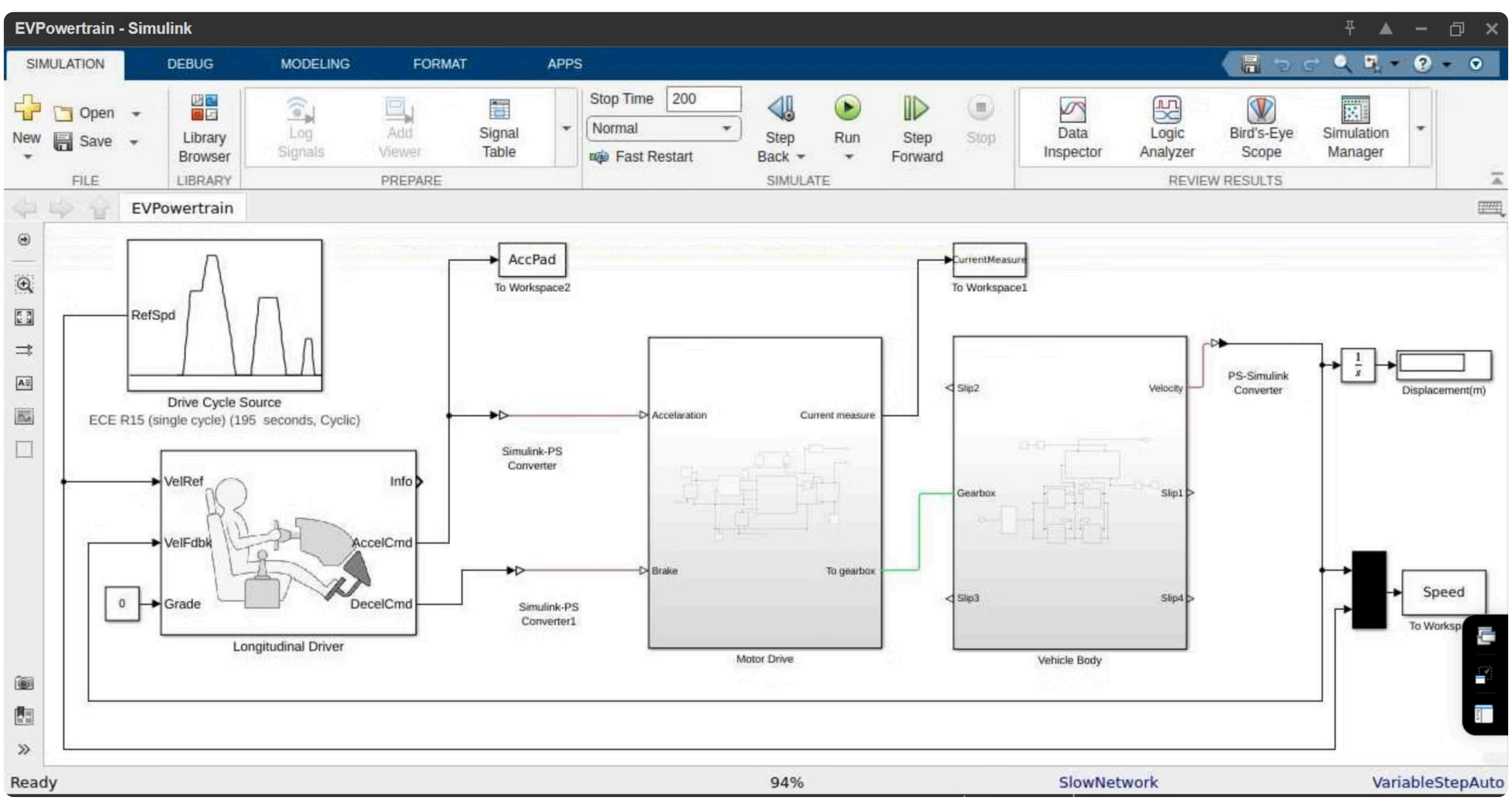
- Simulink
- Simscape
- Simscape Electrical
- Simulink Control Design

Working:

