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AGORA: MISSION TO DEMONSTRATE TECHNOLOGIES TO ACTIVELY REMOVE ARIANE ROCKET BODIES

Abstract

We present Agora (Active Grabbing Orbital Removal of Ariane), an Active Debris Removal (ADR) mission aimed at removing discarded Ariane rocket bodies (R/Bs). The Agora mission goal is to demonstrate technologies to autonomously remove an Ariane R/B in a controlled manner, using an active detumbling device and a robotic grabbing mechanism, within a cost cap of 200M FY2015, by 2025.

Expended R/Bs belong to a growing class of space debris objects that pose a sizeable risk to operational satellites. The threat of on-orbit collisions must be addressed within the near-future to ensure that the risk of catastrophic events, like the Iridium-Cosmos collision in 2009 (Kelso, 2009; Tan et al., 2013), is mitigated. Liou et al. (2010) indicate that at least five large objects will need to be removed per year, over the next 200 years, from the Low-Earth Orbit (LEO) region, to stabilize the current debris population. This necessitates development and demonstration of key Active Debris Removal (ADR) technologies, including robust Guidance, Navigation Control (GNC) for autonomous close-proximity operations.

We detail the payload systems incorporated on the chaser spacecraft to rendezvous, detumble, grab, and de-orbit an Ariane 5 R/B. The de-tumbling payload will aim to reduce the tumbling rate of the R/B to enable safe attachment of a de-orbiting kit. The de-tumbling phase is a dissipative process based on Joule's Law: eddy currents are generated on the target due to an enhanced magnetic field, generated actively by an on-board electromagnetic coil (Ortiz Walker, IAC 2014). The robotic payload will ensure (semi-)autonomous capture of the R/B and deployment of a de-orbiting kit, while compensating for dynamic coupling between the chaser and the robotic manipulator that will arise during actuation of the latter. In particular, we present analysis of two configurations: a) a semi-rigid clamping mechanism, based on an anthropomorphic robotic finger design, for the capture of the target, and a manipulator, for deploying the de-orbiting kit, and b) a robotic manipulator in free-flying control mode for both tasks.

The framework for Agora complements the European technology roadmap for ADR, and is aligned with missions such as e.Deorbit (European Space Agency) and DEOS (German Aerospace Center). Thus, we also provide an overview of the impact of Agora on global ADR efforts and synergy with technology development within Europe.