IAF SPACE POWER SYMPOSIUM (C3)
Advanced Space Power Technologies (3)

Author: Mr. Shuo Jiang
CAST, China, 454782907@qq.com

Ms. Xuan Zhang
China Academy of Space Technology (CAST), China, pihaihappy@163.com
Mr. Lei Yun
CAST, China, yunleizz@163.com
Mr. Siyue Jiang
China Academy of Space Technology (CAST), China, jiangsiyue2008abc@163.com
Mr. Yaoxian Jiang
CAST, China, 707756091@qq.cim
Mr. Yini Zhao
CAST, China, zhaoyini@163.com
Ms. Wenfang Zhang
CAST, China, 516547746@163.com
Mr. Yalin Li
CAST, China, liyl169@163.com

ARTIFICIAL INTELLIGENCE BASED SOH ESTIMATION ALGORITHM FOR LITHIUM-ION BATTERIES IN ORBIT

Abstract

The real-time estimation of the state of health (SOH) for lithium ion batteries is extremely important for the maintenance of spacecraft. It will support the mission planning of loads, de-orbit of the whole spacecraft and on-orbit replacement of the batteries in the future. In order to solve the problem of SOH estimation of lithium battery under dynamic operating conditions in orbit, a SOH estimation method based on artificial intelligence was designed. First this paper introduces application solution of Li-ion batteries applied on the large, long life and high reliability GEO satellite platform. By analyzing in-orbit telemetries from the first flight satellite from 12th, October 2015, Li-ion batteries thermal behavior, battery management results, battery flight performance, cell voltage consistency and balance function are verified. Then, this paper analyzes the battery charge and discharge cycle data at different life stages based on the flight experience of lithium ion batteries on China GEO satellites. For the problem of the limited number of on-orbit telemetry parameters, we first studied the feasibility of SOH evaluation based on charging capacity, calendar aging and the time of tapering. The output voltage, current, temperature and state of charge which can be monitored while the battery is working were extracted and compound into a new health factor. Based on the first-order resistance-capacity (RC) equivalent circuit model, two state-space battery models are built. Besides, artificial intelligence based Li-ion battery life assessment and prediction models were established to solve the estimation problem of SOH and to improve the calculation efficiency and accuracy. Besides, this paper evaluated the impact on SOH results from different state of charge (SOC) estimation methods. Finally, through simulation of the end of discharge voltage, it is proved that this method is pertinent and effective in the evaluation of the SOH of lithium ion batteries in orbit. More details will be proposed in the full paper.