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FUEL-FREE MAGNETIC RENDEZVOUS USING MAGNETIC TORQUER FOR CUBESAT-SIZED SMALL SATELLITES

Abstract

This research proposes a new method for rendezvous operations of Cubesat-sized small satellites using both plasma and magnetic force for multi-satellite missions including satellite docking missions. Therese days, more and more multi-satellite space applications attract interests for a variety of missions. To achieve the multi-satellite missions, Cubesats are considered as possible space applications to realize these missions. To realize the multi-satellite missions with the Cubesats, rendezvous between multi-satellites are the key technologies under the strict limitations of mass and power consumption. Although, the rendezvous has been achieved by thrusters in conventional usual sized satellites, the thrusters cannot be installed due to the strict constraints in some small satellites in some Cubesats. As a result, the multi-satellite missions are, in some cases, difficult to be realized, although the small satellites can perform preferable ability in the multi-satellite missions. In this research, we propose a new method to achieve orbit control including guidance and navigation in small satellites with plasma and magnetic force. In this method, relatively large magnetic torquers for attitude control interact with space plasma and causes plasma drag force, which can be used for relative orbit control. Furthermore, the magnetic torquers can also be used for close rendezvous with magnetic force between two satellites where the inaccurate plasma drag force cannot be used, which enable the close-navigation and docking operations between two satellites. With the application of the MTQs, the satellites do not need to install additional components for orbit control. Therefor the satellite can achieve light weight and small power consumption. As a result, the Cubesat-sized satellites can relatively easy to achieve the rendezvous. In this study, first, the plasma drag force are evaluated based on the PIC (Particle-in-Cell) simulations. Then, a MPC (Model Predictive Control) method is developed to achieve the rendezvous using plasma and magnetic relative orbit control. Based on numerical simulation results, the research concludes that the proposing method is potential method for Cubsat rendezvous. The technical issues to realize the system is also discussed in the presentation.