ATTITUDE CONTROL DESIGN FOR THE SOLAR POLAR ORBIT RADIO TELESCOPE

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This paper studies the attitude dynamics and control of the Solar Polar Orbit Radio Telescope (SPORT). The SPORT which consists of one parent satellite and eight tethered satellites runs around the Sun in a polar orbit. The parent satellite locates at the mass center of the constellation, and tethered satellites which are tied with the parent satellite through a non-electric rope rotate around the parent satellite. It is also supposed that the parent satellite and all tethered satellites are in a plane when the constellation works.

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Fig.1 the SPORT constellation

Firstly, this paper gives the dynamic equations of the tethered satellite and the parent satellite. From the dynamic characteristic of the tethered satellite, we then find that the roll axis is coupled with the yaw axis. The control torque of the roll axis can control the yaw angle. But the control torque of the roll axis and pitch axis provided by the tether is very small, it can not meet the accuracy requirement of the yaw angle. In order to improve the attitude pointing accuracy of the tethered satellite, a gradient pole is set in the negative orientation of the yaw axis. The gradient pole can improve not only the attitude accuracy of roll angle and pitch angle, but also that of the yaw angle indirectly.

As to the dynamic characteristic of the parent satellite, the roll axis is coupled with the pitch axis due to the spinning angular velocity. At the same time, the roll axis is coupled with the yaw axis because of the orbiting angular velocity. And there also exists a constant torque which acts on the roll axis of the parent satellite. The constant torque makes the pitch angle drifting 360° in one orbit. So it can be used to control the spinning axis of the parent satellite pointing to the Sun.

Finally, the paper shows the movement of the attitude angles through the mathematical simulation. From the result of the simulation we find that the attitude angles of the tethered satellite are stable with the passive control method. The maximal attitude accuracy is about 2.3 deg in yaw and 2.5 deg in roll and 0.9 deg in pitch, and the stable attitude accuracy is about zero in roll and yaw. But for the attitude movement of the parent satellite, the active control method must be used to reduce the nutation and procession movement.