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END-TO-END FRAMEWORK FOR CLOSE PROXIMITY IN-SPACE ROBOTIC MISSIONS

Abstract

Robotic satellite operations will be an integral component of future space missions, such as on-orbit servicing, in-space robotic assembly, and orbital debris mitigation. A key requirement shared among such space missions is the capability to carry out robust and autonomous close proximity operations between the involved agents. Therefore, in order to launch a successful in-space robotic campaign, it is imperative to design a thorough and holistic description of the operations pipeline that allows for the coordination and integration of the distinct mission phases.

Independent of the types of agents involved – ranging from cooperative and known spacecraft to unknown and uncooperative tumbling objects – proximity operations consist of four general stages: angles-only rendezvous (phase 1); stand-off inspection (phase 2); trajectory rendezvous and docking (phase 3); and joint maneuvering (phase 4). This paper presents an end-to-end framework that encompasses and describes the objectives, requirements, interfaces, and flows of information between the warranted modules to successfully carry out such space missions; the modules include planning, guidance, perception, estimation, and control tasks. To showcase the distinct challenges and approaches, use case examples are presented, including detumbling an unknown, uncooperative target object, and servicing an inactive spacecraft using a manipulator arm.