Paper ID: 10550
oral
student

SPACE POWER SYMPOSIUM (C3)
Advanced Space Power Technologies and Concepts; Part 1 (3)

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OPTIMAL POWER HARNESS ROUTING FOR SMALL-SCALE SATELLITES

Abstract

The power harness can account for a significant percentage of the mass even of small-scale satellites. Furthermore, its impact on data transmission and attitude control due to the induced magnetic field should be minimized. Various parameters need to be taken into consideration when designing a satellite's harness, starting from external parameters such as the planet's magnetic field to constraints such as the limited available space. The tight constraint on the mass of low-cost small scale satellites imposes an optimal design of the harness. This paper presents an approach to optimal power harness design based on a modified ant colony algorithm (ACO). The optimisation of the harness routing topology is formulated as a multi-constrained multi-objective optimisation problem in which the main objectives are to minimise the length of the mass of the harness, minimise the induced dipole, minimise the power and data losses. The modified ACO algorithm automatically routes different types of wiring, connecting one or more power sources (solar arrays and batteries) to the subsystems and then calls a power harness simulator, which evaluates the total mass, the induced dipole and the power and data losses due to a particular harness topology. The optimisation algorithm works incrementally on a finite set of waypoints, forming a tree, by adding and evaluating one branch at a time, either starting from the power source and ending up at the interfacing subsystem or vice versa starting from the loads and branching out to the source. Constraints are introduced as forbidden waypoints through which ants cannot travel. The paper will present the application of the proposed approach to the design of the harness of the ESA European Student Earth Orbiter (ESEO). A representative model of the satellite will be used in the simulator. The optimised design will be compared to a human based design for different possible operational scenarios.