Abstract

The estimation of the State of Health (SoH) of *lithium-ion* batteries is a crucial aspect in maintaining the performance and safety of electric vehicles. Accurate SoH estimation is essential to ensure optimal performance and extend the battery's lifespan. The system receives inputs in the form of voltage, temperature, and battery cycle data, and produces output in the form of SoH values expressed as a percentage. This topic is critical because conventional approaches are often less effective in handling *sequential* and complex data, which affects estimation accuracy. The discrepancy between training and testing data distributions also presents challenges that can impact the reliability of the prediction system. This study employs a Bidirectional *Long Short-Term Memory* (*BiLSTM*) model combined with Bayesian Optimization for hyperparameter tuning. *BiLSTM* is chosen for its ability to process *sequential* data and capture temporal context from both directions. The dataset used consists of 22,278 *data points* from NCA batteries. Bayesian Optimization is implemented to optimize parameters such as the number of LSTM units, dropout rate, and learning rate. The developed model achieved excellent performance with a *Mean Squared Error* of 0.5510, *Mean Absolute Error* of 0.5464, and an R^2 Score of 0.9868. These results demonstrate high accuracy in SoH estimation and contribute significantly to the development of a more intelligent battery management system for electric vehicles.

Keywords: ***state of health, bidirectional long short-term memory, bayesian optimization, battery management system, electric vehicle***