Paper ID: 11293
oral
student

ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics - Part 1 (5)

Author: Mr. kenji kitamura
Tokyo University , Japan

Dr. Junichiro Kawaguchi
Japan Aerospace Exploration Agency (JAXA), Japan
Dr. Yuichi Tsuda
Japan Aerospace Exploration Agency (JAXA), Japan

# PRECISE ATTITUDE ESTIMATION OF SOLAR SAIL SPACECRAFT UTLIZIING COUPLING BETWEEN ATTITUDE AND ORBITAL DYNAMICS

**Abstract**

Orbit determination is the process to estimate the position and velocity, i.e. six orbital elements, from a given set of observations of spacecraft. The common measurements used in orbit determination are range and range rate. For precise orbit determination, the acceleration of spacecraft by solar radiation pressure (SRP) must be taken into account. In order to incorporate the SRP acceleration, the attitude history and the SRP model – surface shape and optical surface feature of spacecraft – need to be known beforehand. Especially, in case of solar sail spacecraft, since their SRP effect is strong, coupling between attitude and orbital dynamics is more remarkable than ordinary ballistic missions. Therefore, by positively utilizing this coupling, it is possible to refine the attitude information based on the residual errors of orbit determination. In this study, we assume that the systematic errors in the orbit determination of the spacecraft are caused solely by the errors in attitude information, and propose an attitude error correction method which utilizes the coupling between attitude and orbital dynamics. In order to examine the validity of the method, both the simulation and the analysis of actual data are conducted. As actual data, flight data of IKAROS – Japanese interplanetary solar sail demonstration spacecraft – are used. The observations used in the orbit determination of IKAORS are range and range rate. In this paper, an estimator is designed whose input is the residuals of the orbit determination result – the difference between actual measurements and modeled observations of range and rage rate — and whose output is the amount of error correction in the attitude history. It is confirmed that orbit and attitude errors are both decreased through this method. Furthermore, it is possible to recursively improve the accuracy of both attitude and orbit determinations by repeatedly applying this estimation method and orbit determination process. This paper explains the theoretical background of this method and shows the result of analysis using the actual data.