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Author: Mr. Ryota Ikeda
Aoyama Gakuin University, Japan

Dr. Toshihiro Chujo
Japan Aerospace Exploration Agency (JAXA), Japan
Dr. Osamu Mori
Japan Aerospace Exploration Agency (JAXA), Japan
Dr. Yoshiki Sugawara
Aoyama Gakuin University, Japan
Mr. Kenichiro Sawada
Japan Aerospace Exploration Agency (JAXA), Japan

THERMAL DESIGN STRATEGY UTILIZING TRANSFORMABLE STRUCTURE OF SPACECRAFT

Abstract

As an innovative spacecraft system, a transformable structure spacecraft is proposed, which is composed of many form elements coupled with each other by an internal force actuator and capable of transferring the form to each other. Herewith, in addition to being able to switch the function of the spacecraft largely by changing its form on orbit, it is possible to control attitude without propulsion using nonholonomic properties and internal force. Moreover, not only the function of the transformable structural spacecraft can be changed by the change of shape, but also various characteristics caused by the shape can be changed on orbit. Thermal characteristics, structural characteristics, etc. can be cited, but if these are actively utilized, characteristics suitable for the mission on orbit can be selected. In this research, focusing on thermal characteristics, we consider changes in thermal characteristics due to shape changes. In general spacecraft, thermal control is carried out by changing the attitude or by using a heater. However, if a transformable structure is used, it is possible to passively cool and heat a specific part of the spacecraft due to a change in the thermal environment by the construction of a heat shield plate or the like. On the other hand, since it is coupled with other characteristics such as structure, it is also necessary to consider the trade-off when considering the entire system. As an example, the transformable spacecraft under consideration in JAXA has an infrared telescope that needs cooling as a mission equipment and we considered applying thermal design that makes use of a transformable structure to mission equipment. By blocking sunlight by the panel against the mission unit, thermal control becomes possible without changing the attitude of the mission unit, so that the flexibility of the mission can be improved.

Therefore, the purpose of this study is to evaluate the relation between the panel shape of the transformable spacecraft and the thermal environment of the mission part by thermal analysis and obtain the guideline of the panel form suitable for observation mode. From the relationship, we clarify conditions such as the number of panels and arrangement of the transformable structural spacecraft to realize the demand of the thermal environment of the mission section and propose a system design method of the transformable structural spacecraft considering thermal characteristics. In addition, we propose a system design method of transformable structural spacecraft considering characteristics other than thermal characteristics.