Single particle models for the numerical simulation of lithium-ion cells

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In the last decade there has been an increasing interest in the development and improvement of electrical energy storage devices in the automotive industry, to use them in electrical vehicles. Electrochemical lithium-ion batteries have good properties such as high energy and power density, a long life expectancy, low self-discharge rate, non-memory effect, among others; that's why this technology is one of the preferred candidates to be used by this industry.

However, for safety reasons, due to the batteries sensitivity to inappropriate use parameters and to improve their performance, it is necessary to design and implement battery control algorithms in which a mathematical model is used to estimate the cells internal behavior. The so-called pseudo-2D (P2D) is the most popular validated model for lithium-ion batteries in the literature, but due to its high computational cost of resolution this model is not suitable for its implementation in real-time applications.

In this master's thesis, the family of the simple single-particle models (SPM) were deduced, studied and implemented. These models present a reduced computational cost, compared to the P2D model, so that they could be suitable for their use in real-time battery control software.