Condition Monitoring, Fault Diagnosis and Thermal Management of Li-ion Batteries

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Evading Thermal Runaway in Li-ion battery through Fault Diagnosis/Fault-Tolerant Control Designs

Electro-thermal Model Identification, Precise SOC/SOE & Core Temperature Estimation in Li-ion Battery

Methodology

- **Electrothermal Battery Model:** Data driven high fidelity electrothermal model identification exploiting the strategy honey badgers adopt for searching food based on HPPC test.
- **State of Charge (SOC)/ Core Temperature Estimation**: Attractive ellipsoid nonlinear observers based on the identified electro-thermal model are designed to obtain high precision estimation of SOC and core temperature averting any hazards. Highly noise immune estimations enable the use of low-cost sensors.
- **Fault-tolerant Control:** Prediction of thermal runaway by a controller which lowers the SOE through commands to the battery+cooling system.

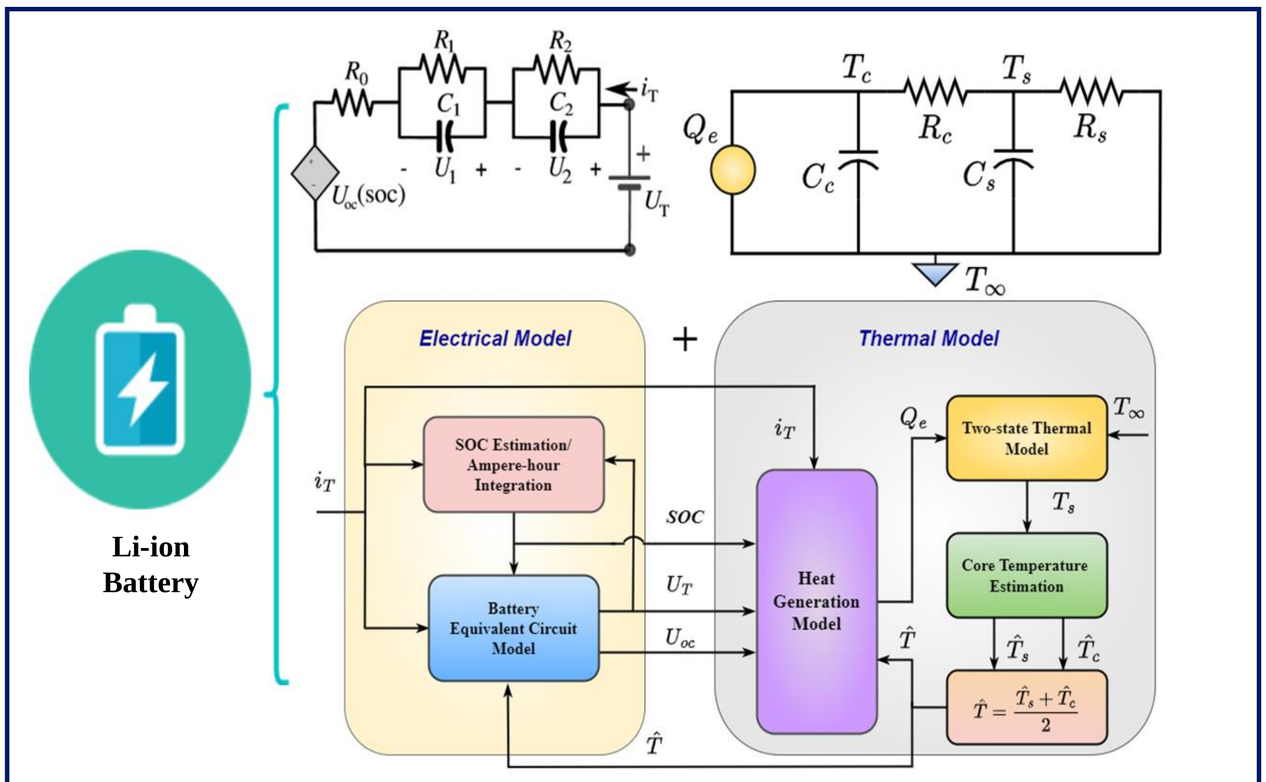

Figure 1. *Schematic representation of the adopted methodology (Model parameter estimation, SOC/SOH estimation, Core temperature estimation) as workstream A for electro-thermal model identification: a pre-requisite for fault tolerant control development in Workstream B in Figure 2. (Ts, Tc, are the surface and core temperature; Uc, Uoc are the terminal voltage and open circuit voltage and i_T is the charging current)*

