

CONTROL AND ENERGY MANAGEMENT OF RECONFIGURABLE MODULAR LITHIUM-ION BATTERY SYSTEMS

ENTREPRISE

L'ESTACA, école d'ingénieurs faisant partie du groupe ISAE, forme en 5 ans des ingénieurs passionnés par les technologies qui répondent aux besoins de nouvelles mobilités et mène une recherche appliquée au service de tous les acteurs des transports (aéronautique, automobile, spatial, naval et transports guidés et ferroviaires).

L'ESTACA c'est une formation d'ingénieur et des mastères spécialisés habilités par la Commission des Titres d'Ingénieurs, ainsi que des équipes d'enseignants et de chercheurs qui accueillent plus de 2 500 étudiants repartis sur 3 campus (Montigny-le-Bretonneux (78), Laval (53) et Bordeaux (33))

ESTACA'Lab, le laboratoire de recherche de l'ESTACA, regroupe aujourd'hui une trentaine d'enseignants-chercheurs et une quarantaine de doctorants. Il développe une recherche appliquée dans un contexte fortement collaboratif pour une mobilité durable, intelligente et sûre.

CONTEXTE ET OBJECTIF

Lithium-ion batteries have become the dominant energy storage technology in a wide range of applications, particularly in the transportation sector, such as electric vehicles (EVs) and fuel-cell hybrid EVs. As these applications require high power and energy density, reliability, and long service life, the integration of embedded battery systems and the development of advanced battery management strategies have become increasingly important.

In this context, modular battery energy storage systems, where the pack is composed of multiple controllable battery units (each unit corresponding to a single cell or a small group of cells connected in series and/or parallel), offer several advantages. A modular architecture enables improved energy efficiency, health-aware control, fault tolerance, continuity of service, enhanced operational flexibility, and better thermal management. These features are essential for embedded systems in which performance, safety, and durability are critical.

However, modular battery systems also introduce new challenges. To fully exploit the benefits of modularity, each battery unit must operate efficiently while ensuring global consistency at the pack level. This requires accurate estimation of individual unit states, coordinated control algorithms, and real-time optimization to maintain balanced electrical and thermal behavior across all units.

The objective of this internship is to contribute to the development of advanced control and energy-management strategies for a modular lithium-ion battery system composed of battery units and DC/DC converters. Particular emphasis is placed on improving energy efficiency and enabling health-aware operation throughout the entire operating cycle of EV applications.

POSTE ET MISSIONS

Début du stage : February 2026

Durée du stage : 24 semaines

Principales missions :

- Literature review and state-of-the-art analysis of modular lithium-ion battery systems, energy management strategies, state estimation and control algorithms
- Modeling and simulation of modular battery units (battery units combined with DC/DC converter) using MATLAB/Simulink
- Development of control strategies to improve energy efficiency and enable health-aware operation at both the unit and system levels
- Development of state estimation strategies for battery monitoring and diagnosis (this step may be based on assumptions; the main focus remains on control).
- Coordination and optimization of energy management strategies across multiple units during charging and discharging cycles
- Validation and testing of the proposed strategies through simulations and, where possible, on embedded platforms

PROFIL

Diplôme(s) requis : 5th-year engineering student or Master's (M2) student in the final year of their academic program in Electrical Engineering, Control Systems, or related fields

Compétences attendues :

- Knowledge of control systems and state estimation techniques
- Familiarity with energy management and battery management systems (BMS)
- MATLAB/Simulink (numerical validation) and dSPACE/ControlDesk (experimental validation)
- Analytical skills, problem-solving, and teamwork

PÔLE DE RECHERCHE ET LIEU DU POSTE

☒ ESTACA Paris-Saclay à Montigny-le-Bretonneux (78)

☐ ESTACA Laval (53)

☐ ESTACA Bordeaux (33)

☐ **PÔLE MÉCANIQUE DES STRUCTURES COMPOSITES ET ENVIRONNEMENT (MSCE)**

☐ Qualité de l'air

☐ Allègement

☒ **PÔLE SYSTÈMES ET ENERGIE EMBARQUÉS POUR LE TRANSPORT (S2ET)**

☒ Energie et contrôle

☐ Systèmes embarqués

ESTACA Paris-Saclay
12 avenue Paul Delouvrier - RD 10
78180 Montigny-le-Bretonneux
Tél. : 01 75 64 50 41

ESTACA Laval
Parc Universitaire Laval-Changé
Rue Georges Charpak - BP 76121
53061 Laval Cedex 9
Tél. : 02 43 59 47 00

ESTACA Bordeaux
8 rue des Bateliers
33100 Bordeaux
Tél. : 05 35 31 49 70

CONTACTS

Contacts : Dr. Jianwen MENG, Pr. Toufik AZIB

E-mail : jianwen.meng@estaca.fr, toufik.azib@estaca.fr

REMARQUE :

The candidate will be asked to give a 10-minute oral presentation, supported by slides, highlighting their academic background and relevant student projects in control engineering, battery systems, energy management strategies, or related fields.

INFORMATIONS COMPLEMENTAIRES :

Prise en charge de 50 % des frais du transport.