Chapter 4
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Complexities and Solution Strategies in Structural Health Assessment

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ABSTRACT

The complexities and solution strategies in the health assessment of civil infrastructures are briefly discussed. To meet the current needs of locating defect spots and their severity accurately and efficiently, infrastructures are represented by finite elements. To increase the implementation potential, the stiffness parameters of all the elements are tracked using only few noise-contaminated dynamic responses measured at small part of the infrastructures. To extract the required information, Kalman filter concept is integrated with other advanced numerical schemes. An unscented Kalman filter (UKF) concept is developed for highly nonlinear dynamic systems. The basic UKF concept is improved in several ways. Instead of using one long duration time history uased in one global iteration, very short duration time histories and multiple global iterations with weight factors are used to locate the defect spot accurately and efficiently. The capabilities of the procedure are demonstrated with the help of two informative examples. The proposed procedure is much superior to the extended Kalman filter-based procedures developed by the team earlier.

Keywords: Complexities; solution strategies; health assessment; civil infrastructures.

1. INTRODUCTION

The complexities and solution strategies in the health assessment of civil infrastructures cannot be overstated. Initial attempts were made using common sense. However, the solution strategy evolves over a very long period of time. The same basic concept is being developed at present using the current state-of-the-art advanced mathematical concepts embedded in highly powerful computational framework. The world communities at present are trying to assess the health of civil infrastructures to help maintain our way of life. Some of these infrastructures were designed a long time ago and their design life may have expired. They need to be replaced; however, we do not have resources to replace them. Their design lives need to be extended. One attractive economical approach is to inspect them as comprehensively as possible to identify the location, type, and severity of defects if any, and then repair them in the most cost-effective way to bring them back to the original state when initially designed.

A simple concept of health assessment has become very complex to satisfy the current needs. To assess health of an earthen utensil, our forefather tapped it and listened to the sound it produced. Obviously, this simple concept cannot be used to assess health of structures. Similar challenges are faced by physicians to assess human health. They now have access to numerous equipment and test protocols with various degrees of sophistication. They need to use them very judiciously using information on cost and benefit.

Looking back to the chronology of events for the development of SHA techniques for civil infrastructures, the engineering profession also followed strategies similar to the physicians. To identify the location, type and severity of defects in large infrastructures, it is necessary to represent

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