IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Advanced Systems, Technologies, and Innovations for Human Spaceflight (7)

Author: Dr. Peng Li
Technology and Engineering Center for Space Utilization, Chinese Academy of Sciences, China

ARCHITECTURE DESIGN OF MANNED SPACECRAFT AUTONOMOUS HEALTH MANAGEMENT SYSTEM

Abstract

Autonomous health management can fast and timely recognize, isolate, and handle the manned spacecraft's faults to guarantee its safe and reliable operation from the system level under limited ground human intervention. Compared with traditional earth-based track telemetry and control systems, on-orbit health management can save processing time and labor costs and avoid failure propagation and expansion. However, the current system relies on domain knowledge to generate fault criteria and fails to diagnose complex coupling or unknown faults. Moreover, predictive maintenance functions are rarely considered. This paper proposes a health management system architecture, including fault characterization, condition monitoring, ensemble fault diagnosis, health prognosis, and fault management sub-systems. Specifically, the ensemble fault diagnosis sub-system combines a knowledge-driven expert system with data-driven machine learning modules to increase failure diagnostic accuracy and the health prognosis sub-system attempts to assess health degrees and predict remaining useful life for mission re-planning and intelligent controls. Finally, the global navigation satellite system receiver payload in satellite constellations is adopted to elaborate the proposed health management system architecture, and simulation results demonstrate its effectiveness.