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Software

IMAT+Modal™ | Advanced Utilities for the Test Engineer

Overview

IMAT is a MATLAB® interface offered by ATA Engineering, Inc. (ATA). Designed for test and analysis engineers, it provides a framework for easily importing finite element (FE) simulation data and measured test data into the MATLAB environment to leverage MATLAB's versatile programming, visualization, and mathematical strengths. With the IMAT toolbox, test and simulation data such as mode shapes, time histories, spectra, and other functions can be viewed and manipulated in MATLAB while preserving all of the native data attributes.

IMAT+Modal extends the core capabilities of IMAT by providing additional functionality for the modal test engineer. IMAT+Modal includes methods for pretest analysis to allow users to optimally select accelerometer locations for a modal test, provides procedures for reducing a full finite element model (FEM) down to the test-measured degrees of freedom (DOF), and provides modal parameter estimation routines for extracting shapes from the test data. The IMAT+Modal collection of utilities significantly aids in test planning and postprocessing.

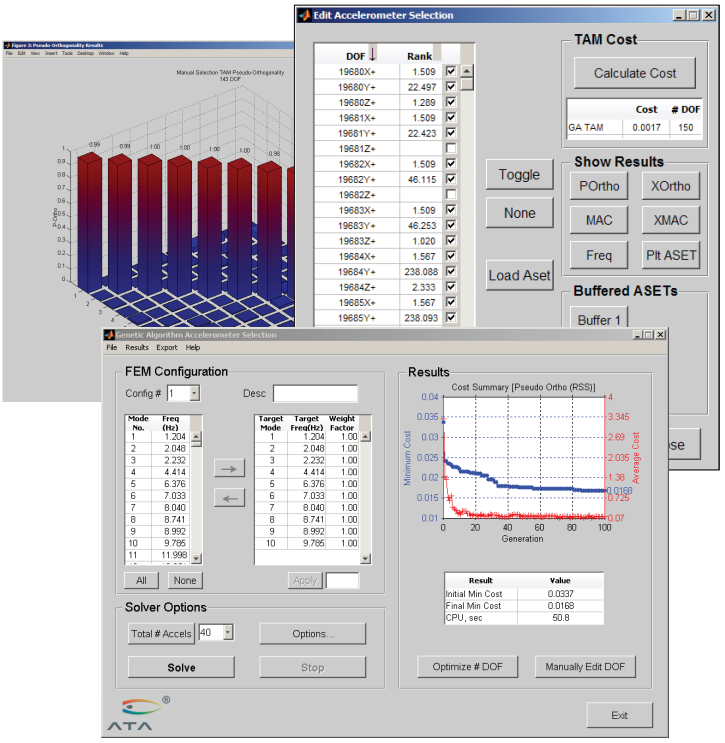
The IMAT+Modal toolbox comprises several components, including the Test-Analysis Model Toolkit (TAMKIT), the Genetic Algorithm (GA), and the Modal Test Kit (MTK), and the Alias-Free Polyreference (AFPoly) GUI application.

Prepare and Plan Modal Tests with IMAT+Modal

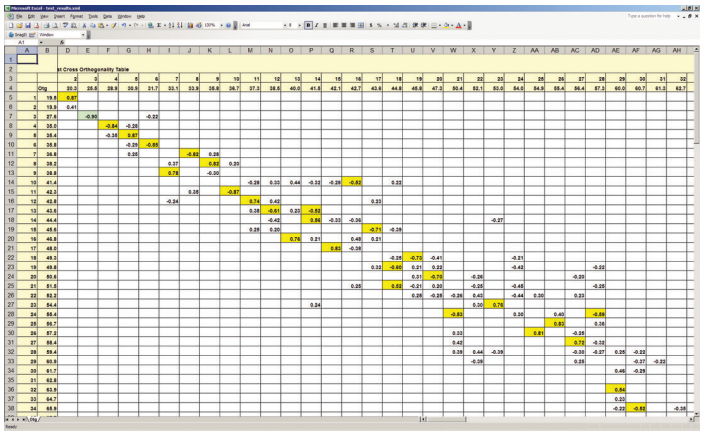
The Test-Analysis Model Toolkit (TAMKIT) is intended for structural dynamics engineers who perform pretest analysis and posttest correlation of modal survey tests. It provides procedures for selecting the instrumented degrees of freedom and for reducing the FEM matrices to these DOFs. It is implemented as a set of Nastran DMAP alters, with MATLAB functions used to read and interpret the Nastran output. It also includes procedures for comparing two similar models and for comparing test and analysis modes after completion of a modal test.

The Genetic Algorithm (GA) allows users to optimally select accelerometer locations for a modal vibration test. The GA will efficiently select optimal accelerometer locations to maximize the linear independence of test-measured mode shapes. The software can accommodate multiple FEM configurations, simultaneously selecting the best accelerometer locations for multiple-configuration modal tests to minimize the test setup time. GA can also optimally select triaxial accelerometer locations and gives the user the option of manually including or excluding specific degrees of freedom from the final DOF set.

selectASET is an alternative method to select accelerometer locations. It uses a "brute force" approach to select accelerometers by iteratively removing the least important DOFs from a candidate set of accelerometer locations to achieve the user-defined objective. Like GA, selectASET can accommodate multiple FEM configurations, can operate on individual DOFs or triaxes, and can be set to manually include or exclude DOFs/triaxes from the final set.



➤ Select optimum test accelerometer locations and review selection quality for multiple configurations quickly using the Genetic Algorithm.



