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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

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 utimately 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 enhence the quality of Test/Analysis models.

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