Predicting Rocket or Jet Noise in Real Time

Measurement data can be analyzed in real time.

Stennis Space Center, Mississippi

A semi-empirical theoretical model and a C++ computer program that implements the model have been developed for use in predicting the noise generated by a rocket or jet engine. The computer program, entitled the Realtime Rocket and Jet Engine Noise Analysis and Prediction Software, is one of two main subsystems of the Acoustic Prediction/Measurement Tool, which comprises software, acoustic instrumentation, and electronic hardware combined to afford integrated capabilities for real-time prediction and measurement of noise emitted by rocket and jet engines. [The other main subsystem, consisting largely of acoustic instrumentation and electronic hardware, is described in "Wireless Acoustic Measurement System," which appears elsewhere in this section.]

The theoretical model was derived from the fundamental laws of fluid mechanics, as first was done by M. J. Lighthill in his now famous theory of aerodynamically generated sound. The far-field approximation of the Lighthill theory is incorporated into this model. Many other contributions from various researchers have also been introduced into the model. The model accounts for two noise components: shear noise and self noise. The final result of the model is expressed in terms of a volume integral of the acoustic intensities attributable to these two components, subject to various directivity coefficients.

The computer program was written to solve the volume integral. The inputs required by the program are two data files from a computational fluid dynamics (CFD) simulation of the flow of interest: the computational-grid file and the solution file. The CFD solution should be one that has been obtained for conditions that closely approximate those of an experimental test that is yet to be performed.

In the current state of development of the model and software, it is recommended that the observation points lie along a radius at an angle >60° from the jet axis. The software provides, and is driven via, a graphical user interface, which facilitates its use. Optionally, the program accepts additional input in the form of data on the measured sound pressure level as a function of frequency at a given far-field location, preferably at an angle of 90° from the jet axis. The user is prompted to use default empirical constants or to choose constants based the measurement data. The user can view the results and compare them with other computational or experimental data. Once satisfied with the results, the user can save a graph of the results in a file that can be imported into documents.

This program was written by Kader Frendi of the University of Alabama in Huntsville for **Stennis Space Center**.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Dr. Kader Frendi
The University of Alabama
5000 Technology Drive, Room THN264
Huntsville, AL 35899
Phone No.: (256) 824-7206
E-mail: frendi@eng.uah.edu

Refer to SSC-00215-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Computational Workbench for Multibody Dynamics

NASA's Jet Propulsion Laboratory, Pasadena, California

PyCraft is a computer program that provides an interactive, workbenchlike computing environment for developing and testing algorithms for multibody dynamics. Examples of multibody dynamic systems amenable to analysis with the help of PyCraft include land vehicles, spacecraft, robots, and molecular models. PyCraft is based on the Spatial-Operator-Algebra (SOA) formulation for multibody dynamics. The SOA operators enable construction of simple and compact representations of complex multibody dynamical equations. Within the PyCraft computational workbench, users can, essentially, use the high-level SOA operator notation to represent the variety of dynamical quantities and algorithms and to perform computations interactively. PyCraft provides a Python-language interface to underlying C++ code. Working with SOA concepts, a user can create and manipulate Python-level operator classes in order to implement and evaluate new dynamical quantities and algorithms. During use of PyCraft, virtually all SOA-based algorithms are available for computational experiments.

This program was written by Abhinandan Jain of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42891.