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

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AN AGENT BASED OPTIMIZATION METHOD FOR MICRO-SATELLITE POWER SYSTEM DESIGN WITH DISTRIBUTED POWER BALANCING CONSTRAINTS

Abstract

An agent based optimization strategy is proposed for the design of the power system of a micro satellite. The system is divided electrically into several sections, including the solar array, battery, GPS, and Attitude Control System (ACS). The activities of the devices onboard are subject to temporal and resource constraints. Plans of activities to be performed onboard are strongly affected by the energy consumption and production. The situation becomes more complex for small scale satellite in which only physically limited space and resources are available for the power system. Moreover, the array and battery performance vary greatly with the space environmental factors and satellite attitude; and in cases of ACS failure, the power system should be able to support the safe mode operations. Therefore, an efficient optimization method for enhancing the power system robustness is required.

In this paper, the power system design is formulated as a multi-objective optimization problem with distributed satisfaction constraints. The optimization model is built up via minimizing the weight power ratio to obtain efficient electrical energy consumption. Subsystems of solar array, battery and apparatuses on board are associated to the various agents. The interaction messages of agents are sent through the communicating information of power balancing. Taking into account various uncertainties, the distributed reliability constraint multi-objective optimization problem is solved with the local and global heuristic optimizer.

At the local level, effects of device operations during eclipse and daylight period, battery charge and discharge are investigated. The model of energy balancing and scheduling is established for evaluating power system performance during the life cycle. Dynamic backtracking algorithm is performed for the Constraint Satisfaction Problem (CSP) of the individual agents. The agent gets the value assignments to its local variables that satisfy its local constraints. Heuristic optimization algorithm works on the interaction of the agents, evolves with the collaboration of population of agents and selects those individuals with better performance.

Numerical simulation for a cube-shaped sun-synchronous satellite is performed to illustrate the effectiveness of the proposed method. Better use of the energy or more reliable of the power system are verified by a set of tests taking into account environmental influences and ACS failures.