Embedded detection of the state of temperature of Li-ion batteries by Intelligent Gray Box Model

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The development of embedded diagnosis tools for Li-ion batteries directly supports the Battery 2030+ roadmap's goal of improved performance, lifetime, and safety [1]. By monitoring internal parameters that define the State of Charge (SOC), State of Health (SOH), and State of Temperature (SOT) of the cells, these tools can significantly enhance battery management and redefine the secondary lives of the cells. To achieve this, the ULYSSE project, a French regional initiative supported by EIPHI Graduate school (contract "ANR-17-EURE-0002") and by the Bourgogne-Franche-Comté Region, is developing a gray box model with machine learning integration. This model, which acts as a digital twin (a virtual replica of the battery), aims to monitor key physical and chemical parameters within the cell. The project utilizes Embedded Electrochemical Impedance Spectroscopy (EEIS) for reliable, real-time monitoring. This data is then used to develop the battery digital twin through equivalent circuit modeling and train an intelligent feedforward neural network classifier, functioning as a Battery Thermal Supervising Systems algorithm. This combined approach allows for accurate, faster, and real-time SOT determination regardless of the battery's SOC level. Following an overview of the Intelligent gray box model (IGBM) development process, the presentation will focus on recent project results, particularly on sensorless SOT detection using the industry-standard STM32 microcontroller.

Keywords: State of temperature (SOT), Intelligent Gray Box Model (IGBM), Embedded Electrochemical Impedance spectroscopy (EEIS), Equivalent Circuit Model (ECM), Feedforward Neural Network Classifier (FNNC),

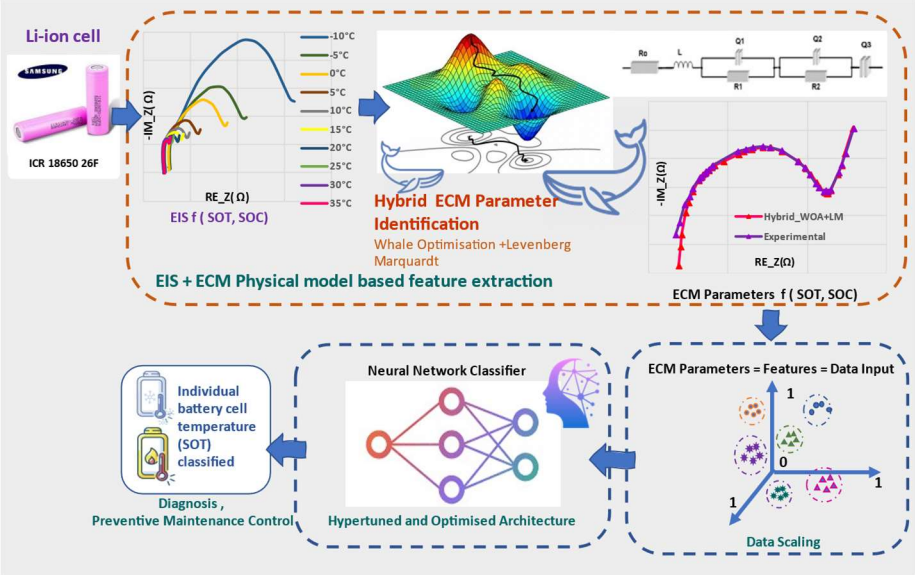

Figure 1. SOT detection by IGBM.

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