State of charge estimation of Lithium-ion batteries based on advanced equivalent electrical models

Master project

Advisors

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Location

This SAFT Master project will take place at CRAN (Centre de Recherche en Automatique de Nancy), UMR CNRS 7039 : 2 avenue de la forêt de Haye, 54516 Vandœuvre-lès-Nancy, France

Duration

5 to 6 months, starting date between February 1 and March 31 2021

Funding

924€/month gross

Keywords

Control engineering, observer, estimation, Lyapunov stability, batteries, Matlab-Simulink

Context

The global economic demand for electrochemical storage batteries is increasing today. This growth is mainly due to the emergence of hybrid and electric vehicles (Hybrid-Electric Vehicle, Plug-in Hybrid Electric Vehicle and Battery-Electric Vehicle) on the one hand, and the energy storage market related to renewable energies and power grid management on the other.

SAFT is particularly present in this context as a precursor of the deployment of lithium batteries. SAFT produces, among others, lithium-ion batteries in Poitiers, Nersac and Bordeaux. This SAFT M.Sc. project will take place at CRAN in Vandœuvre-lès-Nancy.

Topic

The lithium-ion batteries have many advantages in terms of volume capacity and weight. However, this type of batteries requires a management system for safety reasons, but also to prevent their premature ageing. A better management of lithium-ion batteries will necessarily require a better knowledge of the internal states, in particular the state of charge. In this context, a relevant approach consists in estimating this state of charge by exploiting a mathematical model of the dynamics involved with the help of an observer.

State of charge estimators available in the literature are mostly based on first-order modeling of the electrical behavior of the battery, which is often too coarse and can be limiting. The objective of this project is to contribute to the improvement of existing estimators, by associating them with equivalent higher order electrical models, typically three or more if the model describes the dynamics of each of the battery electrodes. We will thus have at our disposal more accurate estimators, which would help improving our management of lithium-ion batteries in the longer term.

The project will be carried out in the following stages:
- Literature review of lithium-ion battery models by equivalent electrical circuits.
- Development of a multi-order model and an associated state representation.
- Observability study and synthesis of a state of charge observer.
- Implementation of the observers obtained using Matlab-Simulink.

References

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Profile

This is a Master project for a student in control or electrical engineering. Matlab skills and good knowledge of the English language are expected.

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