Paper ID: 59683
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (1) (8)

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INITIAL STUDY ON ATTITUDE CONTROL OF TRANSFORMABLE SPACECRAFT AROUND UNSTABLE EQUILIBRIUM POINT USING SOLAR RADIATION PRESSURE

Abstract

JAXA and other organizations are considering transformable spacecraft. The transformable spacecraft is a spacecraft that can change its structure. Utilizing these characteristics, this spacecraft has an engineering challenge to perform attitude control without fuel using the non-holonomic properties and the solar radiation pressure. The mission that is being considered is an on-orbit interferometer, which requires highly accurate attitude stability. In transformable spacecraft, the effects of solar radiation pressure can be controlled by structural changes. This allows the solar radiation pressure to be used for attitude control. In addition, an equilibrium point can be created by structural changes. The equilibrium point is an advantage in stabilizing the attitude because the torque caused by solar radiation pressure due to the attitude change is reduced. It is considered that attitude control around the stable equilibrium point is relatively easy. If a control method around the unstable equilibrium point can be established, the observation range will be greatly expanded. In this study, we propose a method for attitude stabilizing control of transformable spacecraft at unstable equilibrium point using solar radiation pressure. The proposed method identifies the equilibrium point as well as stabilizes the attitude. The proposed method can be roughly divided into the following three sequence.

- Control the solar radiation pressure by changing the structure of the spacecraft and obtain the angular velocity in the target direction.
- Control the solar radiation pressure by changing the structure of the spacecraft and stabilize the attitude of the spacecraft at the target attitude angle.
- Change the structure of the spacecraft so that it becomes an equilibrium point at the target attitude angle.

Using three sequence according to the states and stabilize at the desired attitude angle by repeating these sequences. Numerical analysis confirmed the effectiveness of the proposed method under certain condition. However, in the proposed method, the parameters are determined by experience. Furthermore, control is only successful under certain condition. Therefore, in addition to the proposed method, the attitude of the spacecraft is stabilized by reinforcement learning, etc., and compared with the above-mentioned proposed method for evaluation.