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SOME TEST/ANALYSIS ISSUES
FOR THE
SPACE STATION STRUCTURAL CHARACTERIZATION EXPERIMENT

by

Chaur-Ming Chou
Assistant Professor
Department of Mechanical & Energy Engineering
University of Lowell
Lowell, Massachusetts 01854

26716117

The Space Station Structural Characterization Experiment (SSSCE) [1,2] is an early space flight experiment that uses the space station as a generic structure to study the dynamic characteristics of Large Space Structures (LSS). On-orbit modal testing will be conducted to determine natural frequencies, mode shapes and damping of dominant structural modes of the space structure assembly. This experiment will ultimately support the development of system identification and analytical modeling techniques for Large Space Structures.

In order to ensure the success of SSSCE (in-space validation of modeling techniques for LSS), adequate measurement and instrumentation requirements have to be established during the experiment-definition study. Among the issues affecting these requirements, spatial and modal coverages of the modal test data are of particular interest. Topics such as total number of sensors, type of measurements (translation and rotation), optimal sensor locations (measurement degrees-of-freedom), selection of target modes, effects of modal superposition and truncation, separation of global and local modes, etc. are all of fundamental importance and must be investigated.

A detailed analytical Finite Element Model (FEM) of the space station is generally available and can be used to study the spatial and modal coverages for SSSCE instrumentation requirements. Techniques involving the use of FEM mass and stiffness matrices as well as the frequencies and modal matrix are proposed in this research. A least squares filtering matrix obtained from the product of the modal matrix and its generalized inverse is utilized to assess the modal truncation effect on the measured data [3]. Modal kinetic energy distributed at each DOF is a good indicator to identify the global and local modes [4]. The optimal sensor locations can be determined by maximizing the totality of observed kinetic energy with respect to the selected measurement DOF [5,6].

In addition, system identification and model refinement techniques [7,8] developed in the Modal Analysis & Controls Laboratory (MACL) at University of Lowell can be implemented on the Test/Analysis model for SSSCE. Techniques such as System Equivalent Reduction/Expansion Process (SEREP), estimation of rotational DOF, modal vector correlation, analytical model improvement, model change localization (damage detection), and structural dynamics modifications, etc. can be integrated to systematically enhance the quality of Test/Analysis models.

REFERENCES

1. Johnson, J.W. & Cooper, P.A., "The Space Station Structural Characterization Experiment," Presented at USAF/NASA Workshop on Model Determination for Large Space Systems, Pasadena, CA, March 22-24, 1988.
2. Pappa, R.S., "Some Instrumentation Requirement Issues for the Space Station Structural Characterization Experiment," Presented at USAF/NASA Workshop on Model Determination for Large Space Systems, Pasadena, CA, March 22-24, 1988.
3. Chwastyk, T.F. & Rapp, D.G., "A Quantitative Method for Evaluating Sensor Layouts," The Shock & Vibration Bulletin 57, Part 2, January 1987.
4. Warnaar, D.B. & McGowan, P.E., "Effects of Local Vibrations on the Dynamics of Space Truss Structures," AIAA Paper No. 87-0941, AIAA Dynamics Specialists Conference, Monterey, CA, April 9-10, 1987.
5. Udawadia, F.E. & Garba, J.A., "Optimal Sensor Locations for Structural Identification," Proceedings of the Workshop on Identification and Control of Flexible Space Structures, JPL Publication 85-29, Vol. III, April 1985.
6. Matta, K.W., "Selection of Degrees of Freedom for Dynamic Analysis," ASME Journal of Pressure Vessel Technology, Vol. 109, February 1987.
7. O'Callahan, J.C. & Chou, C.M., "Localization of Model Changes for Optimized System Matrices Using Modal Test Data," Proceedings of the 6th International Modal Analysis Conference, Orlando, FL, February 1988.
8. Chou, C.M., O'Callahan, J.C. & Avitabile, P., "Improved Modal Data for Generalized Beam Structural Modifications," AMD-Vol. 76, Symposium of Reanalysis of Structural Dynamic Models, 1986 ASME Winter Annual Meeting, Anaheim, CA, December 1986.