Paper ID: 77992
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IPB)

Author: Mr. Hayate Tajima
The University of TOKYO, Graduate school, Japan

Mr. Yuta Takahashi
Tokyo Institute of Technology, Japan
Dr. Takuma Shibata
Muroran Institute of Technology, Japan
Prof. Shin-ichiro Sakai
Japan Aerospace Exploration Agency (JAXA), ISAS, Japan

STUDY ON SHORT RANGE FORMATION FLIGHT AND DOCKING CONTROL USING AC MAGNETIC FIELD

Abstract

Rendezvous and docking is a key operational technology, such as In-space assembly (ISA), a resupply of supplies to space stations, and a sample return mission. However, the use of propulsion systems at short distances causes negative effects such as sensor contamination, which can lead to failure of the satellite or onboard equipment. On the other hand, motion control by electromagnetic coils mounted on the satellite is expected to overcome propulsion weaknesses. In particular, AC magnetic fields allows the elimination of unwanted magnetic interactions and electromagnetic torque control, enabling control among desired satellite groups, absolute attitude control, and angular momentum management. Considering ISA from small satellite swarm, the AC magnetic field is effective since it is necessary to consider payload limitation, collision avoidance, and contamination from propulsion systems. In docking, the distance between satellites is short, but the magnetic field models of previous studies are based on the assumption that the coils are far enough apart (Far field model), which causes deviations from the accurate model at short distances. Such deviations may cause satellite collisions because the desired values are not obtained as the satellite approaches. Therefore, it is not recommended to use far field model at short distances, and it is necessary to propose control laws based on more accurate magnetic field models. For these reasons, the purpose of this study is to realize ISA from small satellite swarm, and we propose a multi-satellite control system using AC magnetic field. In this research, our proposed controller utilizes a magnetic field model described by Biot-Savart's law without distance approximations (Near field model) in consideration of short distance operation. In the docking simulation of two small satellites equipped with electromagnetic coils on three axes, control current calculations are performed on a far field model basis and a near field model basis, respectively, and the results are compared. As a result, in the case of the far field model-based method used in previous studies, the desired control value was not obtained as satellites approached, and a collision occurred. On the other hand, the proposed near field model-based method provided accurate, collision-free control even at short distances. In conclusion, this research proposed a new multi-satellite control method using AC magnetic field and considering short distance operation, and confirmed the effectiveness of the proposed method through numerical simulations assuming the docking of two small satellites.