World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:15, No:01, 2021

A Comparative Study of Various Control Methods for Rendezvous of a Satellite Couple

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Abstract : Formation flying of satellites is a mission that involves a relative position keeping of different satellites in the constellation. In this study, different control algorithms are compared with one another in terms of ΔV, velocity increment, and tracking error. Various control methods, covering continuous and impulsive approaches are implemented and tested for satellites flying in low Earth orbit. Feedback linearization, sliding mode control, and model predictive control are designed and compared with an impulsive feedback law, which is based on mean orbital elements. Feedback linearization and sliding mode control approaches have identical mathematical models that include second order Earth oblateness effects. The model predictive control, on the other hand, does not include any perturbations and assumes circular chief orbit. The comparison is done with 4 different initial errors and achieved with velocity increment, root mean square error, maximum steady state error, and settling time. It was observed that impulsive law consumed the least ΔV, while produced the highest maximum error in the steady state. The continuous control laws, however, consumed higher velocity increments and produced lower amounts of tracking errors. Finally, the inversely proportional relationship between tracking error and velocity increment was established.

Keywords : chief-deputy satellites, feedback linearization, follower-leader satellites, formation flight, fuel consumption, model predictive control, rendezvous, sliding mode
Conference Title : ICAMEA 2021 : International Conference on Aero-Mechanical Engineering and Applications
Conference Location : Istanbul, Türkiye
Conference Dates : January 28-29, 2021