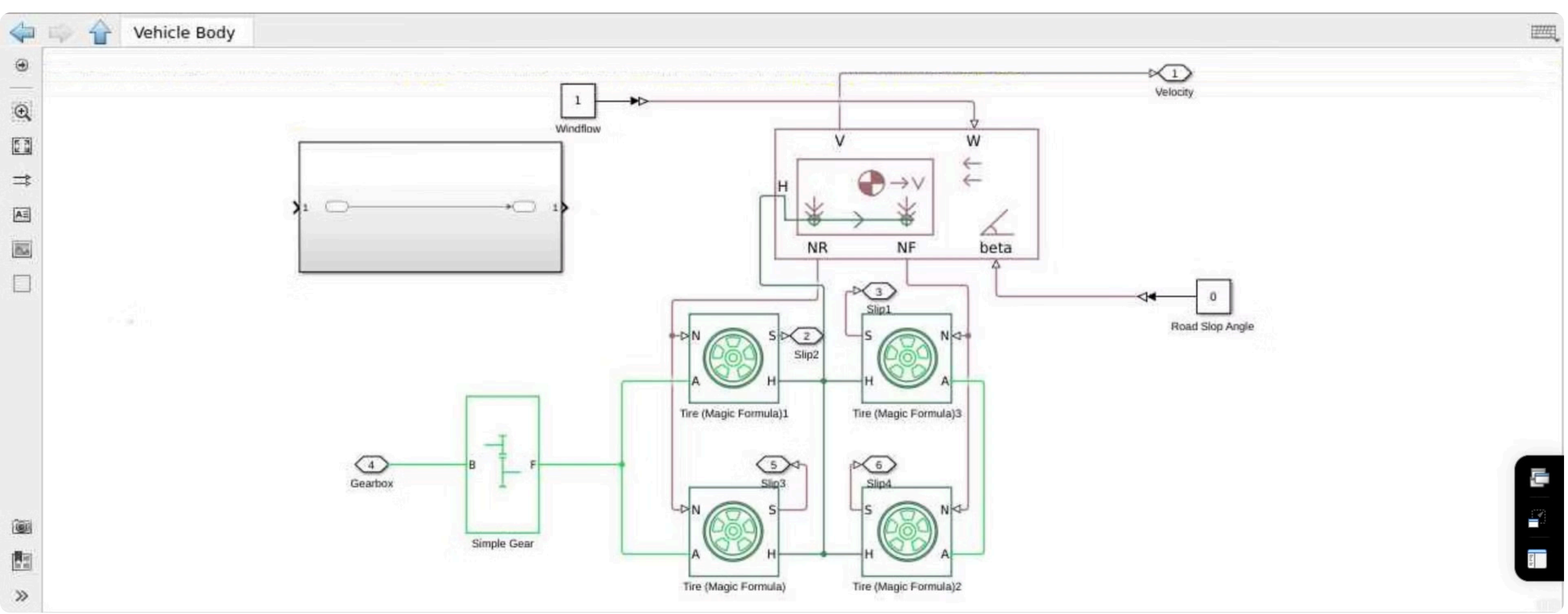
1. **Battery Pack:**
   - The lithium-ion battery provides power to the EV drivetrain.
   - It is modeled with parameters like nominal voltage, internal resistance, capacity, and State of Charge (SoC).
   - Battery output is monitored for voltage drop and discharge rates.
2. **DC-DC Converter:**
   - Steps up/down the battery voltage for the inverter input.
   - Maintains a stable supply to ensure efficient motor control.
3. **Inverter:**
   - Converts regulated DC voltage to three-phase AC voltage.
   - Uses PWM (Pulse Width Modulation) control to match motor requirements.
4. **Electric Motor:**
   - Receives AC voltage from the inverter and delivers mechanical torque.
   - Torque output is dependent on current and rotor speed.
   - The motor operates efficiently within its torque-speed characteristics.
5. **Transmission:**
   - Usually a fixed gear ratio system.
   - Transfers motor output to the drive axle and wheels.
6. **Vehicle Dynamics:**
   - Incorporates forces like aerodynamic drag, rolling resistance, and gradient resistance.
   - Calculates vehicle acceleration, velocity, and position.
7. **Controller:**
   - A drive cycle is provided to a controller block.
   - Based on the desired speed, the controller modulates throttle input.
8. **Sensors & Feedback:**
   - Real-time feedback on:
     - Motor speed
     - Battery SoC
     - Vehicle speed
     - Current and voltage levels

