Recursive Application of Approximate Higher-Order Nonlinear State Transformations and Nonlinear Feedback for Computing Continuous Thrust Circular Orbit Transfers

Thursday, September 21, 2017 | 4:00 p.m. | 202 Reed McDonald

Abstract

An approximate feedback linearization method is applied iteratively to the problem of circular orbit transfer to obtain an analytic exact solution up to the r-th degree for continuous thrust circular orbit transfers. The coordinate transformation and feedback parameters are computed symbolically using a one-step approach in multi-stage form. During the recursive steps, patterns were detected in the approximate solutions as they evolved illuminating a family of exact solutions to the circular orbit nonlinear feedback control problem utilizing the null space that appears as part of the computations. It is shown that applying higher-degree feedback improves the closed-loop system stability for the orbital transfer problem and at some point the performance improvement of ever increasing higher-degree approximations diminishes, hinting at convergence to an exact solution. The relationship between the r-th degree exact solution obtained through the recursive approximations and a known exact solution is illustrated where it is shown that two different exact solutions can have different performance in terms of fuel usage leading to the possibility of optimization.

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Dr. Robert H. Bishop, P.E. is the Dean of Engineering at the University of South Florida and full professor in the Department of Electrical Engineering. He was on the faculty at The University of Texas at Austin where he chaired the Department of Aerospace Engineering and Engineering Mechanics and was the Dean of Engineering at Marquette University. Prior to academia, he was a member of the technical staff at the Charles Stark Draper Laboratory. Dr. Bishop received his PhD from Rice University in Electrical & Computer Engineering and his MS and BS from Texas A&M University in Aerospace Engineering. He is a Fellow of the American Institute of Aeronautics and Astronautics and a Fellow of the American Astronautical Association.

Refreshments served at 3:45 p.m.