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RELATIVE ANGLE CONTROL CONSIDERING FRICTION OF THE DRIVE HINGE OF A SPACECRAFT COMPOSED OF MULTIPLE PANELS

Abstract

A group centered on JAXA is developing a transformable spacecraft in which two telescopes and multiple panels are connected by drive hinges. As a feature, the drive hinge allows the shape to be significantly changed in orbit. By non-holonomic attitude control using this deformation, the attitude can be controlled without generating thrust by jet injection. From the initial shape in orbit, the panel is moved to deform. When returning to the initial shape, change the order in which the panels are moved and deform them. Non-holonomic attitude control is a method of changing the attitude of a spacecraft by moving it as described above.

It is desirable to change the attitude quickly for orbit control. Deformation is performed by rotating only one of the multiple hinges and keeping the other hinges stationary. A possible problem is that because we want to move the hinge quickly, an inertial force larger than the static friction force is generated, and other hinges also move. On the ground, this problem does not have a significant impact. In order to move, a large torque is required to overcome gravity, and the gear ratio is increased. This will slow down the movement and increase the static frictional force, so this is not a problem. However, it becomes an important problem in orbit. It can move with a small force compared to the ground. In addition, it is not recommended to employ gear drive systems from the viewpoint of demand for quick movement and weight reduction. From the above, it is necessary to construct a control law that can meet the requirements of weight and speed. This control law is a problem assumed in a spacecraft composed of many driving elements, and it is a method that can be generally used not only for transformable spacecraft.

In this study, we create a simple model of the transformer by simulation and examine the control method. In order to design and evaluate the control system, we will introduce a non-smooth friction model that can sufficiently express the physical characteristics of multiple static friction forces that interfere with each other and can be calculated efficiently. After that, we will develop an experimental device using an aerodynamic levitation device to simulate a weightless space. By using the developed experimental device, we confirm the validity of the mathematical model and the proposed control method.