Improved Charging and Monitoring of Lithium Polymer Batteries

Inventors:

Dr. Song-yul (Ben) Choe
Professor
Department of Mechanical Engineering

Xueyan Li
PhD Graduate

Meng Xiao
PhD Graduate

Reference:

EVS27, Barcelona, 2013
(Link)
(Fast-Charging Algorithm)

Contact:

Brian Wright
Auburn University
Innovation Advancement & Commercialization
334-844-4977
dircomm@auburn.edu
iac.auburn.edu
Reference: Lithium Polymer Batteries

View More Available Technologies

Overview: The increasing demands for portable power and renewable energy have contributed to the popularity of rechargeable lithium-ion battery technologies, including lithium-ion polymer batteries. These light, safe and easier to package batteries continue to increase in prevalence and span several industries, including electric vehicles, medical devices, power tools, portable consumer electronics and energy storage systems. With this popularity, however, comes an increasing need for fast charging and better management of battery states, performance and life. This suite of new algorithms is designed to improve the charging and charge monitoring capabilities of lithium-ion polymer batteries.

Advantages:

- **FASTER —** Drastically reduced charging times (Fast-Charging Algorithm)
- **EXTENDED LIFE —** Expected to generally extend the life of batteries (Fast-Charging Algorithm)
- **BETTER PREDICTIONS —** Faster and more accurate prediction of state-of-charge and state-of-health of a battery than mathematical models and electric equivalent circuit models (Reduced-Order Model)
- **BROAD FUNCTIONALITY —** Functions over broad range of currents and temperatures (Reduced-Order Model)

Description: For the Fast-Charging Algorithm, a charge is applied to the battery using a charging profile, and the terminal voltage of the battery is monitored. A mathematical model (such as the Reduced-Order Model described here) is used to estimate the desired State-of-Charge (SOC) of the battery and the predicted terminal voltage. The error between the estimated and measured voltage is determined, and that error is then used to calculate the SOC of the battery. Finally, the charging profile is adjusted to guide the battery to the desired SOC. This enables control of the charging current profile, which can reduce charge time while protecting the cell from aging, lithium plating, and capacity losses. As shown by simulation, battery charging times can be reduced to 30–40% of the time required for typical charging methods, which translates to recharging 2–3 times faster than the current standards combined with constant current and constant voltage charging.

The Reduced-Order Model (ROM) can accurately track the dynamic behavior of a battery using the terminal voltage, current, temperature, and concentrations in the electrode and electrolytes. This simpler model consumes less computational power for calculation of battery variables than a full-order model, yet it can be used to predict the state-of-charge (SOC), health, and other state variables of the battery in 1/6th the computational time. This enables accurate and near-real time monitoring of battery performance, SOC, and remaining effective life. The ROM has been validated experimentally over a range of current rates and temperatures.

Status:

- Fast-charging algorithm is subject of U.S. Patent 9,197,089
- Algorithms are proprietary and copyrighted
- Additional IP includes 11,283,103, 20210013731 and foreign counterparts (all co-owned)
- ROM has been verified experimentally, demonstrating similar accuracy and an 85% reduction in calculation time compared to full order models
- Fast-charging algorithm has been verified by simulation, demonstrating charging 2-3 times faster than current standards
- This technology is available for exclusive or non-exclusive licensing