Advanced Battery Management System for Lithium-Ion Batteries

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Lithium-ion batteries play an important role in the global energy landscape. They are widely used in a variety of applications due to desirable properties such as high energy density, high efficiency and slow material degradation.

However, these batteries are known to become explosive when overcharged due to overheating, leading to disastrous consequences including the destruction of laptops and the generation of fires on commercial aircraft. Given their widespread usage, it is essential that lithium-ion batteries operate safely and reliably under varying load and weather conditions.

The safety and performance of these batteries can be improved by understanding the complex combination of chemical kinetics, transport phenomena and electrochemical reactions that occur during charge and discharge cycles. However, due to the complexity of these batteries, most first-principles models are approximate and are unreliable at high discharge rates or extreme temperatures.

We use scientific computing principles, numerical methods and machine learning techniques to develop state of the art mathematical models of lithium-ion batteries that can be used for real-time control and cell development. These novel, fast and accurate models can be used in control and estimation algorithms to derive an optimal charging profile that minimizes charge time while simultaneously meeting all battery safety and health constraints.

Using advanced analytics to improve lithium-ion battery models, it may be possible one day to fully charge an electric vehicle in 10 minutes instead of 10 hours.

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