



Bayesian Model Updating for Systematic Damage Detection

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Objectives

1. To develop new, efficient, and effective method to update a parameterized mathematical model of a structure within the Bayesian statistical framework.
2. To optimize the design of strain sensor system in terms of their number and spatial deployment, with focus on maximizing the information associated with the experimental measurements.
3. To apply the Bayesian model updating methodology for damage systematic detection. The plan is to address three key features: occurrence of damage, its location, and its severity.
4. To perform analytical and experimental studies to validate the proposed methodology. The plan is to demonstrate the effectiveness and efficiency of the proposed methodology using simulated and experimental data from the subject structure in various intact and damaged conditions.

Achievements

1. Three Bayesian methodologies namely Bayesian time domain method in time domain, Bayesian spectral density method and Bayesian Fast Fourier Transform method in frequency domain have been proposed for complex modal parameter identification of a linear non-classically damped system from ambient vibration data.
2. A methodology has been proposed for Bayesian model updating and damage detection by utilizing displacement modal data and dynamic condensation technique. In addition, methodologies has also been developed using modal data from multiple setups and for Hierarchical Bayesian model updating.
3. A methodology for Bayesian model updating and damage detection using strain-based modal data and dynamic condensation has been developed.
4. A methodology for Bayesian model updating using strain-based modal data and modified strain-based formulation has been developed.
5. A methodology has been proposed for designing an experiment for model updating by integrating Bayesian Updating with Subset Simulation and improved version of the Generalized Subset Simulation.

Publications

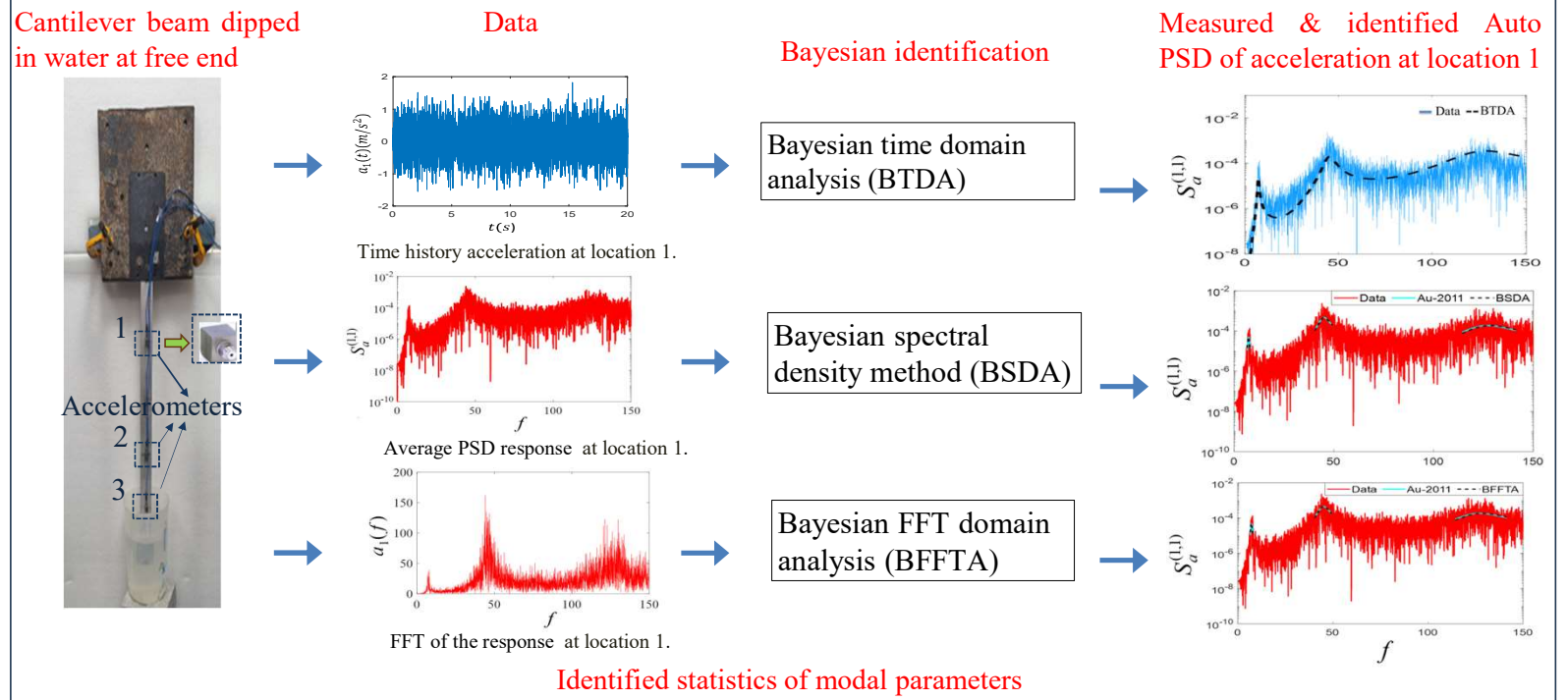
List of papers published in Journals: 5

- [1] Rather, S. and S. Bansal, Bayesian Modal Identification of Non Classically Damped Systems Using Time-Domain Data, Mechanical Systems and Signal Processing, 2023.
- [2] Henikish, E. K., A. Das, and S. Bansal, On the Bayesian Model Updating Based on Model Reduction Using Complex Modal Data for Damage Detection, Journal of Sound and Vibration, 2023.
- [3] Kiran R. P. and S. Bansal, Finite element model updating and damage detection using strain-based modal data in the Bayesian framework, Journal of Sound and Vibration, 2024.
- [4] Das A., R. P. Kiran and S. Bansal, A novel Metropolis-within Gibbs sampler for Bayesian model updating using modal data based on dynamic reduction, Structural Engineering & Mechanics-An International Journal, 2023.
- [5] Das A. and S. Bansal, Hierarchical Bayesian model updating using modal data based on dynamic condensation, Journal of Vibration Engineering & Technologies, 2023.

