Master's Thesis/ Wissenschaftliche Hilfskraft Position (m/f/d): Predictive Modelling of Battery Degradation using Data-Driven Machine Learning Methods

Reference number: <342>
Place of work: Geesthacht, Kiel
Join Date: 01 July 2025
Career Level: Study & Thesis, Student Activity
Employment level: Part-time
Duration of employment: 6 months
Remuneration: Remuneration is paid in accordance with the applicable collective agreements of the public service (federal government).

About DLR Institute of Maritime Energy Systems:

The DLR Institute of Maritime Energy Systems researches and develops innovative solutions for the decarbonization and emission reduction of shipping. In cooperation with industry, these are being put into practice. To this end, the institute is building a large-scale infrastructure to test and test the newly developed energy systems in a standardized laboratory environment and under real conditions.

Position Background:

Component degradation is an important concern in multiple industries. It affects not only the reliability but also the safety and efficiency of mechanical and electronic systems. Factors such as mechanical wear, thermal stress, corrosion, and environmental conditions contribute to the progressive degradation of components, resulting in higher maintenance costs and unexpected failures. Predicting and mitigating degradation through effective monitoring and modeling is crucial for all industries as downtime and failures can lead to considerable financial and operational costs.

One of the important applications of degradation modeling is in battery systems. Chemical and mechanical aging cause batteries' performance to diminish with time and usage. This results in reduced capacity, safety risks, and lower efficiency. The State of Health (SoH) and Remaining Useful Life (RUL) of batteries are determined using conventional physics-based techniques, frequently computationally demanding and dependent on substantial empirical testing. As a result, data-driven machine learning methods have emerged as powerful tools for capturing degradation patterns and improving predictive accuracy.

Machine learning algorithms are commonly used in predictive modeling to assess sensor data, detect abnormalities, and forecast degradation trends. Random Forests, Support Vector Machines (SVM), and Deep Neural Networks (DNN) have been used successfully to identify early-stage degradation trends in complicated datasets. Reinforcement learning methods can be used to optimize maintenance strategies by dynamically adjusting Depth of Discharge (DoD) based on real-time degradation trends. Since sensor data only provides snapshots of the system's current state, the goal of this thesis is to use existing battery degradation datasets to assess system health and predict reliability in future time domains. Second major task would be working and developing a data pre- processing standardization module so that different types of sensor data can be used for the predictive models. This approach will not only enhance our understanding of system behavior under current operating conditions but also enable more accurate predictions of Remaining Useful Life (RUL) under both stable and varying conditions, ultimately improving maintenance strategies and extending component lifespan.

Your Tasks:

- Literature Review on existing Machine Learning methods for battery degradation modeling.
- Develop a universal Data Pre-processing Module based on parameters used in different Battery Management Systems (BMS) with different sensor datasets.
- Implement ML models to predict component lifespan and failure modes under normal and changing operating conditions.
- Document findings and contribute to at least one research paper.

Your Profile:

- Currently pursuing a Master's degree in Computer Science, Data Science, Mechanical/Electrical Engineering, or a related field.
- Strong background in machine learning, deep learning, and data analysis.
- Experience with Python and ML frameworks (e.g., TensorFlow, PyTorch, Scikit-Learn).
- Knowledge of signal processing and time-series analysis is a plus.
- Analytical mindset, independent, and problem-solving skills.

Contact for more details:

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