CPS: Small: Imposing Recovery Period for Battery Health Monitoring, Prognosis, and Optimization

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Battery health deteriorates over time and usage, degrading system performance in different ways and causing many real-life problems/accidents

Challenge

Degraded reliability

Apple's free battery replacement program for iPhone 6S in Nov. 2016

Limited lifetime

Up to 50% degradation of battery capacity is observed on Samsung's Galaxy S4

Reduced operation time

Contemporary smartphones can seldom operate for a day without recharging them

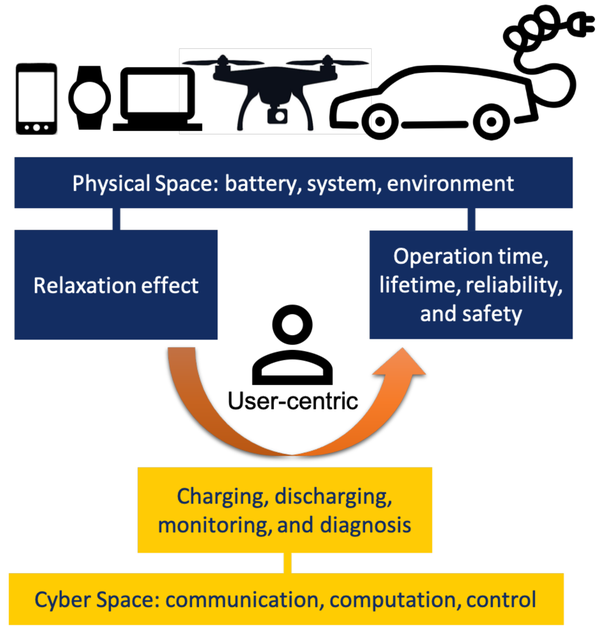
Publicized safety problems

Samsung's Note 7 battery overheating and

Apple's iPhone 8 battery swelling problem

Scientific Impacts

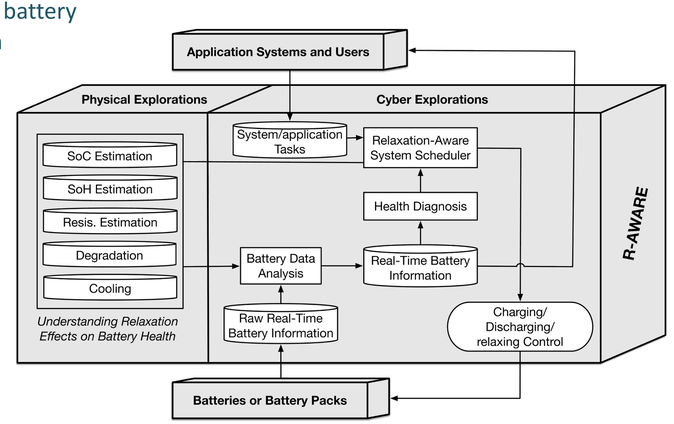
- A thorough understanding of battery's relaxation effect considering physical factors such as ambient temperature, battery age, battery state-of-charge, etc.
- Uncovering and quantifying the impacts of human behaviors in system optimization
- Corroborating a research methodology of combining the physical modeling with (cyber) data-driven analysis



Solutions: Relaxation-Aware Battery Health Management

Input: user requirements and system dynamics

Action: monitor & update, in real time, conditions of batteries/systems/environments, and schedule system operations to exploit relaxation effects on battery health



Broader Impact in Economical-Social-Environmental Advancements

- Improve competitiveness of OEMs (e.g., 3 patents have been filed)
- Provide end users reliable and safe battery systems
- Facilitate the wide deployment of battery systems and thus reduce fossil-fuel consumption (e.g., a commercial company approached us to further develop the solution for solar applications)

Broader Impact in Education and Outreach

- Graduated 1 PhD student who joined Apple's battery team, as well as 1 MS student
- Presented at different universities and conferences to researchers, as well as open houses to high school students/parents
- Integrated with senior/graduate level courses (e.g., EECS 373/473 Embedded Systems, EECS 571 Principle of Real-Time Computing, CSCI 3511 Hardware-Software Interface, CSCI 3515 (Internet of Things), and CSCI 5575 (Cyber Physical Systems)

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