IAF SPACE POWER SYMPOSIUM (C3)
Solar Power Satellite (1)

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DYNAMIC MODELING AND SIMULATION OF THE CORE CIRCLE STRUCTURE OF SSPS-OMEGA

Abstract

A novel design project for space solar power station (SSPS-OMEGA), proposed by Chinese scholars, adopts the design idea of spherical spacecraft to ensure the structural balance and stability of extra-large spacecraft under the gravitational environment. The main structure of the SSPS-OMEGA includes core circle structure, condenser lens, hyperboloid photovoltaic (PV) cell array, microwave transmitting antenna and connecting cables. Among those structures, the core circle structure bears most of the mass of the spacecraft, plays an important role in supporting the spacecraft structure, and is the main installation position of the spacecraft attitude orbit control engine and flight control computer. This paper aims at the orbit assembly of the core circle structure, analyzes its dynamic characteristics under the gravity field, and provides theoretical support for future orbit experiments. The paper first establishes the on-orbit installation task scenario of the core circle structure and determines the installation strategy to be adopted. Assume that space robots are used for on-orbit installation operations, and the robot carries the core circle module along the structure of the installed core circle structure to the position to be installed to complete the installation. Secondly, only considering the influence of the earth's gravity gradient, the on-orbit installation of the core circle structure was modeled. The core circle structure is simplified into a multi-segment spring damping model, and the system is described using a topology matrix. A new concept of virtual spacecraft is proposed. Based on the concept of virtual spacecraft and the relative kinematics of spacecraft, a new dynamic analysis algorithm during the orbital installation process is proposed. Finally, based on the above dynamic analysis algorithm, two structural strengthening methods are proposed to reduce structural vibration caused by gravitational gradient, and comparative numerical simulation calculations are performed. The results show that the new dynamic analysis algorithm can effectively give the motion characteristics of the core circle structure. The two proposed methods of structural reinforcement can effectively reduce the free vibration of the structure and provide a reference for the subsequent vibration prediction and suppression, and provide important support for the development of SSPS-OMEGA.