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PRELIMINARY DESIGN OF A LEO SPACECRAFT FOR FAR RENDEZVOUS, ON-ORBIT INSPECTION AND SOFT-DENY

Abstract

With the multiplication of orbital launchers, it's getting easier and easier to access space and because of the absence of clearly defined rules, future problems are to be expected. For example, the private commercialization of Low Earth Orbit (LEO) poses several risks when companies focus on near term business success rather than long term sustainability and safety of operations. It is already possible to cite examples of unauthorized spacecraft launches that don't have a license to use certain bands of the Radio Frequency (RF) spectrum or that pose a risk of collision with other spacecraft. To avoid these threats, it is conceivable to have a space system which is able to inspect and identify a suspect spacecraft directly from space. To address this issue, this paper explores the preliminary design of a LEO spacecraft system which can perform on-orbit inspection of a non-cooperative target. To accomplish this mission a proposed operations concept in multiple stages is presented: First, a far rendezvous approach to get to a relatively short and safe distance to the target spacecraft, second, a long range identification of the target with a visible and infrared payload, third, the characterization of the RF emission of the target to ensure identification and finally, how to perform contactless restrictions to the mission capabilities of a noncooperative target (soft-deny). Subsequently, a list of state-of-the-art available technologies for each purpose is evaluated, including the needed ones for the optical identification, the RF Spectrum analysis and the techniques to temporarily interfere with a non-authorized mission in LEO. The proposed concepts are evaluated taking into account the constraints that are imposed in the mission, such as interception times, mass, power and autonomy requirements, all these elements provide a framework to define possible architectures for the spacecraft and the other mission elements. All the alternatives are subject to a trade-off evaluation using multi-objective optimization as the way to deal with conflicting objectives, this is important to select the type of propulsion and the size of the platform. In summary, this analysis provides the foundation to establish a feasible design for a LEO spacecraft capable of on-orbit inspection and to perform soft-deny of potentially hazardous satellites.