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Author: Dr. Giulio Campiti
Politecnico di Bari, Italy, giulio.campiti@gmail.com

Dr. Giuseppe Brunetti
Politecnico di Bari, Italy, giuseppe.brunetti@poliba.it
Dr. Francesco Santoro
Altec S.p.A., Italy, francesco.santoro@altecspace.it
Dr. Marco Reali
Italian Air Force , Italy, marco.reali@aeronautica.difesa.it
Dr. Roberto Vittori
Politecnico di Bari, Italy, roberto.vittori@poliba.it
Prof. Mario N. Armenise
Politecnico di Bari, Italy, marionicola.armenise@poliba.it
Prof.Dr. Caterina Ciminelli
Politecnico di Bari, Italy, caterina.ciminelli@poliba.it

FEASIBILITY ASSESSMENT OF AN AUTONOMOUS COLLISION AVOIDANCE SYSTEM FOR SATELLITES

Abstract

Decisions to execute spacecraft collision avoidance manoeuvres are largely driven by the uncertainty levels on the predicted positions of the potentially colliding space objects. In Low Earth Orbit (LEO), most manoeuvres being performed are the result of false alarms triggered by the limited knowledge available, causing unnecessary interruptions of satellite operations and resource wastage. As the number of risky conjunctions continues to rise, satellites will be increasingly busy avoiding objects instead of conducting nominal activities. With the aim of reducing false alarm rates, this work explores the feasibility of improving conjunction information before potential collisions by using lightweight sensors on-board satellites to observe and gather data on the hazardous objects. A first proof of concept is described by showing that potentially colliding objects almost always encounter several times before their closest approach, providing short windows for potential observations. This consideration was drawn following the reconstruction and analysis of the kinematics for more than 10,000 close approaches that occurred in LEO during 2022. Findings reveal that 70 percent of the times two conjuncting objects make a pass at less than 100 km prior to the closest approach. By discussing several aspects of conjuncting objects' relative kinematics, the requirements for the on-board sensor are derived to ensure successful in-situ observations together with the desired improvements in accuracy compared to ground-based data. Based on these results, potential technologies for the realisation of the sensor are discussed and compared considering both performance requirements as well as Size, Weight and Power (SWaP) considerations.