Successive Backward Sweep Methods for Optimal Control of Nonlinear Systems with Constraints

Doctoral Dissertation Defense

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June 7th, 2013
09:00 am – 11:00 am
H.R. Bright Building - HRBB 702

Abstract

Several forms of the continuous and discrete-time Successive Backward Sweep (SBS) method for solving nonlinear optimal control problems involving terminal and control constraints are proposed in this dissertation. The method is relatively insensitive to the initial guesses of the state and control histories and their consistency with respect to the system dynamics is not required. Hessian modifications are utilized, when required, to enable the backward integration of the gain equations for non-convex problems. Waypoints, impulsive control, and homotopy methods are developed for handling singularities in the calculation of the terminal constraint Lagrange multipliers and for reducing convergence sensitivity for highly nonlinear problems. The SBS method requires the satisfaction of the Jacobi no-conjugate point check and hence, produces optimal solutions. A variety of highly nonlinear optimal control problems involving orbit transfer, atmospheric reentry, and the restricted three body problem are treated.

DongHyurn Cho is a PHD candidate in the Aerospace Engineering Department working under the supervision of Professor Srinivas Rao Vadali. His research interests are in the areas of optimal control of nonlinear system. He is currently a major in Korea Air Force and will be employed as an aerospace engineering faculty at Republic of Korea Air Force Academy.