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COLLISION AVOIDANCE MANEUVERS OPTIMIZATION USING EVOLUTIONARY ALGORITHMS

Abstract

The significant increase in the number of satellite missions in recent years has led to the generation of an environment dominated by space debris. So, collision avoidance maneuvers are now crucial to ascertain safe operation of satellites. These maneuvers do not provide a long-term solution like active debris removal, but mitigate the problem by providing a cheaper, quicker, and efficient way. So, it has been extensively studied and widely implemented in practice. For apply some optimization method in this scenery it can be used genetic algorithms, that are a particular class of evolutionary algorithms that use techniques inspired by evolutionary biology such as heredity, mutation, natural selection, and recombination. They can also be defined as global optimization algorithms and model a solution to a specific problem. This method provides a way to find solutions to problems that would be unlikely to be analytically feasible.

The present work aims to use this method to optimize the consumption of fuel in collision avoidance maneuvers (CAMs) in a context where there are several conjunctions between a satellite (that it is required to be protected) and debris space. The necessity for a CAM is based on one of them conjunctions presents either the miss distance or the probability of collision exceeds a threshold previously settled. However, the maneuver choosed can increase the probability of collision of other conjunctions, or even create conjunctions that have not existed yet. All these dynamics are involved in the optimization process, because in the fitness function is used the maximum probability of collision and the minimal miss distance from all conjunctions within the time of simulation, and whether one of these values exceeds the threshold, a penalty will be imposed. It is considered two different burn strategy: an impulse in the in-track direction and two impulses (before and after the time of closest approach - TCA) in a random direction (radial, in-track, cross-track frame), at final is compared the results obtained from each burn strategy choice.