Structural Dynamics Toolbox 4

for modelling and testing mechanical systems

The *Structural Dynamics Toolbox* enhances core capabilities in controls and signal processing supported by many MATLAB based products through mechanical engineering extensions. A complete integration in the MATLAB development environment guarantees easy adaptation to specific user needs.

For analysis, the *SDT* provides a general finite element architecture that can be used in all fields and a range of specialized solvers to create models used to study vibration problems. Interfaces with popular FEM codes and Graphical User Interface (GUI) visualization tools let you build on the MATLAB/*SDT* ease of use to pre-/ post-process computations done using *SDT* or other codes. Key compiled functions allow treatment of large models.

For test, the *SDT* provides all the modal analysis tools needed to exploit frequency domain measurements. GUIs are provided for visualization of responses, frequency domain identification, animation of modes and operational deflection shapes, topological correlation, and test/analysis correlation criteria.

Key features

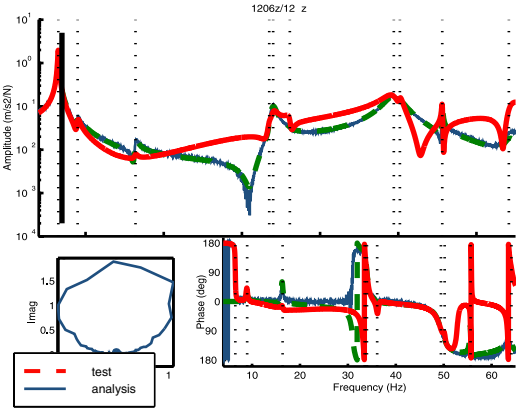
Analysis

- General 3-D Finite Element Modelling with an open architecture allowing easy user developments
- Pre-processing and visualization of FEM computations
- Model reduction, substructuring and system model building
- Physical parametrization of FEM models for optimization or updating

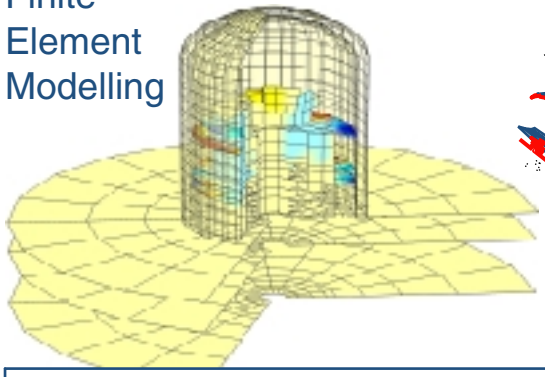
Test

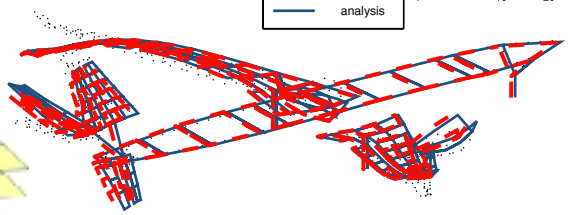
- GUI based visualization of test data and frequency domain identification
- Animation of test and FEM results
- Topology correlation and test/analysis criteria
- Import/export routines for popular test and FEM model formats
- Specialized routines to go from test and finite element models to state-space and other system dynamics formats

Experimental Modal Analysis



Finite Element Modelling





System Dynamics

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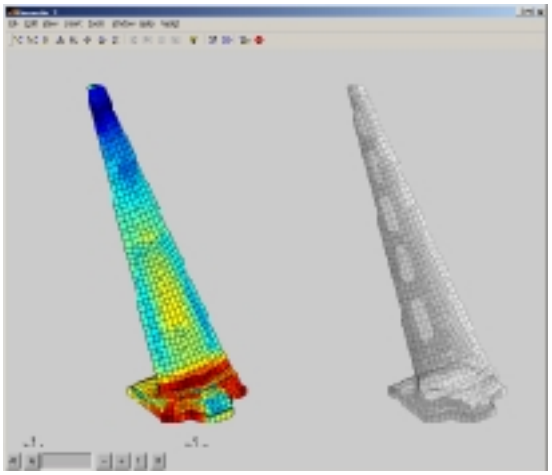
Finite Element Analysis

Mesh manipulations

The femesh user interface enables the creation and extensive manipulations of finite element models. Commands allow element and node selection, translation, extrusion, repetition, revolution, mesh refinement, … All these operations are compatible with both *SDT* and user defined elements and are used extensively for part visualization, parametrization, …



A general purpose FEM architecture

Assembly tools and a compiled skyline static solver optimize MATLAB memory management and allow good performance for large models. The open specification of data structures and element function services allows integration of user developments in the pre-/post-processors and solution methods.

