State of charge and total capacity on-line estimation of Lithium-ion batteries

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 exhibit 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 necessarily requires a better knowledge of internal states and parameters. In this context, one approach consists in estimating these internal data by exploiting a mathematical model of the dynamics involved.

The objective of this project is to contribute to the improvement of existing management systems. The idea is to use control engineering techniques to estimate both the state of charge and its total capacity, two data that are inaccessible by measurement. We will thus have a better knowledge of its state of ageing.

The project will be carried out in the following stages:
- Literature review of adaptive estimation techniques for electrical equivalent models.
- Design of adaptive observers to estimate both state variables and total capacity.
- Implementation using Matlab-Simulink and comparison of the observers obtained : (i) when the other parameters are constant; (ii) when they are time-varying.

References

[Blondel et al., 2019] Blondel, P., Postoyan, R., Raël, S., Benjamin, S., & Desprez, P. Nonlinear Circle-Criterion Observer Design for an Electrochemical Battery Model. *IEEE Transactions on Control Systems Technology*, 27 (2), 889-897, 2019.

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[Zheng et al., 2018] Y. Zheng, M. Ouyang, X. Han, L. Lu, J. Li. Investigating the error sources of the online state of charge estimation methods for lithium-ion batteries in electric vehicles. Journal of Power Sources, 377, 161-188, 2018.

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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