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# ATTITUDE AND ORBIT CONTROL OF CHINA'S SPACE STATION WITH LARGE SCALE FLEXIBLE STRUCTURES IN ULTRA-LOW FREQUENCY

**Abstract**

Since the first module was launched on April 29, 2021, the assembly of the main structure of China's Space Station has completed. China's Space Station consists of three main segments, namely the core module Tianhe, the experiment modules Mengtian and Wentian. This paper presents the design and on-orbit verification of the attitude and orbit control system of China's Space Station with ultra-low frequency and large flexibility. The frequency of flexible attachments of common spacecraft generally ranges above 0.2 Hz. Due to considerable energy requirement the solar arrays of space station are large in size, low in frequency and dense in modes. At the same time, the on-orbit assembly of the space station requires use of manipulator. For example, during module assembly stage, the space station is in "dumbbell" shape with ultra-low system frequency of 0.01 Hz. The structure creates great challenge for the design of the control system. According to different actuator, the attitude and orbit control of the space station can be divided into two schemes, i.e., Control Moment Gyro(CMG) control and jet control. For CMG control scheme, we adopt an architecture of attitude trajectory planning, filtering, attitude tracking control and control command filtering. First, attitude trajectory is planed for target attitude, and a structure filter up to 12 orders is used to filter the coarse trajectory. Then the Lyapunov attitude tracking controller is designed satisfying the variation of moment of inertia. The last controller includes feedforward and feedback parts, and the structural filter is used to filter the feedback part to form the final control command, which is sent to the control moment gyros for realization. For the jet control scheme, in addition to the previous CMG control architecture, a pulse width modulation is added to generate jet pulses. For space station the mass range can reach more than 10 times, and the inertia does more than 100 times. Adapting variable configuration and different control ability of jets, a technique of unitization of overall effect of moment of inertia and jets control ability is used. The parameters are design in unitized virtual space and then transformed to physical space. The above methods are applied to China's Space Station, and the on-orbit results show that the methods can effectively suppress the vibration of the flexible structure in large scale with ultra-low frequency during attitude stability, attitude maneuver, and orbit control.