Import/export

While femesh handles simple geometries, industrial models need general 3-D meshers that are only available in full fledged CAD systems. *SDT FEMLINK* thus provides interfaces with popular formats: NASTRAN, ANSYS, Universal File Format, ADAMS, PERMAS, …

Element functions

A library of fundamental elements contains masses, bars, beams (Bernoulli and Timoshenko), thin and thick triangular and quadrilateral plates (3, 4 and 8 nodes), solids (4, 6, 8 and 20 node isoparametric elements). These support linear elastic behavior for isotropic materials. The specification for element functions allows up to 99 DOFs per node as well as internal element DOFs.

Statics and dynamics

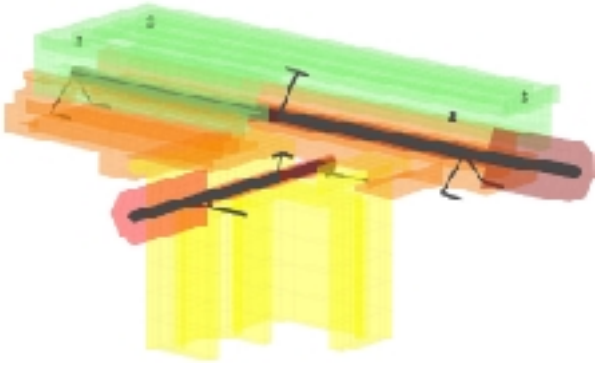
The *SDT* provides standard solutions for static response to loading cases, partial eigenvalue solutions (subspace and Lanczos), standard reduced models (Guyan, Craig-Bampton and MacNeal …), damped models, creation of state-space models, computation of frequency response functions, computation of element strain and kinetic energy. Reduced models can be transformed to state-space form for easy incorporation in the *Control Toolbox* or SIMULINK

Physical Parametrization

The upcom function allows easy manipulations of large parametrized models. Physical parameter variations (modulus, density, thickness, …) can be associated with arbitrary element set selections. Model matrices, modeshapes, modeshape sensitivities, and frequency responses can be easily computed at each design point. The main applications of this interface are optimization and finite element model updating based on experimental data.

Visualization

The object oriented GUI allows visualization and animation of FEM and test. You can combine 3-D surface, wire-frame, or sensor objects in the nominal or deformed configuration, redefine new deformations or sensor configurations for the current structure, scan through a set of deformations, efficiently zoom with the mouse, control amplification, animate real, complex, or color shapes, show selected substructures, rotate the structure, and more.



Experimental modal analysis

Database management

A number of high quality products provide data acquisition capabilities and signal processing can be performed within MATLAB. Once measurements performed, the *SDT* supports database wrapper objects that allow easy manipulations of datasets with options describing units, physical meaning, etc. Bi-directionnal transformation between the Universal File Format and database wrappers is provided.

Data Visualization and Analysis

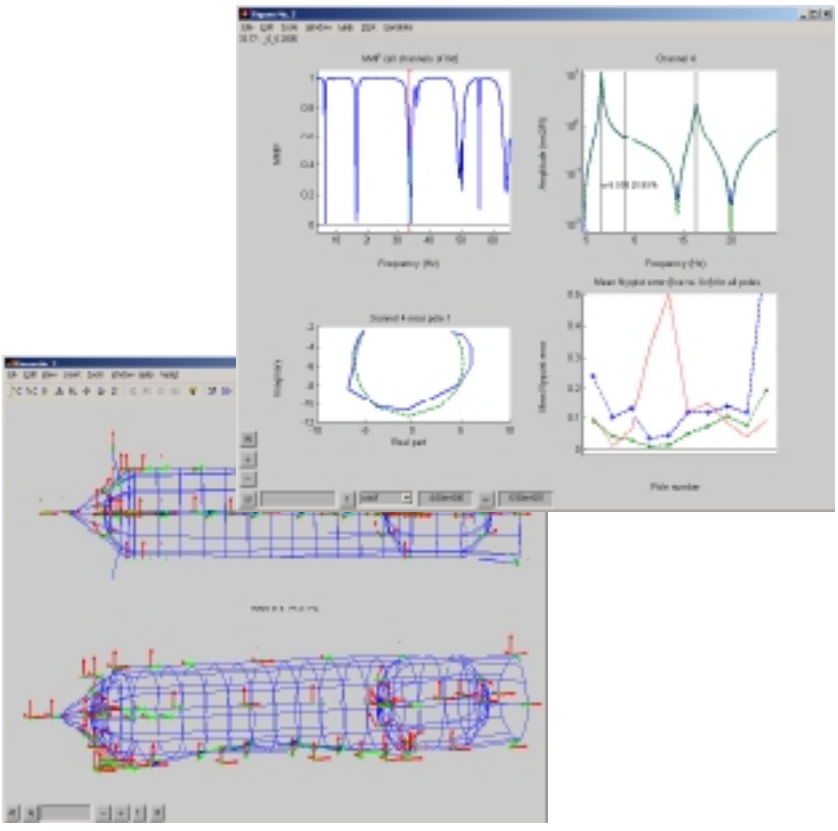
The iicom, iiplot graphical user interface for the visualization of Multiple-Input Multiple-Output (MIMO) datasets easily generates Bode plots, Nyquist plots, Multivariate Mode Indicator Function, complex residue phase spread, pole location, etc. Once the plots generated, simple mouse/key movements let you scan through the data set, get information on certain points, zoom, etc. Version 4 introduces new plots, context menus, and optimized speed.

