Felddatenbasierte Batteriediagnose und Lebensdauerprognose

Field data based battery diagnosis and End of Life prediction

R. Kratzing[1], T. Lehmann[1], S. Neupert[2], J. Kowal[2]
[1]Fraunhofer-Institute for Transportation and Infrastructure Systems IVI, Vehicle Systems
[2]Technische Universität Berlin, Institut of Energy and Automation Technology, Electrical Energy Storage Technology EET
Contact: Richard Kratzing, richard.kratzing@ivi.fraunhofer.de

Motivation of the Project

- Laboratory tests do not reflect real-life application scenarios
- Criterion for end of life is the capability to carry out load cycles, instead of fixed values for C and R
- Therefore, development of methods to determine
  - the aging behaviour based on stress factors
  - aging condition without additional capacity tests
  - use behaviour for application-specific end of life prediction for lithium-ion batteries based on field data.

State of Research

- Acquisition of field data from car fleet (24 vehicles) and bus fleet (53 vehicles) with > 18 months of use
- Development, implementation and validation of a battery model and aging prediction models including prediction of buckling behaviour based on neural networks

pending: final test of the algorithms and further publication until the end of the project in March 2024

Results

Individual vehicle and fleet models based on laboratory and field data

- Fleet model combines aging prediction from laboratory data and field data

Campaign/ cells	Duration/ cycles	Conditions	Reference tests
NMC-cell 11Ah (31 cells)	• since 2018 • up to 14.000 cycles	• 25 °C < T < 45 °C • -2C < I < 2C • 10% < dod < 100%	every 100 cycles
NMC-cell 46Ah	• since 2019 • up to 6.500 cycles	• 35°C < T < 45Y°C • 20% < dod < 90%	every 250 cycles resp. every 30 days
NMC battery type 1 (15 buses)	• ~ 1,5 years • 200-500 cycles per year	• T = 25 °C • 30% < dod < 80%	2 (annually for selected buses)
NMC battery type 2 (44 buses)	• ~ 1,5 years • 200-500 cycles per year	• T =25°C • 30% < dod < 60%	6 (annually for selected buses)

Table 1: Overview of data sources, data scope and operating conditions

- Evaluation of the estimation algorithms by means of dedicated capacity tests for individual vehicles

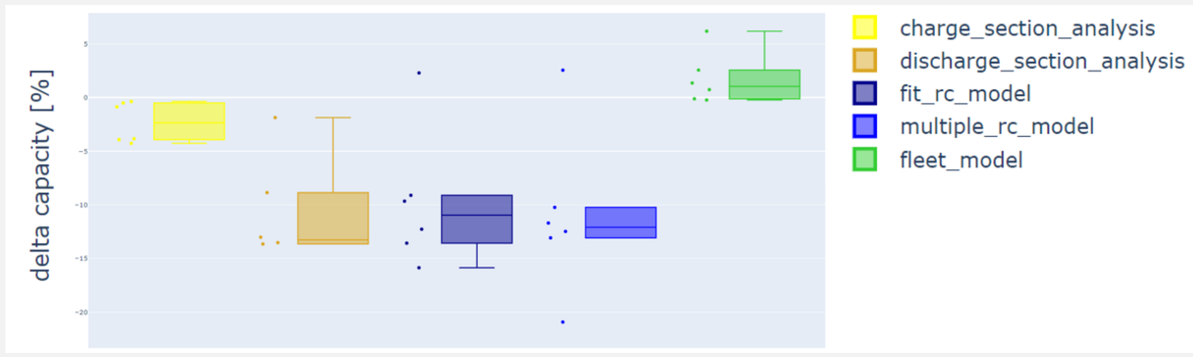


Figure 1: Comparison of different algorithms with reference tests

End of Life prediction

- Determination of typical operating profiles (= scenarios)
- Performance of virtual experiments (e.g. capacity test, scenarios) to determine available energy content

→ Scenario-based end of life prediction instead of universal reference value (20% capacity loss)

→ purposeful evaluation allows longer use of the battery

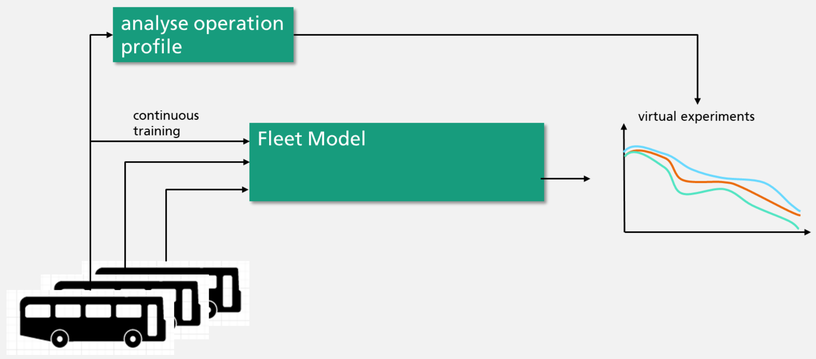
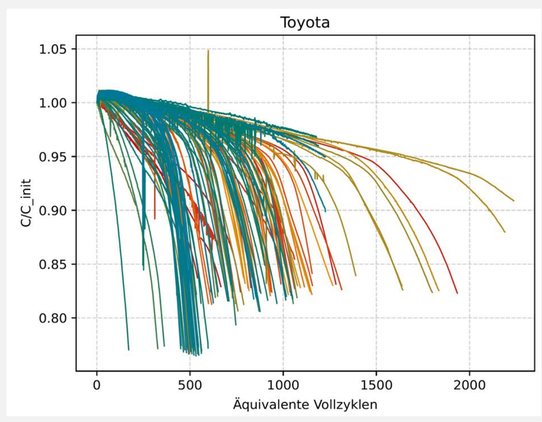
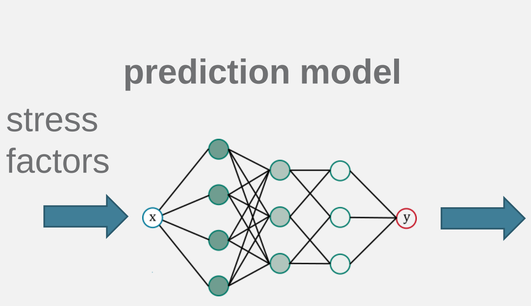


Abbildung 2: End of Life prediction using virtual experiments

Knee point prediction

- Data set with buckling behaviour from Toyota Research
- Point prediction using neural network
- Various gradients of the existing data possible
  - Tuning will be continued
- Progression prediction in progress





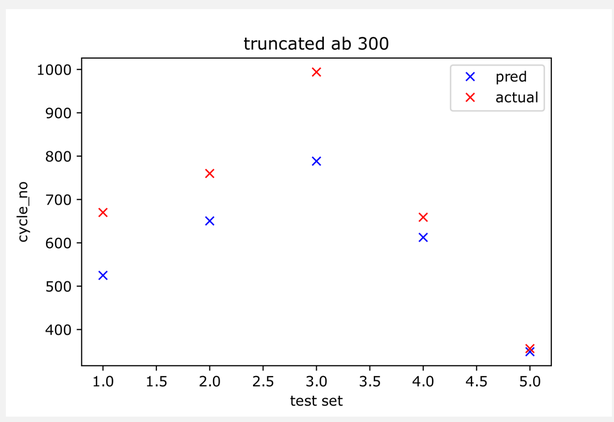


Figure 3: prediction of buckling behaviour by point prediction using a neural network

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