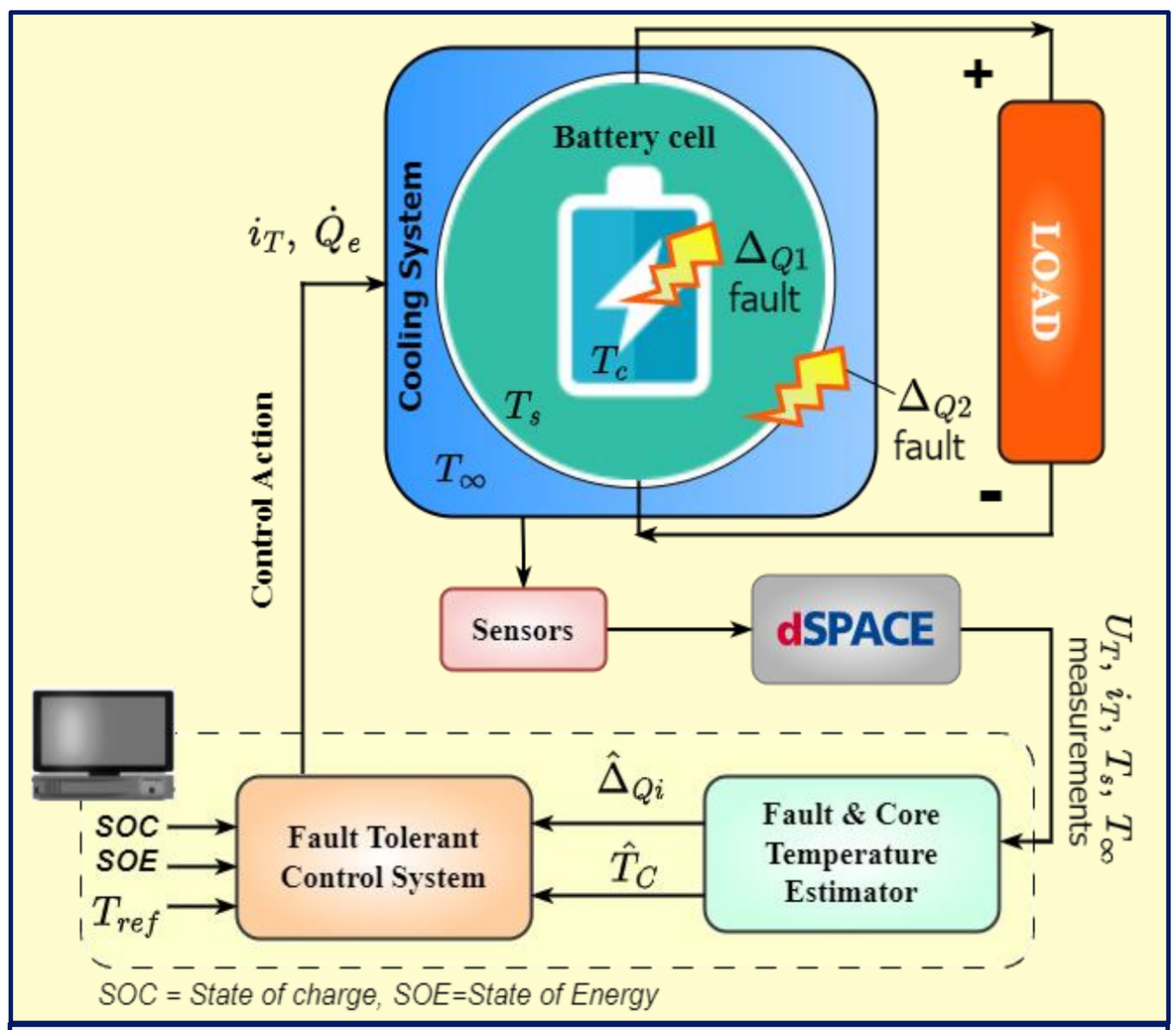

Figure 2. *Schematic block diagrammatic representation of the proposed fault tolerant control scheme with different modules to evade thermal runaway in Li-ion batteries*

Results

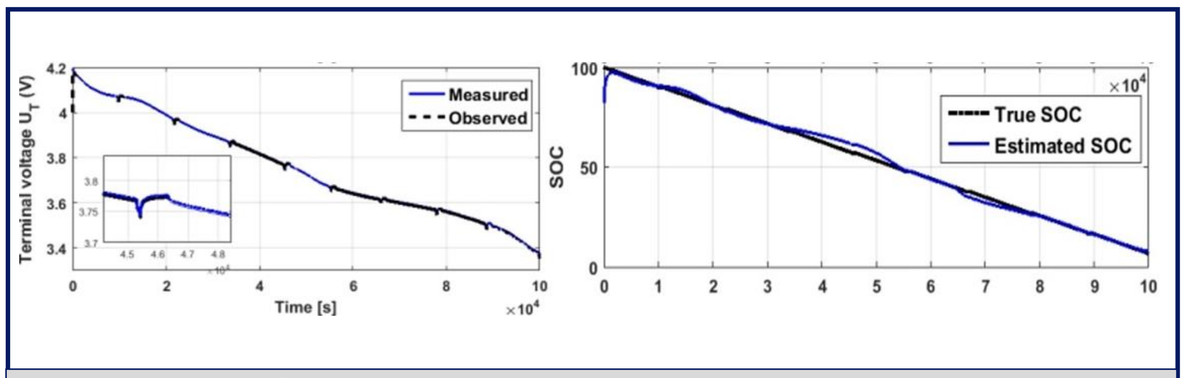

Figure 3. *Robust state of charge estimation using nonlinear observer under varying model parameters and temperature variations after model identification using evolutionary optimization algorithm*