INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	**Ph.D.**

Thesis Title: **Kalman Filter And Its Advanced Variants For Condition Assessment Of Hysteretic Structural Systems.**

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SHORT ABSTRACT

Bayesian Filtering is an efficient tool for structural health monitoring. In this context, Constrained minimum variance unbiased (CMVU) algorithm was developed using sigma point transformation for simultaneous identification of the hysteretic parameters and input excitation from noisy structural responses. The identification results presented in this study clearly showed the robustness of the proposed algorithm, which can estimate both hysteretic properties and input excitation with a sufficient level of accuracy. Besides estimating hysteretic parameters and input excitation, the CMVU algorithm could calculate the restoring force generated by the structure during ground excitation, which cannot be obtained directly using instrumentation alone. In the absence of this measured restoring force, researchers often use the total inertia force acting on the structure under base excitation as the restoring force, which leads to incorrect hysteretic behaviour. It was shown that the CMVU algorithm was capable of capturing the true nature of the hysteretic plot, which was further utilized as an engineering demand parameter to estimate the damage state of the structure. First, the proposed strategy was tested with a simulated example, followed by the experimental validation with shake table test data of a full-scale bridge pier to study the cumulative in-situ damage state in terms of the Park & Ang damage index.

Although phenomenological models like Bouc-Wen are good enough to capture the input-output relationship of hysteretic structures, they may not adequately capture the damage mechanism of complex systems that involve information related to the presence, location, type, and extent of the damage. To address this issue, a damage estimation framework through mechanics-based nonlinear finite element (FE) model updating was developed in the light of the 'Open System for Earthquake Engineering

Simulation (OpenSees)' finite element package to obtain more insight into the incurred dar traditional unscented Kalman filter (UKF) algorithm was augmented with the parameter bounds to avoid possible instability, which may occur in Opensees solver during the updating process. The proposed framework was validated using the simulated noisy measurement data (i.e., acceleration, strain history, etc.) of a reinforced concrete frame, and the updated parameters were subsequently used for damage estimation using Park & Ang damage index. Further, it is applied to the shake table data of the reinforced bridge pier experiment, and the results show close conformity estimated damage to the actual one. Each proposal of the above-mentioned studies was validated both numerically and experimentally to prove its efficiency and practicality. It includes both phenomenological and mechanics-based nonlinear models of the hysteretic systems. Overall, the study shows the ability of the proposed algorithms for damage quantification that are fundamental for decision making (i.e., future retrofitting/rehabilitation).