Screenshots (SS):

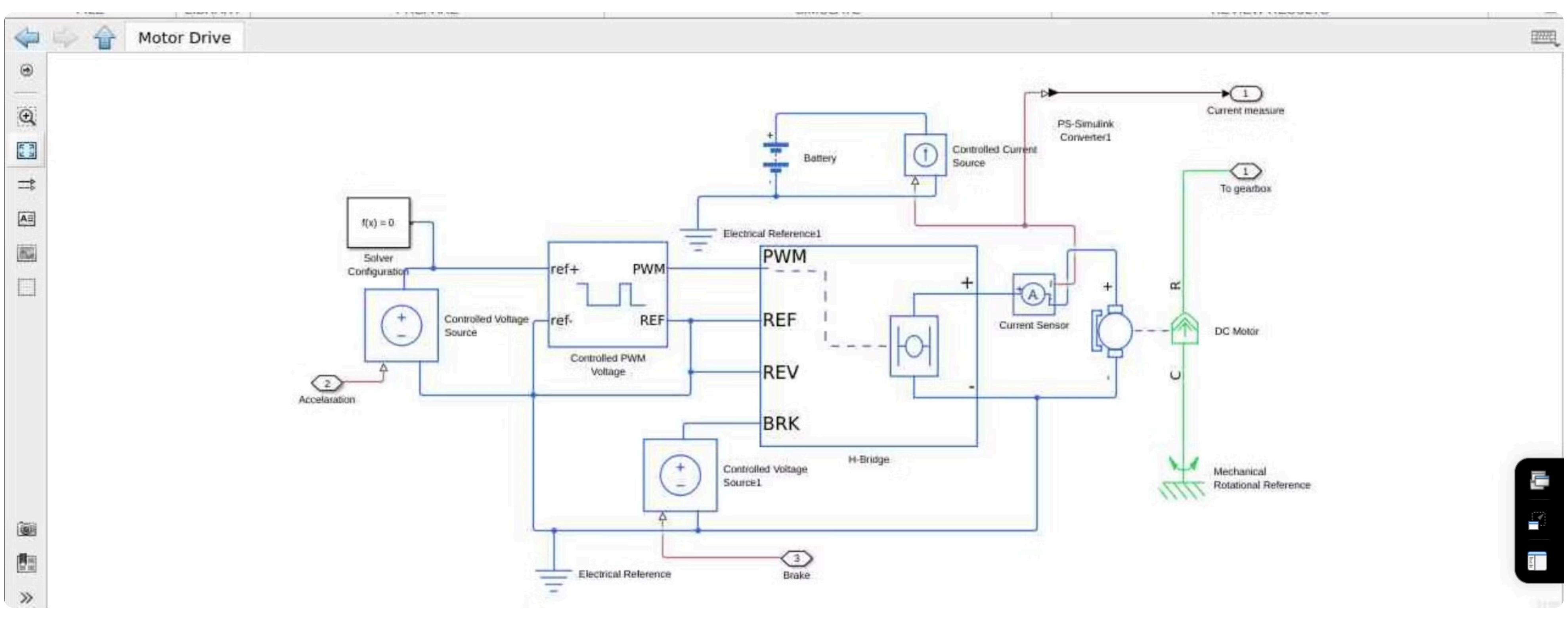
1. Overall EV Powertrain Model



2. Battery and SoC Monitoring Block



3. Inverter and Motor Control Subsystem



Conclusion:

The electric vehicle powertrain simulation effectively demonstrates the behavior of key components in an EV system. This model provides valuable insights into energy consumption, vehicle performance, and system-level efficiency. By adjusting parameters like battery size, motor type, and drive cycle, engineers can evaluate design trade-offs and optimize EV performance. This simulation serves as a robust platform for exploring future innovations in electric mobility.