Paper ID: 57579
student

18th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Orbit Determination and Propagation (9)

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SHOOTING METHOD TO ALLOW FOR PERTURBATIONS IN THE OPTIMIZED BOUNDARY VALUE INITIAL ORBIT DETERMINATION

Abstract

Space debris poses threats to functional spacecraft around the Earth due to the possibility of collisions in orbit. The debris object population needs to be cataloged to monitor the space environment. Optical surveys result in observations of objects on very short arcs (when compared to their orbital period). These short-arc angles-only observations are not suitable to derive a reliable orbit, hence two of them are associated together to test if they belong to the same object and to compute initial orbits. Initial Orbit determination (IOD) is done using the Optimized Boundary Value Initial Orbit Determination (OBVIOD), which is one existing method to associate short-arc optical observations. A so-called shooting method is used inside the OBVIOD to include perturbations. This method consists of choosing a hypothetical value for a variable at first boundary and propagating to the second boundary. The propagation from one boundary to the second includes perturbations such as solar radiation pressure, Earth's geopotential terms, solar and lunar gravitational forces. The root-finding method used inside the Shooting procedure may take its initial value from the unperturbed solution. However root-finding methods, like e.g. Newton-Raphson, might have difficulties in the convergence or converge to a wrong solution in case the initial value lies far from the actual root. In addition, for multiple revolutions scenarios several possible solutions, according to the high and low path of the Lambert problem, have to be computed inside the OBVIOD. In this paper, we propose to use a root-finding method based on bisection to get global convergence. Constraints originating from an admissible region approach are set to narrow down the possible scenarios, which will be computed to find the desired solutions. Both, the proposed method and Newton-Raphson are tested for their performance inside the Shooting-OBVIOD. Tests are done using simulated short-arc angles-only observations, separated by single or multiple revolutions, and different area to mass ratio values for the observed objects.