Lithium-ion batteries have been used extensively as a main energy source for electronics (e.g., cameras, laptops, and cellular phones) and electric transportation (e.g., electric vehicles and hybrid electric vehicles). Nevertheless, as with most battery systems, lithium-ion batteries suffer from capacity and power fade issues during the repeated charge-discharge process. As the performance of batteries deteriorates, battery-related breakdowns become more frequent, which becomes a disturbing nuisance. To guarantee safe and reliable battery operation, a battery prognostics and health management system is required to monitor and control lithium-ion batteries to provide good battery performance. In this system, we shall:

- Develop a sophisticated system that provides accurate estimation for SOC of rechargeable battery, particularly in dynamic ambient environment;
- Develop degradation models and estimation methods for effective RUL prediction of rechargeable battery;
- Evaluate and test the proposed methods using both experimental and filed data, and compare its performance with the state of art.

**Battery Performance Indicators**

**SOC Estimation**

- Three different model-based filtering algorithms for SOC estimation are compared.
- A combined dynamic loading profile is proposed to evaluate the three algorithms.
- Robustness against uncertainty of initial states are investigated.

**RUL Prediction**

**Framework:**

- Modelling:
  - Expression:
    \[ C = \alpha_1 + \alpha_2 \ln(k) + \alpha_3 (1 - \alpha_3) k \]
  - Mechanism:
    - Where \( C \) is the normalized capacity fading.
    - \( k \) is the normalized cycle number.
    - \( \alpha_1, \alpha_2, \alpha_3 \) are constant coefficients.
    - \( \alpha_3 \) is the initial state of health.
  - When \( k = 0 \):
    \[ \ln(1 - \alpha_3) = \ln(1) = 0 \]
  - When \( k = \infty \):
    \[ C = \alpha_1 + \alpha_2 \ln(\infty) + \alpha_3 (1 - \alpha_3) \infty \]

- Predicting:
  - Real data
  - Extracted values
  - Particle evaluation paths
  - RUL prediction