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ONBOARD COMPLETE SOLUTION TO THE FULL-BODY RELATIVE ORBITAL MOTION PROBLEM

Abstract

The relative motion between the leader and the deputy is a six-degree of- freedom (6-DOF) motion, which represents the coupling of the relative translational motion with the rotational one. In recent years, increasing attention has been paid to the modeling of the relative 6-DOF motion of spacecraft . Also, controlling the relative pose of satellite formation is a very important research subject. The common approach is to consider the relative translational and rotational dynamics for the chief–deputy spacecraft formation to be modeled using vector and tensor formalism. In this paper, we reveal a dual-tensor-based procedure to obtain exact expressions for the 6-DOF relative orbital law of motion between two Keplerian confocal orbits. The solution is obtained by pure analytical methods, and it holds for any leader and deputy motion, without involving any secular terms or singularities. The relative orbital motion is reduced, by an adequate change of variables, into a dual Euler fixed-point problem. Orthogonal dual tensors play a very important role, with the representation of the solution being, to the authors' knowledge, the shortest approach for describing the complete onboard solution of the 6-DOF orbital motion problem. The solution does not depend on the local-vertical–local-horizontal (LVLH) properties involves that is true in any reference frame of the leader with the origin in its mass center. To obtain this solution, one has to know only the inertial motion of the leader spacecraft and the initial conditions of the deputy satellite in the LVLH frame. A representation theorem is provided for the full-body initial value problem. Furthermore, the real and imaginary parts are split, and representation theorems for rotation and translation motion are obtained. Regarding translation, a closed-form free of coordinate solution is revealed, based of generalised trigonometric function in space at constant curvature. They hold for all types of reference trajectories of the leader (elliptic, parabolic, hyperbolic) and deputy (elliptic, parabolic, hyperbolic, rectilinear).

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