System Control in Battery Production and Management

Joint Workshop of

Swedish Electromobility Center (SEC) and Batteries Sweden (BASE)

Time: December 13, 2024, 9:00-11:40

Location (hybrid session)

Online: https://chalmers.zoom.us/j/4457155045?omn=62118373343

Physical location: Hörsalsvägen 11, 412 58 Göteborg (Room information: TBD)

Agenda

Time	Activity	Presenter
9:00-9:05	Opening remarks	Changfu Zou Associate Professor, Chalmers
9:05-9:40	Talk 1: Model-based battery manufacturing process optimization and control	Mona Faraji Niri, Associate Professor, Warwick University
9:40-10:05	Talk 2: Smart battery - A new technology	Prof. Remus Teodorescu Professor, Aalborg University
10:05-10:25	Coffee break	
10:25-11:00	Talk 3: Data-driven survival modeling for predictive maintenance	Mattias Krysander Associate Professor, Linköping University
11:00-11:35	Talk 4: Innovative approaches to battery management: Dynamics systems, control, machine learning, and experimental integration	Simona Onori, Associate Professor, Stanford University
11:35-11:40	Closing remarks	Torsten Wik Professor, Chalmers

Talk Details

Title: Model-Based Battery Manufacturing Process Optimization and Control

Mona Faraji Niri is an Associate Professor of Battery Modelling at Warwick Manufacturing Group, University of Warwick, UK, and an AI and Data Science Fellow of the Alan Turing Institute. Mona has 12 years of experience in modelling, control algorithms, and artificial intelligence with a solid profile of delivering high-quality and collaborative R&D projects for energy applications in academia and industry. She is leading the Battery Modelling team in WMG with a deep interest in the challenges of battery manufacturing. Mona's experience also covers cell-to-module configuration optimization and battery management system (BMS) algorithms for first and second-life batteries. She has published over 60 high-quality journal papers and supervised various doctoral students. Mona has received The Royal Academy of Engineering's endorsement for her contributions to AI in the Energy Systems Control field and was awarded the TechWomen100 title as an academic. She has been a finalist for the IET Sir Henry Royce medal.

Abstract: Rechargeable batteries are the key element of electrified transportation systems during the transition to a net zero future. However, they are essentially complex systems with electrochemical, mechanical, and electrical aspects influencing their performance. Manufacturing processes of these batteries (lithium-ion and alternatives) have various steps and need almost 600 variables to be decided. This makes optimizing the manufacturing process and battery performance very difficult, time- and resource-consuming. Multi-physics and AI techniques for process models provide the opportunity to understand the impact of key manufacturing variables on battery performance and the impact of use cases on its lifetime. Such model-based practices empowered by AI make the product performance predictable and reduce the number of tests and experiments needed for their design and optimization.

Title: Smart battery - A new technology

Remus Teodorescu joined the Department of Energy Technology at Aalborg University in 1998 where he is currently a Full Professor. Between 2013 and 2017, he was a Visiting Professor at Chalmers University. He has been an IEEE/PELS Fellow since 2012 for contributions to grid converter technology for renewable energy systems. In 2022, he became a Villum Investigator and leader of the Center of Research for Smart Battery at Aalborg University. His main current research areas are AI for batteries and advanced power electronics for the green energy transition.

Abstract: Artificial intelligence is gaining momentum in complex prediction, health management, and marketing, and it is expected that soon Physical AI, based on the concept of physics-informed neural networks, will make an impact in engineering due to their capability to learn from complex physical models and accelerate execution on next-generation BMS platforms. This presentation will introduce the AAU concept of Smart Battery with AI and bypass devices that will be capable of improving the safety and sustainability of battery technology in the near future in energy and transportation sectors, which are essential for the green energy transition.

Title: Data-driven survival modeling for predictive maintenance

Mattias Krysander is an Associate Professor with the Department of Electrical Engineering, Linköping University, Sweden. His research interests include model-based and data-driven diagnosis and prognosis. To address the complexity and size of industrial systems (mainly vehicle systems), he has used structural representations of models and developed graph theoretical methods for assisting the design of diagnosis systems, fault isolation, and sensor placement analysis.

Abstract: Predictive maintenance is an effective strategy for reducing maintenance costs by predicting the future health state of a system. Survival models have proven particularly useful for this purpose. Due to the complex behavior of system degradation, data-driven methods are often preferred, with neural network-based approaches showing excellent performance. This presentation describes typical data for survival analysis, explores survival models for predicting failures, and demonstrates how individualized maintenance policies can be optimized using these predictions. The techniques are illustrated using a case study on the starter batteries of heavy-duty trucks.

Title: Innovative approaches to battery management: Dynamics systems, control, machine learning, and experimental integration

Simona Onori, Ph.D., is an Associate Professor of Energy Science and Engineering at Stanford University. She is a Fellow of SAE. She is the recipient of various awards, including the 2021 IEEE Transactions on Control Systems Technology (TCST) Outstanding Paper Award (as advisor), 2020 U.S. DOE C3E Award in the research category, 2017 NSF CAREER Award. She has been serving as the Editor-in-Chief of the SAE International Journal of Electrified Vehicles since 2020 and Associate Editor of IEEE TCST since 2023. Dr. Onori received her Ph.D. degree in control engineering from the University of Rome “Tor Vergata”.

Abstract: In this talk, I will provide an overview of the activities at the Stanford Energy Control Lab, focusing on the latest research and innovations in lithium-ion battery management. Emphasizing second-life applications, battery life extension through experimentation, and state-of-charge and state-of-health estimation, the lab’s work integrates dynamic systems, control strategies, and machine learning tools to create innovative solutions designed for seamless deployment in Battery Management Systems (BMS). The talk will also explore the critical role of field data in enhancing BMS design and performance.