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DEVELOPMENT OF SATELLITE CLUSTER FLIGHT ALGORITHMS UNDER THRUSTING ERRORS

Abstract

One of the most widely considered topics in satellite cluster flight is the control of relative positions among satellites, referred to as cluster keeping. In general, satellite cluster keeping is aimed at keeping the satellites in a specific range of distances. In order to maintain relative distances within given bounds, maneuvers are required. Fuel consumption should be minimized in order to decrease mass. However, in practical situations, thrust parameters are often uncertain. Errors can occur in the magnitude of the thrust as well as in its direction. These errors are often caused by the uncertainty of operating in the space environment. Moreover, the on-board sensors used for thrust measurements are noisy and biased. These effects may seriously jeopardize the cluster flight mission on the long term.

The main purpose of this research is to robustify cluster control methods under thrusting errors and uncertainties, and minimize the effect of thrusting errors and noise on the evolution of relative distances and on the consumption of fuel. In particular, this research develops algorithms that minimize the fuel consumption during the maneuver as well as minimize the time of the maneuver in spite of thrusting errors and noise. An inverse dynamics controller was implemented, using mean orbital elements feedback, while an adaptive control scheme was used for the thrust pointing error reduction in order to obtain optimality in terms of fuel consumption and operation time.

In order to verify the performance of the cluster keeping controller under these conditions, a Kalman Filter was designed for estimating the mean elements. A comparison between the results with and without noise are presented. A Monte-Carlo simulation results are also presented in order to show the convergence of the errors created by noise.

In conclusion, the inverse dynamics controller with the adaptive control scheme is able to function in an optimal way under thrusting errors and noise.