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ATTITUDE CONTROL USING ITERATIVE LEARNING CONTROL CONSIDERING ORBITAL MOTION OF NRHO

Abstract

Recently, sustained exploration to the Moon has been proposed as a first step in deep space exploration to Mars and beyond. In particular, the orbital characteristics of NRHO have been actively studied, and the development of a Lunar Orbital Platform-Gateway is being considered as a base for space exploration. The development of the Gateway will enable lunar exploration based on orbital characteristics of superior stability, as well as Earth-peripheral observation and evaluation of the radiation environment in extraterrestrial orbit. However, automation of attitude control is required due to the difficulty of frequent attitude control inputs from the Earth and the long period of unmanned operation in NRHO.

Attitude control methods for spacecraft have been widely studied, such as sliding mode control, passivity-based control, and Iterative Learning Control (ILC). ILC is a control method based on a step-by-step control to improve attitude tracking accuracy considering the effects of repetitive disturbances. Hitherto ILC has been applied to ground track orbits, but there is no research for spacecraft attitude control considering orbital motion, such as Earth-Moon system periodic orbits for deep space exploration. In the Earth-Moon system CR3BP, the gravity gradient torque from the Moon and the Earth affects the attitude motion of spacecraft significantly according to its orbital motion. In previous studies, the combination of the anticipatory ILC method and the closed-loop feedback control system has been confirmed to improve attitude tracking accuracy for ground track orbits. In this study, we apply it to NRHO orbits with significantly large disturbance and confirm its effectiveness.

In the first layer, a target torque to track the target angular velocity and attitude is calculated by ILC. In this layer, the feedforward control input is computed by using the error information in the previous revolution without an accurate information of the current periodic orbit. In the second layer, the control input obtained in the first layer is used as the reference for the second layer, and CMG steering law is derived from the error information. Then, the process is repeated until the output torque from the CMG becomes desired one. In future, this control method would be applicable to orbit-attitude coupling problem to control the attitude continuously according to environmental changes due to orbital motion.