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Data Driven Methodologies for State of Health Observer Design for Lithium Ion Cells

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In this presentation, the topic of online estimation of ageing processes in battery cells is addressed. Especially in hybrid electrical vehicles (HEVs), an accurate observation of the electric power supply is essential, in order to extend battery life and preserve the usable capacity. Accordingly, a proper online monitoring of the state of charge (SoC) of the battery is required. Typically, SoC estimation is based on a nonlinear model using Kalman filter theory. However, to take account of ageing is an important issue in order to allow for the application of such observers in an HEV. Thus, the actual state of health (SoH) of the cell has to be estimated online and considered as well for SoC estimation.

In this work, the design of the nonlinear observer for SoC and SoH is based on a purely data driven battery model. While such a data based approach enables the application for any type of battery chemistry, a major disadvantage of these black-box models is that the physical interpretation of the model parameters is not easily possible. Therefore, model based ageing data analysis using data from a large scale ageing experiment of Lithium Ion cells is presented and the adaptation of the data driven model is discussed. Thus, the model is adapted in a way that age-related effects (such as capacity decay and resistance increase) are taken into account for SoC estimation.

Based on the time-variant battery model, a cascaded observer structure for simultaneous SoH and SoC estimation is proposed. The performance of the combined SoC/SoH observer is demonstrated using real measurement data from a Lithium Ion cell.

Keywords: nonlinear system identification, battery ageing, nonlinear observer, state of charge, state of health