➤ MTK generates report-ready formatted test and analytical shape comparison output containing MAC and orthogonality comparisons.

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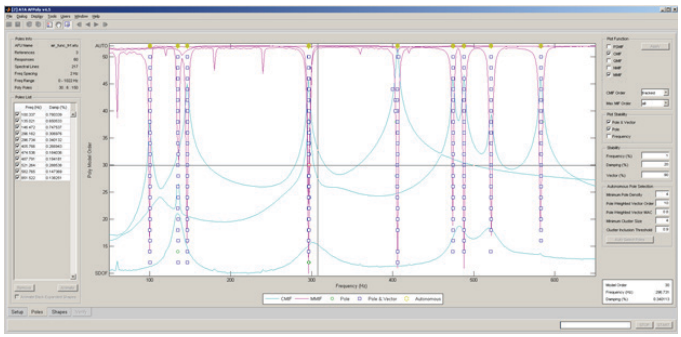

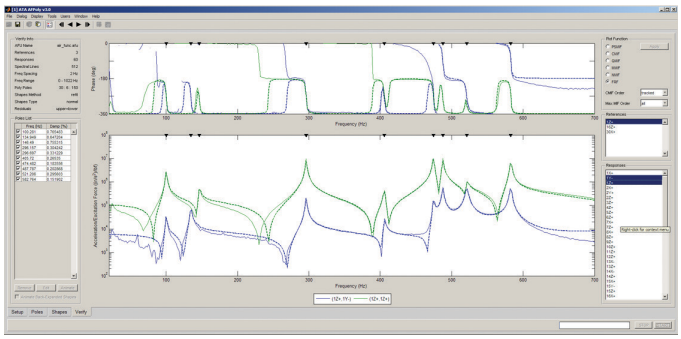

- Select poles from a stability diagram and overlay measured and synthesized FRFs to verify the results.

The Modal Test Kit (MTK) is a MATLAB toolbox that contains routines for placing sensors and exciters, extracting modes from test data, verifying shape extractions through FRF synthesis comparisons, providing shape independence and completeness checks, and other useful routines for analyzing modal survey test data. One such useful routine is the ability to select and display shaker locations and orientations for optimal target mode excitation during a modal test. FEM entities such as coordinate systems, nodes, elements, and tracelines can also be imported into MATLAB. Several utility functions provided with IMAT allow for coordinate transformations and plotting, allowing you to display and animate mode shapes. You can even create AVI files of your mode shape animations.

Estimate Modal Parameters with IMAT+Modal

AFPoly™ stands for “Alias-Free Polyreference” and refers to a multi-reference modal parameter estimation technique. ATA Engineering developed AFPoly as the implementation of a robust and proven modal parameter estimation technique that has been extensively used in the field by ATA’s test group. AFPoly is a frequency-domain Laplace method that uses orthogonal polynomials and accounts for out-of-band poles when estimating modal parameters.

The AFPoly GUI guides users through the process of identifying modal parameters (shape coefficients, damping, and natural frequency) in a step-by-step manner. Users import frequency response functions (FRF) with the GUI, solve for poles, and identify the valid poles with the help of autonomous pole selection. Shapes are then extracted and verified by overlaying various measured and synthesized mode-indicator functions. Once the shapes have been verified, they can be exported for further analysis.

IMAT+Modal Key Features

IMAT is a prerequisite for IMAT+Modal.

Key features of TAMKIT:

- Select instrumented DOFs and reduce FEM matrices to specified DOFs
- Reduce FEM matrices using several reduction methods
- Evaluate test-analysis model (TAM) quality
- Compare between two similar models
- Compare between test and analysis modes

Key features of the Genetic Algorithm and selectASET:

- Direct Nastran compatibility
- Automated and GUI driven
- Works with multiple FEM configurations; simultaneously select accelerometer locations on multiple FEM configurations
- Use industry-standard pseudo-orthogonality or self-MAC cost functions to rank the effectiveness of a set of accelerometer locations
- Export orthogonality, MAC, and frequency comparisons to Excel-compatible XML format to document results
- Select degrees of freedom that must be included or excluded from the final target DOF set
- Optimally select triaxial locations if desired

Key features of the MTK toolbox:

- Pretest activities including exciter selection (single or multiple configurations) and pretest results summary in a formatted XML file or XLSX file for import into Microsoft Excel
- Single and multiple reference mode indicator functions
- Modal parameter estimation utilities including the AFPoly GUI, single reference, and enhanced FRF extraction methods
- FRF synthesis from modal parameters
- Test mode shape verification
  - Independence and completeness checks based on MAC or orthogonality
  - Test vs. FEM comparison tables
  - Test summary XML and XLSX files
  - Advanced tools such as grid point energy checks
  - Computation of mode shapes from TAM matrices
- Supplemental routines
  - Sorting of modes from multiple extractions to generate final mode set
  - Removal of bad sensors from TAM matrices
  - Back expansion of mode shapes and frequency response functions to test display model for viewing

Hardware Platforms

The IMAT toolbox was written primarily in the MATLAB language. Versions are available for 64-bit Windows, 64-bit Linux, and 64-bit Mac platforms. MATLAB R2015a (or higher) is a prerequisite for IMAT v7.1.

About ATA

ATA Engineering has more than forty years of experience in structural dynamics analysis and testing, and is a world leader in the area of test-analysis correlation and model updating. For more information please visit www.ata-e.com.