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RELATIVE NAVIGATION SENSOR SYSTEMS FOR NEAR EARTH ASTEROIDS AND OTHER CHALLENGING MISSION ENVIRONMENTS

Abstract

Near Earth Asteroids (NEAs) present unique and challenging technical requirements for future robotic and human spaceflight missions. Amongst these, the known and unknown environments and conditions associated with navigation for exploration of NEAs are particularly stressing. Fundamental characteristics of NEAs, such as very low albedo, uncertain cohesive and gravitational body forces, flight dynamics and ambiguous physical response to external disturbance sources lead to mission and flight system design challenges. Also, although definable with less uncertainty, deep space environments present additional design drivers. One of the most critical design elements needed to ensure mission success with NEA rendezvous, proximity operations and contact is the relative navigation sensor system, including hardware and software/processing elements. This paper provides a development of critical design considerations, state of the art relative navigation system capabilities, as well as unique development efforts associated with addressing the critical requirements for this kind of mission. The paper describes state of the art LIDAR development results from NASA's Orion MPCV program, as well as other investments completed or still to be completed to address this stressing class of noncooperative rendezvous and docking with a highly reliable, unambiguous relative navigation solution from long range acquisition up through contact, surface interaction and post separation between the vehicle and potential target asteroids. In addition to the critical capabilities that these advancements will provide for the NEA missions, the results will ensure more robust capabilities for other cooperative, semi-cooperative and non-cooperative relative navigation missions, including orbital debris mitigation, satellite servicing and even landing and surface operations at other planetary bodies.