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VI SEMESTER INTERDISCIPLINARY PROJECT

Design and Development of Smart Battery Health Assessment Model using Digital Twinning

ARYAN | YASH ARYAN | SARVAGYA KUMAR | SHUBHAM GARG | RUTURAJ JADHAVRAO | SHOURYA ANAND

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Abstract

The project presents a smart battery health assessment model using digital twinning and machine learning for real-time estimation of State of Charge (SOC) and State of Health (SOH) in $LiFePO_4$ batteries. MATLAB and Simulink were used to build and simulate the model with data-driven techniques and LSTM networks for accurate prediction. The model achieved over 95% R^2 accuracy and reduced error margins significantly. These results highlight the potential of digital twin-based approaches in practical battery monitoring applications.

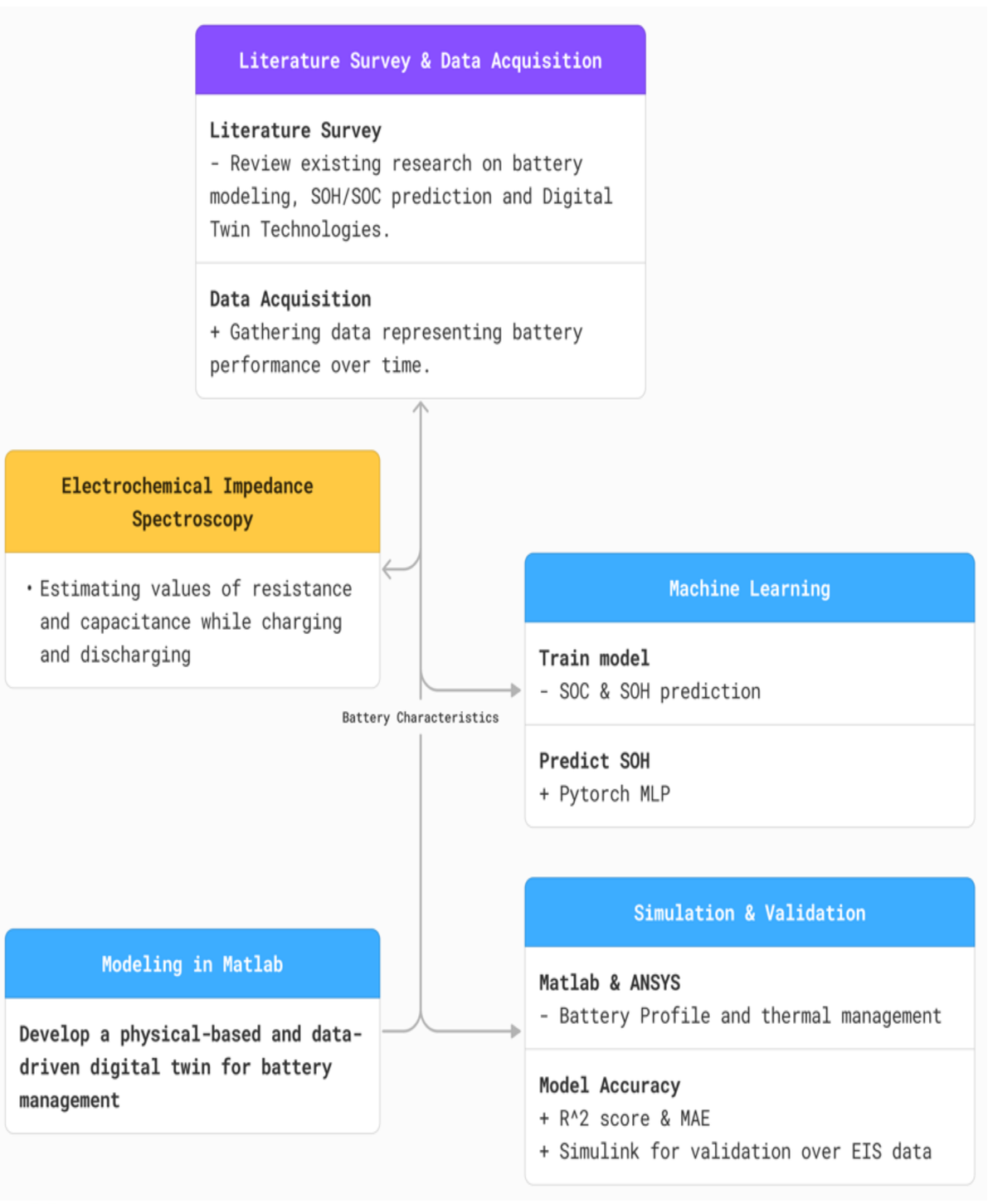
Problem Statement

Design and Develop a smart battery health assessment model that leverages EIS and is implemented via a MATLAB-based digital twin framework for real-time diagnostics **(**identification**)** and prognosis **(**prediction of outcome).

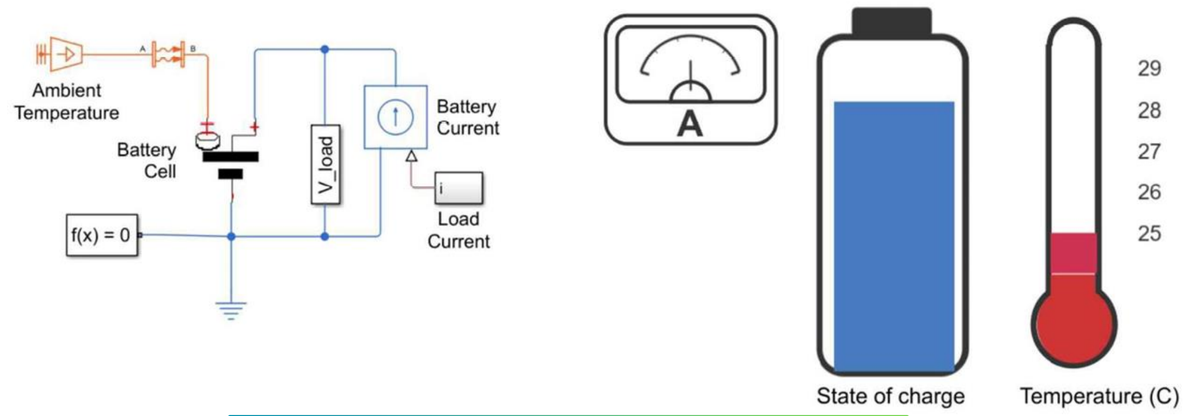
Objectives

- To get series resistance and parallel RC values via EIS.
- To conduct a literature survey to understand EIS and digital twin model.
- To implement algorithms for real-time SOC estimation using impedance parameters and track aging progression(SOH).
- To create the digital twin model against experimental data and benchmark its accuracy in health prediction.

Methodology



Experimentation/Hardware/simulation /Software model



Results

Outcome

- Gained a deep understanding of lithium-ion battery behavior (especially $LiFePO_4$), and how parameters like voltage, resistance, and cycle count affect SOC and SOH.
- Learned to use MATLAB and Simulink for real-time simulation and model implementation, including SOC estimation using the Coulomb counting method.
- Built a web-based graphical user interface (GUI) for SOH.
- Understood how to integrate data-driven and simulation-based methods to form hybrid digital twin models with real-time updates.

References

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Signature

Dr. Sushmita Sarkar

Assistant Professor Dept. of EEE