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TIME-OPTIMAL CONTROL OF RATE CONTROL SYSTEM WITH DYNAMICS PARAMETERS UNCERTAINTIES AND COMMAND DELAY

Abstract

This paper describes a Rate Control System (RCS) Algorithm to be used in sounding rocket payload for microgravity experiments. The low gravity environmental can be obtained during the payload ballistic phase, above the Earth atmosphere influence and no angular movement. Unfortunately, after the payload separation from the sounding rocket there are some residual angular movements that cause a centripetal acceleration to the experiments. So, in order to reduce this centripetal acceleration to levels of g, the payload needs to have a rate control system. The RCS for this purpose normally uses a Cold Gas Subsystem (CGS), with actuators, that must reduce and keep the payload angular velocity close to zero, at this ballistic trajectory phase. A problem to be solved for this control system is the instant and the length of control pulses for each CGS actuator in order to reduce the payload angular velocity as close as possible to zero in minimum time and keep so with minimum fuel consume. To develop this control system algorithm it was considered: the dynamics of actuators force and payload, commands delays due the electromechanical subsystem to activate and deactivate each actuator and that their parameters are not well known. Therefore, considering these conditions it was developed an algorithm based on minimum-time problem from optimal control theory to create a switch function, which is an optimal boundary, to turn on or turn off the actuators. Measuring the error state after each pulse command, this switch function can be updated to compensate the actuator and payload dynamics and the electromechanical delay in real time. Adding linear constraints to this switch function to change the control law, the limit cycle can be reduced, and consequently reduces the fuel consume, to keep the payload angular velocity close to zero. In this paper it is showed the results obtained through simulations for this Rate Control System Algorithm for the following parameters uncertainties: 30