SPACE POWER SYMPOSIUM (C3)
Advanced Space Power Technologies and Concepts (3)

Author: Dr. Rui Ding
Institute of Manned Space System Engineering,China Academy of Space Technology (CAST), China, drzky@163.com

Mrs. Ren Xiaoqiang
Institute of Manned Space System Engineering,China Academy of Space Technology (CAST), China, renxiaoq@yeah.net
Mr. Xiaofeng Liang
Institute of Manned Space System Engineering,China Academy of Space Technology (CAST), China, xfliang1982@163.com
Mr. Li Zhiyong
Institute of Manned Space System Engineering,China Academy of Space Technology (CAST), China, lizhiyong505@yeah.net
Mr. Wei Zheng
China Academy of Space Technology (CAST), China, aerocaster@yahoo.com

A NOVEL LOAD PRIORITY MANAGEMENT POLICY IN A SPACECRAFT POWER SYSTEM USING JUDGMENT MATRIX

Abstract

Determing the high reliability, especially in terms of the safty of cosmonauts for the manned spacecraft, is an acutely complex problem involving power supply, control as well as interaction with the space environment. It has been widely reported that as motivity feeder of loads and actuators, the stability of power system is a crucial element which maintains the normal and long-term operation of the whole system. However, power management exhibits diversification, complexity as well as enormousness when combined with system engineering.

For the power management in the field of aerospace, a power management and distribution system, i.e. PMAD, has representatively been established for the NASA intelligent power supply and distribution design based on an expert system. From an engineering perspective, the knowledge acquisition capability from the expert system becomes the bottleneck of the PMAD and restricts its broden application to some extent. To improve the efficiency of load management, the advanced aircraft power distribution system exploits mission-based hierarchy plan. The load priority is explicitly determined by electrical load types, power system capacity, and missions, etc. However, fewer loads and relatively fixed missions accomplished by poor flexibility incapacitate its application to complex space system.

To draw inspiration from the NASA PMAD and advanced aircraft power distribution system, this paper presents a control architecture for power management of a spacecraft system with multi-task flight. In view of both flight-mode complexity and load diversity, a novel power management policy based on judgment matrix is proposed and will be applied to the spacecraft system. Firstly, irrelevant loads will be excluded when a specific flight mode is applied. Then the loads can roughly be subdivided into five categories based on their hierarchy. As a bonus offered by the PMAD, weights are introduced into our load management system to schedule and establish the load priority. To establish the load priority list, a set of crucial parameters involving working-mode coefficient, grading coefficient and comprehensive indexes (in terms of unquantifiable coupling weights, quantitative power consumption and working hours) has

to be well defined using judgment matrix. In particular, the coupling weights are inenarrable and have to be finely determined based on fuzzy set. Using the judgment matrix, the power system is capable of modulating electrical load suitable to supplied power, with updated priority list generated accordingly. A simulation is provided and results are presented demonstrating the feasibility of the management policy for efficient load management.