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LOW COST CLUSTER SELF RECONFIGURABLE MODULAR SPACECRAFT FOR MULTIMODAL SPACE AND GROUND OBSERVATION MISSIONS

Abstract

With the development of the aerospace industry, the complexity of space missions is increasing. In order to ensure the safety of in-orbit spacecraft and subsequent launch missions, it is urgent to solve the problems of space debris avoidance and cleanup, the taking over and service of on orbit faulty spacecraft, and the safety protection of important space assets. These tasks require advanced space observation technology as a priori information. However, due to the shortcomings of traditional space observation technology, such as single task type, high execution cost and inferior volume of space observation equipment, when encountering an emergency, the space observation equipment performing a specific task is often unable to respond to other tasks timely and effectively due to the mismatch of interface and capability. Therefore, the traditional single remote sensing satellite observation scheme has been unable to meet the requirements of rapid response to space and earth observation in complex scenes. The compound eye structure of insects in nature enables them to obtain a wider field of vision, capture more visual information, and react quickly when natural enemies attack. Inspired by this, this paper designs a low-cost cluster self-reconfigurable modular spacecraft to achieve multimodal space and ground observation tasks through cluster self-reconfiguration. The modular spacecraft adopts a hexagonal design in its structural design, which is convenient for stack launch and has the ability of on orbit splicing and self-reconfiguration. Each spacecraft is equipped with an optical load unit that can realize omni-directional observation, which can realize omni-directional observation without changing the attitude of the spacecraft. In addition, this paper proposes a self-reconfigurable modular spacecraft cluster collaborative planning technology, which enables the spacecraft cluster configuration to be dynamically adjusted according to the task type and target configuration. We have designed three configurations: linear configuration, plane configuration and three-dimensional configuration, which can realize the observation of the narrow and long region of the earth, the close-up imaging of large spacecraft in space and the simultaneous sensing and detection of heaven and earth. Because each spacecraft module is of the same structure, when partial loss occurs, only the failed module can be replaced to achieve low-cost maintenance. The design of modular observation spacecraft in this paper solves the problem of multimodal observation of space and space objects from the perspective of aerospace dynamics, robotics, biology and control theory, and provides a new idea for the innovative design and implementation of space missions.