IAF SPACE SYSTEMS SYMPOSIUM (D1)
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TRANSFORMABLE SPACECRAFT: FEASIBILITY STUDY AND CONCEPTUAL DESIGN

Abstract

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

structure drastically by driving installed actuators and achieve the following four features simultaneously.

The first feature is "attitude change by internal force using non-holonomic characteristic of the system". It is possible to orient the spacecraft to an arbitrary direction by repeating the deployment of the panel in an appropriate order by the internal force actuator. Note that this method is different from conventional attitude control method which utilizes conservation of angular momentum, e.g. control by reaction wheel, and it enables an attitude control without disturbance and fuel consumption.

The second feature is that "change of the structure enables the multiple functions by switching modes". Two telescopes will be installed for scientific missions utilizing the features of the transformable spacecraft and used to realize two different observation modes. One is a mode in which each telescope is oriented to different directions to perform wide-field observation (independent telescope mode). The other is a mode in which two telescopes are pointed in the same direction. This mode enables the spacecraft to work as an interferometer (interferometer mode).

The third feature is "orbit control and orbit keeping by controlling the solar radiation pressure on the spacecraft with the use of change of spacecraft structure". Since the spacecraft can change its structure by the internal force actuator, the orbit control and orbit keeping are achieved without fuel consumption. By utilizing this feature, the spacecraft will be inserted into an artificial halo orbit around Sun-Earth Lagrangian point L2, and the technology demonstration of the transformable spacecraft and the observation mission will be performed.

The fourth feature is "passive cooling of observation equipment by use of panels". In the independent telescope mode, observation in the infrared region is performed and sufficient cooling is required. Appropriate arrangement of panels enables shielding of sunlight, and then the passive cooling of the observation equipment is realized. As a result, disturbance due to refrigerator is eliminated, which contributes to accurate attitude control in addition to the contribution by non-holonomic attitude control without disturbance.

This presentation shows the analysis and experimental results for feasibility studies and conceptual designs of above four features. Furthermore, development status of the system and each subsystem to realize the spacecraft are introduced.