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AUTONOMOUS MISSION PLANNING FOR MULTI-AGENT LUNAR MISSION

Abstract

Over the past 50 years, the research has sparked a revived interest within the scientific community and among industrial partners for the exploration and colonization of space (Global Exploration Roadmap 2022). Some of the cutting-edge projects in this regard are the Moonlight and the Artemis Program, complex initiatives involving the creation of a space network, with commercial telecoms and satellite navigation, and a space hub, the Lunar Gateway, as an access point for future operations. In this context, establishing accessory infrastructures, such as coordinated satellite constellations on non-Keplerian orbits, is the pivot in the success of future missions. Alternatively from what has been discussed in many previous works, a different point of view is given by considering a distributed autonomous multi-agent approach, which allows the usage of simpler, smaller, redundant and more cost-effective agents, improving safety and robustness. The purpose of this work is to study autonomous closed-loop planning and relative dynamics (G. Franzini, M. Innocenti 2019) between heterogeneous agents in a formation flying in the lunar environment, to perform relative fuel-optimal maneuvers and achieve a common goal, such as randez-vous operations, and continuous communication. This work is based on the Circular Restricted Three Body Problem Hypothesis, to model the behaviour of the agents and design architectures to autonomously plan the best trajectory for each agent, under connectivity, safety and fuel-optimality constraints. The autonomous mission planning algorithm can be extended to space applications where natural orbital dynamics can be exploited for fuel optimization, building upon approaches commonly used for terrestrial robotic applications (A. Gasparetto et al. 2015). The results will be expressed in terms of fuel-optimality, agent autonomy, graph connectivity and algorithm computational effort, showing how the distributed approach enables tasks and mission scenarios otherwise difficult to achieve.