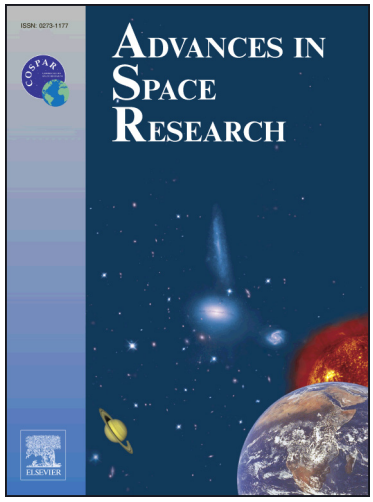

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Marilena Di Carlo, Juan Manuel Romero Martin, Massimiliano Vasile

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Marilena Di Carlo, Juan Manuel Romero Martin, Massimiliano Vasile

Department of Mechanical and Aerospace Engineering, University of Strathclyde, 75 Montrose Street, Glasgow G1 1XJ, United Kingdom

Abstract

In this paper two strategies are proposed to de-orbit up to 10 non-cooperative objects per year from the region within 800 and 1400 km altitude in Low Earth Orbit (LEO). The underlying idea is to use a single servicing spacecraft to de-orbit several objects applying two different approaches. The first strategy is analogous to the Traveling Salesman Problem: the servicing spacecraft rendezvous with multiple objects in order to physically attach a de-orbiting kit that reduces the perigee of the orbit. The second strategy is analogous to the Vehicle Routing Problem: the servicing spacecraft rendezvous and docks with an object, spirals it down to a lower altitude orbit, undocks, and then spirals up to the next target.

In order to maximise the number of de-orbited objects with minimum propellant consumption, an optimal sequence of targets is identified using a bio-inspired incremental automatic planning and scheduling discrete optimisation algorithm. The optimisation of the resulting sequence is realised using a direct transcription method based on an asymptotic analytical solution of the perturbed Keplerian motion. The analytical model takes into account the perturbations deriving from the J2 gravitational effect and the atmospheric drag.

Keywords: Active Debris Removal; Orbital Debris; Debris Mitigation; Automated Trajectory Design; Automatic Planning and Scheduling; Low-Thrust Transfers

Email address: juan.romero-martin@strath.ac.uk, marilena.di-carlo@strath.ac.uk, massimiliano.vasile@strath.ac.uk (Marilena Di Carlo, Juan Manuel Romero Martin, Massimiliano Vasile)