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Project Statement

Comparative Modeling and Simulation of Electric Vehicles (EV) using SIMULINK, QSS, and ADVISOR Toolboxes

Full Name

Email Address

Important Note:

Individual Enrolled Students	Mandatory Project
PG Enrolled Students	Mandatory Project

Nanodegree/Specialization Enrolled	Mandatory Project
MTech Enrolled Students	Mandatory Project

Project Title:

Comparative Modeling and Simulation of EV using SIMULINK, QSS, and ADVISOR Toolboxes

Abstract:
This project involves the modeling and simulation of an electric vehicle (EV) using three MATLAB toolboxes: SIMULINK, QSS, and ADVISOR. Students will develop their own EV models in each toolbox, exploring design features, control strategies, and simulation results. The project's primary objective is a detailed comparative analysis of each toolbox's modeling capabilities and performance outputs.

Project Requirements:

1. Model Creation

- **SIMULINK Model:**
  - Create a custom EV model in SIMULINK, focusing on detailed component modeling and integration.
  - Design key components like the battery system, motor drive, and power electronics, using available blocks or custom subsystems.
  - Choose a control strategy and specify relevant parameters.
- **QSS Model:**
  - Develop an EV model in the QSS Toolbox, utilizing its unique event-driven simulation approach.
  - Model components in QSS with flexibility for handling discrete events, ideal for scenarios such as regenerative braking or rapid state changes.
  - Implement a control strategy and adjust QSS-specific parameters to optimize performance.

- **ADVISOR Model:**
    - Use ADVISOR's pre-built EV templates, modifying or extending them to create a custom model.
    - Incorporate selected components and test predefined control strategies, with an option to introduce modifications if desired.
    - Choose parameters and configurations relevant to your vehicle's design specifications.

2. Simulation and Testing

- Conduct simulations in each toolbox under identical or similar driving scenarios.
- Gather data on parameters such as:
    - **Energy consumption:** Measure the efficiency and consumption rate for each model.
    - **Acceleration performance:** Simulate acceleration profiles and analyze the torque-speed characteristics.
    - **Range and battery SoC:** Track the EV's range and battery state of charge (SoC) during operation.
    - **Control strategy effects:** Compare the impact of different control strategies on vehicle performance, including regenerative braking, torque control, and energy management.

3. Comparative Study Report

- Prepare a structured report comparing the three toolboxes in the following format:

Comparative Study Report Format:

1. Introduction

- Brief overview of each toolbox (SIMULINK, QSS, ADVISOR) and their applications in EV modeling.
- Outline of the EV components and control strategies used in each model.

2. Modeling Approach Comparison

- **Component Modeling:**
  - Describe how each toolbox handles component modeling, including motor, battery, power electronics, and control systems.
  - Discuss the level of customization and flexibility each toolbox offers in defining and interconnecting components.
- **Control Strategy Implementation:**
  - Explain how control strategies (e.g., regenerative braking, torque control, energy management) were implemented in each toolbox.
  - Highlight challenges faced in implementing these strategies and any toolbox-specific limitations or advantages.
- **User Interface and Ease of Use:**
  - Compare the ease of use, availability of built-in functions, and user interface.
  - Discuss any learning curve differences across toolboxes, noting which may be more accessible for different levels of expertise.

3. Simulation Performance Comparison

- **Computational Efficiency:**
  - Compare simulation speed and computational demands of each toolbox.
  - Note any differences in processing time, particularly for complex simulations or high-load scenarios.
- **Accuracy and Precision:**
  - Assess the accuracy of results, especially for key performance metrics like energy consumption, battery SoC, and torque control.
  - Evaluate how well each toolbox models real-world behaviors based on simulation outputs.
- **Results Consistency:**
  - Compare the consistency of results across simulations in each toolbox.
  - Highlight any significant discrepancies and hypothesize reasons behind these differences.

4. Results Analysis

- Present simulation results in tables and graphs for each of the following metrics:
    - **Energy Consumption and Efficiency**
    - **Acceleration and Torque-Speed Characteristics**
    - **Range and Battery SoC**
- Provide visual comparisons, such as bar charts or line graphs, to illustrate differences clearly.

5. Discussion of Findings

- Summarize key findings based on the simulations and model features across each toolbox.
- Discuss which toolbox appears most suitable for specific aspects of EV design and modeling, such as energy efficiency analysis, control strategy implementation, or handling complex component interactions.
- Evaluate the limitations of each toolbox in capturing specific EV behaviors or scenarios and suggest possible workarounds or improvements.

6. Conclusion and Recommendations

- Conclude with a summary of the project's findings, highlighting the strengths and weaknesses of each toolbox.
- Offer recommendations on the choice of toolbox depending on specific EV design requirements.
- Suggest future improvements or additional areas of analysis that could be explored in subsequent projects.

7. Appendices (Optional)

- Include additional tables, charts, or screenshots to supplement the main findings.
- Attach MATLAB code snippets or screenshots of the model structures to provide more insight into the modeling approach.