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Collocation-Based Reconstruction Harmonic Balance Method for Solving Periodic Orbits of Aerospace Vehicles

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ABSTRACT

As a significant research interest in orbital mechanics, periodic orbits are fundamental for understanding orbital behaviors and space explorations. Although the harmonic balance (HB) method and its variants have been the most widely-used approaches for periodic dynamical systems, they are seldom applied to celestial dynamics. Here we use the reconstruction harmonic balance (RHB) method for solving periodic orbits. Starting from a presupposed Fourier form and an initial guess at the solution, the algorithm uses time-domain collocation points to optimally reconstruct the high-order HB procedure without complicated symbolic operations and non-physical solutions. Following a description of the method, it is applied to two aerospace missions with nonlinear time-periodic dynamics: formation-flying and restricted three-body problem. In all cases, the RHB method can derive periodic solutions for the states, which has a semi-analytical form suitable for not only further amplitude-frequency response analysis but online storage. Therefore, the method has clear application in the initial reference orbit design and advanced fuel-efficient aerospace control laws.

KEYWORDS

Reconstruction harmonic balance method; time-domain collocation; formation-flying; three-body problem

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