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A FUZZY PID CONTROLLER FOR SOLAR SAILING CUBESAT

Abstract

This paper presents the design, implementation and testing of the attitude control system of COEPSAT-2. The mission objective of COEPSAT-2 is to demonstrate orbit maneuvering using solar sails and characterize charged particle environment with respect to altitude. The control system of the satellite is focused towards maximizing the solar thrust and also attaining appropriate orientation for reliable communication. Initial analysis shows that, maximizing the thrust for raising the orbit requires a 90 degree pitch maneuver over sunlit region in each orbit. The control system employs 3-axis magnetic control using magnetorquers and a pitch axis reaction wheel. The inability of torquers to generate a torque along the direction of Earth's magnetic field necessitates the use of the reaction wheel where the torque requirement in the Pitch axis is satisfied by it. Two pointing modes are adopted, viz sun-pointing (in sunlit region) and nadir-pointing (in eclipse region). A conventional proportional-integral-derivative (PID) controller has been implemented for the same, however performing poorly in the event of wheel saturation. Uncertainties in the system as well as disturbances such as torque due to Earth's magnetic field, atmospheric torques and gravity gradient torques are likely to lead to problem of wheel saturation. To address this issue, a fuzzy PID control law is proposed to be used over conventional PID control. The control algorithm calculates the torque to be provided by the actuators depending upon the error in orientation, its rate and the summation of the previous errors. The control gains are to be adjusted through a set of rules prescribed in the rule base of the fuzzy controller. This paper along with design of fuzzy controller, also discusses the comparison of performance of fuzzy control and conventional PID for active attitude control problem. This approach generates a robust, accurate and power efficient actuation output. The algorithm discussed is scalable, computationally cheap and easy to adapt for all other cubesat missions.