

Structural Health Monitoring Tools (SHMTools)

Parameter Specifications

LANL/UCSD Engineering Institute

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1 Parameter name: Time Series Data

- **Description:** Time series data acquired from sensors (channels)
- **Type:**
 - **Matrix dimensions:** Matrix t by c by i
 - **Description of each dimension:** t time samples, c channels, i instances
 - **Elements types:** double
- **Sources:** Data acquisition module
- **Destinations** Feature extraction module

2 Parameter name: Classification labels

- **Description:** Labels designating whether a given feature vector is flagged as “undamaged” (0) or damaged (1). These labels are supposed to be matched with a collection of feature vectors for either training (classification) or may be returned as the result of testing.
- **Type:**
 - **Matrix dimensions:** Vector n by 1
 - **Description of each dimension:** Each label corresponds to a feature vector
 - **Elements types:** 0 or 1
- **Sources:** Data acquisition module, user input
- **Destinations** Feature classification module

3 Parameter name: Power Spectral Densities

- **Description:** Measured or computed power spectral densities (PSDs).
- **Type:**
 - **Matrix dimensions:** Matrix n by c by i
 - **Description of each dimension:** n FFT points, c channels, i instances
 - **Elements types:** Real or complex numbers
- **Sources:** Data acquisition module, feature extraction module (spectral analysis)
- **Destinations** Feature extraction module (spectral analysis)

4 Parameter name: Active Sensing Time Series Data

- **Description:** Time series data acquired from actuator sensor pairs
- **Type:**
 - **Matrix dimensions:** Matrix t by p by i
 - **Description of each dimension:** t time samples, p sensor pairs, i instances
 - **Elements types:** double
- **Sources:** Data acquisition module
- **Destinations** Feature extraction module

5 Parameter name: Sensor Ids

- **Description:** List of sensor ids associated with each feature vector. This will serve after classification to identify what sensor a certain reading was recorded from. Various classification policies also depend on these lists.
- **Type:**
 - **Matrix dimensions:** Vector n by 1
 - **Description of each dimension:** Each sensor id corresponds to a feature vector
 - **Elements types:** Integer numbers
- **Sources:** Feature extraction module
- **Destinations** Feature classification module

6 Parameter name: Environment Ids

- **Description:** List of environmental parameters ids associated with each feature vector. Serves to list discrete environmental parameters associated with each reading. Various classification policies depend on these lists.
- **Type:**
 - **Matrix dimensions:** Vector n by 1
 - **Description of each dimension:** Each environment id corresponds to a feature vector
 - **Elements types:** Integer numbers.
- **Sources:** Feature extraction module
- **Destinations** Feature classification module

7 Parameter name: Sensor Layout

- **Description:** Coordinates of actuators and/or sensors
- **Type:**
 - **Matrix dimensions:** Matrix 4 by s
 - **Description of each dimension:** [Sensor ID, X Coordinate, Y Coordinate, Z Coordinate], s sensors
 - **Elements types:** double
- **Sources:** Data acquisition module, user input, parameter file
- **Destinations** Feature extraction module

8 Parameter name: Two Dimensional Boundaries

- **Description:** List of line segments to define boundary of plate structure.
- **Type:**
 - **Matrix dimensions:** Matrix 2 by 2 by b
 - **Description of each dimension:** [X Coordinate, Y Coordinate], [Segment Start, Segment End], b segments
 - **Elements types:** double
- **Sources:** Data Acquisition module, user input, parameter file
- **Destinations** Feature extraction module

9 Parameter name: Active Sensing Actuator/Sensor Pair List

- **Description:** Actuator/sensor pairs used in active sensing process
- **Type:**
 - **Matrix dimensions:** Matrix 2 by p
 - **Description of each dimension:** [Actuator ID, Sensor ID], p pairs
 - **Elements types:** double
- **Sources:** Data acquisition module, user input, parameter file
- **Destinations** Feature extraction module

10 Parameter name: Points of Interest List

- **Description:** Coordinates of points of interest on structure to be analyzed
- **Type:**
 - **Matrix dimensions:** Matrix 3 by p
 - **Description of each dimension:** [X Coordinate, Y Coordinate, Z Coordinate], p points of interest
 - **Elements types:** double
- **Sources:** Data acquisition module, feature extraction module, user input, parameter file
- **Destinations** Feature extraction module

