ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control (2) (2)

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RELATIVE STATE VECTOR GENERATION ALGORITHM FOR ON-BOARD NAVIGATION FOR RENDEZVOUS DOCKING EXPERIMENT

Abstract

ISRO is planning an on-orbit Rendezvous Docking experiment in the near future, to develop and demonstrate the technology needed for rendezvous docking. In this experiment, two IMS(Indian Micro Satellite) Spacecrafts, one designated as target and the other designated as chaser, are launched by a PSLV launcher into two slightly different orbits. No communication link between the target and chaser during the far range rendezvous phase in which relative separation is around 50km to 5km range is envisaged and this phase is a ground guided phase. In the docking phase of the mission, docking sensors such as Laser Range Finder during the relative separation of 5 km to 0.25km, Docking Camera during the relative separation of 300m to 1m ,Visual Camera for real time imaging during the relative separation of 1m to docking are used respectively. This paper presents the study carried out to assess the accuracy achievable with CW(Clohessy Wiltshire) equation as it is one of the constituent for the onboard navigation software based on Kalman filter technique and foreseeing a need for relative state propagation for longer duration in the absence of measurements. The study is carried out with different initial relative separation between the target and chaser. The deviation of relative state obtained from CW equation with that obtained from the individual precise state necessitated the incorporation of J2, the predominant Earth's gravity harmonic in the CW equation. Even with this improved CW model, considerable deviation in the relative state to an order of few km over a day is noticed with respect to precise model. The periodicity of the deviation in the CW relative state obtained from the individual precise state lead to representation of residual relative state by Fourier power series representation with an accuracy of around 10mt. The combination of CW equation with Fourier power series representation for relative state vector results in better accuracy for relative state limited mainly by determination accuracy and the ground propagation accuracy of the individual state vector. This non abstruse approach for relative state generation makes it suitable for onboard implementation.