ORTHOGONAL POLYNOMIAL APPROXIMATION IN HIGHER DIMENSIONS: APPLICATIONS IN ASTRODYNAMICS

Doctoral Dissertation

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Abstract

We propose novel methods to utilize orthogonal polynomial approximation in higher order dimensions, which enables us to perform high precision, long-term orbit propagation with immediate application to efficient propagation of catalogs of Resident Space Objects (RSOs) and improved accounting for the uncertainty in the ephemeris of these objects. More fundamentally, the methodology promises to be of broad utility in solving initial and two point boundary value problems from a wide class of mathematical representations of problems arising in engineering, optimal control, physical sciences and applied mathematics. We unify and extend classical results from function approximation theory in n-dimensions and consider their utility in astrodynamics, using the classical Chebyshev polynomials as basis functions. Two sets of applications are considered that are challenges in astrodynamics. The first application addresses local approximation of high degree and order geopotential models, replacing the global spherical harmonic series by a family of locally precise orthogonal polynomial approximations for efficient computation. The second class of problems includes orbit propagation and solution of associated boundary value problems using Modified Chebyshev-Picard Iteration (MCPI).

Ahmad Bani Younes is a PHD candidate in the Aerospace Engineering Department working under the supervision of Professor John L. Junkins. His research interests are in the areas of Dynamics and Control. He will be employed as a post-doc. at Aerospace Engineering Department under the supervision of Professor John L. Junkins.