✿ Post-Flight Estimation of Motion of Space Structures: Part 1

NASA's Jet Propulsion Laboratory, Pasadena, California

A computer program estimates the relative positions and orientations of two space structures from data on the angular positions and distances of fiducial objects on one structure as measured by a target-tracking electronic camera and laser range finders on another structure. The program is written specifically for determining the relative alignments of two antennas, connected by a long truss, deployed in outer space from a space shuttle.

The program is based partly on transformations among the various coordinate systems involved in the measurements and on a nonlinear mathematical model of vibrations of the truss. The program implements a Kalman filter that blends the measurement data with data from the model. Using time series of measurement data from the tracking camera and range finders, the program generates time series of data on the relative position and orientation of the antennas. A similar program described in a prior *NASA Tech Briefs* article was used onboard for monitoring the structures during flight. The present program is more precise and designed for use on Earth in post-flight processing of the measurement data to enable correction, for antenna motions, of scientific data acquired by use of the antennas.

This program was written by Paul Brugarolas and William Breckenridge of Caltech for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45072.

✿ Post-Flight Estimation of Motion of Space Structures: Part 2

NASA's Jet Propulsion Laboratory, Pasadena, California

A computer program related to the one described in the immediately preceding article estimates the relative position of two space structures that are hinged to each other. The input to the program consists of time-series data on distances, measured by two range finders at different positions on one structure, to a corner-cube retroreflector on the other structure. Given a Cartesian (x,y,z) coordinate system and the known x coordinate of the retroreflector relative to the y,z plane that contains the range finders, the program estimates the y and z coordinates of the retroreflector.

The estimation process involves solving for the y,z coordinates of the intersection between (1) the y,z plane that contains the retroreflector and (2) spheres, centered on the range finders, having radii equal to the measured distances. In general, there are two such solutions and the program chooses the one consistent with the design of the structures. The program implements a Kalman filter. The output of the program is a time series of estimates of the relative position of the structures.

This program was written by Paul Brugarolas and William Breckenridge of Caltech for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45074.

✿ Simulating Operation of a Large Turbofan Engine

John H. Glenn Research Center, Cleveland, Ohio

The Commercial Modular Aero-Propulsion System Simulation (C-MAPSS) is a computer program for simulating transient operation of a commercial turbofan engine that can generate as much as 90,000 lb (≈0.4 MN) of thrust. It includes a power-management system that enables simulation of open- or closed-loop engine operation over a wide range of thrust levels throughout the full range of flight conditions.

C-MAPSS runs in the Simulink (The Mathworks, Inc.) block-diagram language, providing a graphical simulation environment in which advanced control and diagnostics algorithms can be implemented and tested. The software has a graphical user interface (GUI) that makes engine "health" data and control and engine parameters easily accessible. It can run user-specified transient simulations and generate state-space linear models of a nonlinear engine model at an operating point.

C-MAPSS produces GUI screens that enable point-and-click operation and include editable fields for user-specified input. The software includes an atmospheric model for simulating operation at altitudes from sea level to 40,000 ft (≈12 km), Mach numbers from 0 to 0.90, and sea-level ambient temperatures from –60 to +103 °F (≈–51 to +39 °C). CMAPSS has a comprehensive control system consisting of a gain-scheduled fan-speed controller and several limit regulators, integrated in a manner similar to that used in real engine controllers to avoid integrator windup. The simulation code itself operates several times faster than real time, giving it the potential to be deployed (all or in part) as machine code for hardware-in-the-loop applications such as flight simulators and real-time controller/diagnostic system validation.

Overall, C-MAPSS provides the user with a set of tools for performing open- and closed-loop transient simulations and comparison of linear and non-linear models throughout its operating envelope, in an easy-to-use graphical environment.

This program was written by Jonathan S. Litt of Glenn Research Center; Dean K. Frederick of Saratoga Control Systems, Inc.; and Jonathan A. DeCastro of ASRC Aerospace Corp. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18315-1.