IAF SPACE SYSTEMS SYMPOSIUM (D1)
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TRANSFORMABLE SPACECRAFT: FEASIBILITY STUDY AND DEVELOPMENT STATUS

Abstract

Transformable spacecraft under development is an innovative system that consists of several structural components, such as panels, connected together by joints driven by internal force actuators. The spacecraft

can change its structure significantly by driving installed actuators and achieve simultaneous realization of attitude control based on non-holonomic motion, hereinafter called “non-holonomic attitude control”, and transformation to arbitrary shape, which is the most important feature of the Transformable spacecraft. Attitude control based on non-holonomic turn is achieved by repeating the deployment of the panel in an appropriate order by the internal force actuator. Furthermore, it is also possible to change the final structure after attitude control. Such the most important feature can open up new spacecraft concept.

The most important feature leads to following three collateral features. The first is that ”change of the structure enables the multiple functions by switching modes”. The second is ”orbit control and keeping by controlling the solar radiation pressure on the spacecraft by change of spacecraft structure, and it is achieved without fuel consumption”. In this project, Transformable spacecraft will be inserted into an small artificial halo orbit around SEL2, and engineering and science mission will be performed. The third is ”passive cooling of mission equipment achieved by appropriate panel configuration as shielding of sunlight”. As a result, disturbance due to refrigerator is eliminated, which leads to attitude control without disturbance because non-holonomic attitude control also does not yield disturbance.

This study analyzes the feasibility of Transformable spacecraft which demonstrate above special features in orbit, and this presentation shows development status of the system and each subsystem to realize the spacecraft as follows:

- Numerical analysis shows the feasibility of the orbit keeping and non-holonomic attitude control strategy by proposed method.
- Developed panel deployment system is evaluated by numerical analysis and experiment.
- The heat transfer characteristics of the deployment joint between panels are determined by thermal vacuum testing and feasibility of the passive cooling of the Transformable space craft is studied.
- Experimental setup is being developed for demonstrating non-holonomic attitude control using a small model on the International Space Station. - Communication system is analyzed to evaluate the influence of the panel configuration on antenna pattern characteristics.