Prognostics and Structural Health Assessment Using Uncertain Measured Response Information

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Abstract The authors and their team members have been working on developing implementable techniques for the objective rapid assessment of structural health (RASH) just after major natural and man-made events or in the context of maintenance over a period of time. They used the system-identification techniques by eliminating some of its weaknesses. For easier implementation, the excitation information was completely ignored. To locate defects and their severity at the local element level, the structures were represented by finite elements. By tracking the changes in the stiffness parameters of each element, the location(s) and severity of defects are assessed. The team conducted extensive analytical and laboratory investigations to verify all the methods. They had to overcome several challenges related to the conceptual and analytical development, data processing, and the presence of uncertainty in the every phase. To consider nonlinearity in the system identification process, a method known as Generalized Iterative Least Squares-Extended Kalman Filter-Unknown Input (GLIS-EKF-UI), was developed earlier. Since it failed to identify structures in some cases, the authors recently proposed a new method denoted as Unscented Kalman Filter—Unknown Input-Weighted Global Iterations (UKF-UI-WGI). With the help of informative examples, the superiority of UKF-UI-WGI over GLIS-EKF-UI is documented in this paper. Since at the beginning of an inspection, the defects and their severity are expected to be unknown, the authors recommend UKF-UI-WGI for the rapid assessment of health of infrastructures.

Keywords Structural health assessment · Uncertain measured information · Kalman filters · Nonlinear system identification · Unknown input excitation

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U. Kumar et al. (eds.), *Current Trends in Reliability, Availability, Maintainability and Safety*, Lecture Notes in Mechanical Engineering,
DOI 10.1007/978-3-319-23597-4_13