A GUI based MIMO identification procedure allows gradual refinement of the identified model and immediate animation of identified shapes.

Frequency domain identification

A complete methodology to solve the frequency domain output error problem is proposed. This includes advanced single pole MIMO estimation and model tuning strategies which fully replace traditional procedures based on stabilization diagrams. This iterative approach is both more intuitive and very often more accurate than methods found in other modal analysis packages.

Identification functions include treatment of MIMO models, multiple modes, real and complex modes, reciprocity, non-proportional damping models, as well as transformations between pole/residue, state-space, second-order mass, damping, stiffness, or polynomial forms.



Model format conversion

The *SDT* provides a full set of two way model format conversion functions for full order finite element models, truncated normal mode nor models traditionally used in structural dynamics, frequency response xf, pole/residue res, state space ss, polynomial transfer function tf. Transformations from frequency response xf to res, ss and nor are supported system identification phases. Transformations from xf and nor formats to full order finite element parameters correspond to finite element update problems. Other transformations have direct analytical expressions and are supported with an emphasis on providing numerically efficient solutions.

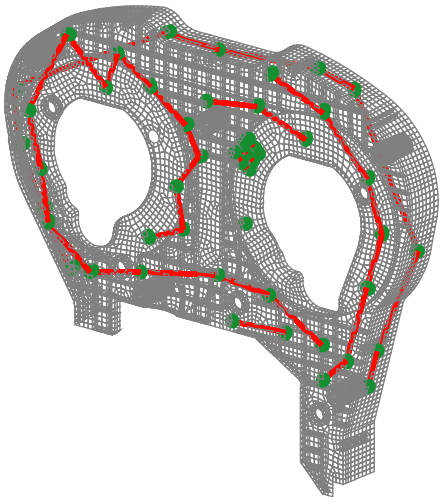
Test/analysis correlation

Topology correlation

SDT visualization and analysis tools support general sensor setups with mixed translation/rotation measurements, non orthogonal sensors, laser measurements, non-coincident test and FEM nodes, ...

fe_sens provides sensor placement algorithms and automated and/or directed test/FEM node linking with support of different test/FEM coordinate systems, mixed translation/rotation sensors, and rotation interpolation for non-coincident nodes of volume models.

The use of observability equations gives access to all correlation and shape expansion methods with no need to modify the FEM model (a unique and very time saving feature).

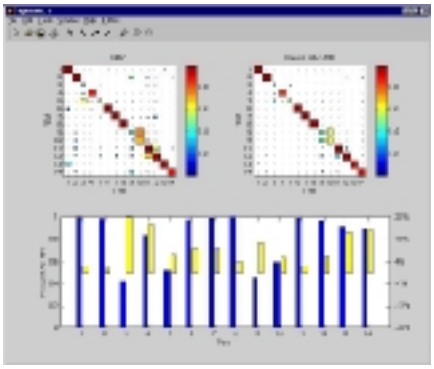


Correlation criteria

The new ii_mac GUI supports the COMAC, MAC, MACCO, POC, and relative error criteria, with standard graphical and tabular output, automated mode pairing, computation and use of reduced mass in all the criteria. Functionality is accessed either though menus or through the *SDT* handle object associated with the figure.

Shape expansion

Expansion methods for arbitrary sensor configurations are modal, static, dynamic, and the advanced minimum residual with and without measurement error. The use of FEM model reduction lifts the computational restriction on using advanced methods.



For demos, application examples, documentation, and pricing

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About the product

Developed since 1991 by Etienne Balmès, the Structural Dynamics Toolbox was first distributed in 1995. Version 4.1 was released in march of 2001. There are more than 500 licenses installed in 15 countries with users at Bosh, Boeing, Daimler Chrysler, EADS, EDF, Ford, GEC/ Alsthom, Lokheed, LANL, NASA, PSA, Rockwell, Saab Aircraft and Dynamics, Renault VI, Siemens, Sony, Valéo, …

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