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Bayesian Model updating of Linear dynamic systems using complex modal data

Eamon Henikish[1*], Sahil Bansal[2] and Rajpurohit Kiran[3]

[1] Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi-110016, India, cez198793@iitd.ac.in
[2] Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi-110016, India, sahil@iitd.ac.in
[3] Department of Civil Engineering, Indian Institute of Technology Delhi, New Delhi-110016, cez218285@iitd.ac.in

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In the lifetime of structures, they may be exposed to damage that deviates their parameters to a new uncertain state. To predict these parameters, they must be updated using experimental data through various model updating methods. Among model updating methods, the Bayesian approach enables the exploration of all the probable models. Many approaches are available, like those that require the solution of the eigenvalue problem [1] and those that do not require the resolution of the eigenvalue problem [2, 3]. Most existing studies have assumed proportional damping, which gives real modal data, which is not the case always [4]. In this paper, a new Bayesian model updating methodology is proposed based on introducing system mode shapes, damping ratios and natural frequencies as additional uncertain parameters. A dynamic condensation technique is used to restrain the model updating problem to work on the observed degrees of freedom (DOF) field only. To decrease the number of uncertain parameters, system mode shapes are integrated out, and Transitional Monte Carlo Markov Chain (TMCMC) is used to sample from the posterior probability density function. The proposed approach has been applied to the 3-storey shear building model. Results show that the proposed methodology can predict the updated structural parameters in many cases, like the cases where the number of observed modes is greater than the number of observed DOF and if the observed modes are not the lowest-frequency modes.

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