No. of papers published in Conferences: 3

Results

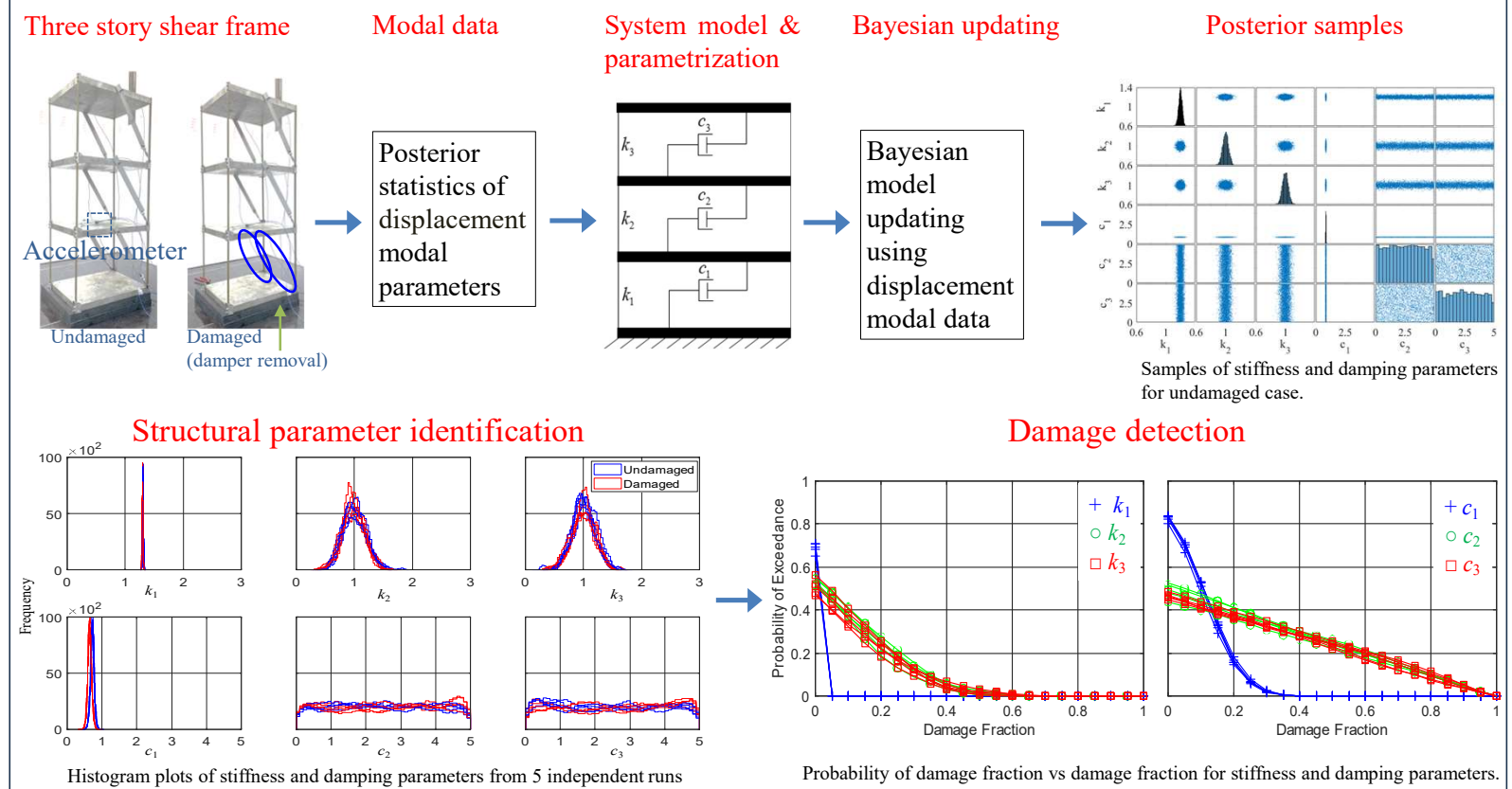
Overview of Complex Modal Parameter Identification [1]



Frequency	MPV	Damping ratio	MPV	Mode shape magnitude	MPV	Mode shape angle	MPV
f_1	7.11 (0.27)	ξ_1	0.05 (9.43)	$ \phi_1^2 $	7.22 (0.18)	$\angle \phi_1^2$	0.01 (1.06)
f_2	44.89 (0.13)	ξ_2	0.07 (1.45)	$ \phi_1^3 $	11.36 (0.32)	$\angle \phi_1^3$	0.02 (0.26)
f_3	126.82 (0.12)	ξ_3	0.14 (0.71)	$ \phi_2^2 $	1.95 (0.10)	$\angle \phi_2^2$	0.08 (0.73)
				$ \phi_2^3 $	0.30 (0.33)	$\angle \phi_2^3$	2.62 (0.31)
				$ \phi_3^2 $	0.83 (0.36)	$\angle \phi_3^2$	3.02 (0.36)
				$ \phi_3^3 $	0.65 (0.31)	$\angle \phi_3^3$	-2.94 (0.37)

The values in parenthesis are COV values. MPV denotes the most probable value. The subscript in modal parameters indicates mode, and the superscript indicates DOF.

Overview of Model Updating & Damage Detection using Displacement Modal data [2]



Overview of Model Updating & Damage Detection using Strain Modal Data [3]