11 Parameter name: FIR Filter

- **Description:** FIR filter taps
- **Type:**
 - **Matrix dimensions:** Vector n by 1
 - **Description of each dimension:** n filter taps
 - **Elements types:** double
- **Sources:** Feature extraction module
- **Destinations** Feature extraction module

12 Parameter name: Window

- **Description:** Window function
- **Type:**
 - **Matrix dimensions:** Vector n by 1
 - **Description of each dimension:** n window samples
 - **Elements types:** double
- **Sources:** Feature extraction module
- **Destinations** Feature extraction module

13 Parameter name: Feature vectors

- **Description:** Collection of feature vectors used to train or test a statistical model of non-damage conditions.
- **Type:**
 - **Matrix dimensions:** Matrix n by d
 - **Description of each dimension:** n instances, d features
 - **Elements types:** Real numbers
- **Sources:** Feature extraction module
- **Destinations** Feature classification module

14 Parameter name: Frequency Response Functions

- **Description:** Measured or computed frequency response functions (FRFs).
- **Type:**
 - **Matrix dimensions:** Matrix n by d by e
 - **Description of each dimension:** n FFT points, d degrees of freedom (DOFs), e ensembles
 - **Elements types:** Complex numbers
- **Sources:** Data acquisition module, Feature extraction module (modal analysis)
- **Destinations** Feature extraction module (modal analysis)

15 Parameter name: Modal Residues

- **Description:** The modal residues are the complex vectors computed by the rational polynomial curve-fitting algorithm, and which are related to the mode shapes of a structure.
- **Type:**
 - **Matrix dimensions:** Matrix n by d
 - **Description of each dimension:** n degrees of freedom (DOFs), d structural modes.
 - **Elements types:** Complex numbers
- **Sources:** Feature extraction module (modal analysis)
- **Destinations** Feature extraction module (modal analysis)

16 Parameter name: Mode Shapes

- **Description:** Structural modes of vibration computed using the modal residues according to a user-selected method.
- **Type:**
 - **Matrix dimensions:** Matrix n by d
 - **Description of each dimension:** n degrees of freedom (DOFs), d structural modes.
 - **Elements types:** Real numbers
- **Sources:** Feature extraction module (modal analysis)
- **Destinations** Feature extraction module (modal analysis), feature classification module

17 Parameter name: Natural Frequencies

- **Description:** Identified natural frequencies using the rational polynomial curve-fitting algorithm, in Hz.
- **Type:**
 - **Matrix dimensions:** 1 by d
 - **Description of each dimension:** d structural modes
 - **Elements types:** Real numbers
- **Sources:** Feature extraction module (modal analysis)
- **Destinations** Feature extraction module (modal analysis), feature classification module

18 Parameter name: Damping Ratios

- **Description:** Identified damping ratios using the rational polynomial curve-fitting algorithm.
- **Type:**
 - **Matrix dimensions:** 1 by d
 - **Description of each dimension:** d structural modes
 - **Elements types:** Real numbers
- **Sources:** Feature extraction module (modal analysis)
- **Destinations** Feature extraction module (modal analysis), feature classification module

19 Parameter name: Wavelet

- **Description:** Wavelet function
- **Type:**
 - **Matrix dimensions:** Vector n by 1
 - **Description of each dimension:** n wavelet samples
 - **Elements types:** Real or complex, double
- **Sources:** Feature extraction module (spectral analysis)
- **Destinations** Feature extraction module (spectral analysis)

20 Parameter name: Time-Frequency Data

- **Description:** Data matrix output for time-frequency analysis methods
- **Type:**
 - **Matrix dimensions:** Matrix f by t by c by i
 - **Description of each dimension:** f frequencies, t time samples, c channels, i instances
 - **Elements types:** Real or complex, double
- **Sources:** Feature extraction module (spectral analysis)
- **Destinations** Feature extraction module (spectral analysis)

21 Parameter name: Kurtogram Data

- **Description:** Kurtogram data matrix
- **Type:**
 - **Matrix dimensions:** Matrix l by f by c by i
 - **Description of each dimension:** l kurtogram levels, f frequencies, c channels, i instances
 - **Elements types:** double
- **Sources:** Feature extraction module (spectral analysis)
- **Destinations** Feature extraction module (spectral analysis)