Quadratic Programming for Allocating Control Effort

A computer program calculates an optimal allocation of control effort in a system that includes redundant control actuators. The program implements an iterative (but otherwise single-stage) algorithm of the quadratic-programming type. In general, in the quadratic-programming problem, one seeks the values of a set of variables that minimize a quadratic cost function, subject to a set of linear equality and inequality constraints. In this program, the cost function combines control effort (typically quantified in terms of energy or fuel consumed) and control residuals (differences between commanded and sensed values of variables to be controlled). In comparison with prior control-allocation software, this program offers approximately equal accuracy but much greater computational efficiency. In addition, this program offers flexibility, robustness to actuation failures, and a capability for selective enforcement of control requirements. The computational efficiency of this program makes it suitable for such complex, real-time applications as controlling redundant aircraft actuators or redundant spacecraft thrusters. The program is written in the C language for execution in a UNIX operating system.

This program was written by Gurkirpal Singh of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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Simulator of Space Communication Networks

Multimission Advanced Communication Hybrid Environment for Test and Evaluation (MACHETE) is a suite of software tools that simulates the behaviors of communication networks to be used in space exploration, and predict the performance of established and emerging space communication protocols and services. MACHETE consists of four general software systems: (1) a system for kinematic modeling of planetary and spacecraft motions; (2) a system for characterizing the engineering impact on the bandwidth and reliability of deep-space and in-situ communication links; (3) a system for generating traffic loads and modeling of protocol behaviors and state machines; and (4) a system of user-interface for performance metric visualizations. The kinematic-modeling system makes it possible to characterize space link connectivity effects, including occultations and signal losses arising from dynamic slant-range changes and antenna radiation patterns. The link-engineering system also accounts for antenna radiation patterns and other phenomena, including modulations, data rates, coding, noise, and multipath fading. The protocol system utilizes information from the kinematic-modeling and link-engineering systems to simulate operational scenarios of space missions and evaluate overall network performance. In addition, a Communications Effect Server (CES) interface for MACHETE has been developed to facilitate hybrid simulation of space communication networks with actual flight/ground software/hardware embedded in the overall system.

This work was done by Loren Clare, Esther Jennings, Jay Gao, John Segui, and Winston Kwong of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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