Structural Health Assessment: Challenges

Achintya Haldar, DIST. M. ASCE and **Abdullah Al-Hussein**
Dept. of Civil Engineering and Engineering Mechanics
University of Arizona, Tucson, AZ 85721, U.S.A.
Email: haldar@u.arizona.edu

Abstract: To address the urgent need of the world communities, the authors and their research team developed several novel techniques for the rapid assessment of structural health in the context of maintenance or just after major natural and man-made events. They are essentially time domain system identification techniques. The structures are represented by finite elements. By tracking the changes in the stiffness parameters of each element the location(s) and severity of defects are assessed. They conducted extensive analytical and laboratory investigations. They had to overcome several challenges related to the conceptual, analytical, and data processing and the presence of uncertainty in every development phase. Some of them are discussed in this paper.

Keywords: Structural health assessment; uncertainty analysis; system identification; extended Kalman filter, unscented Kalman filter

1. Introduction

Structural health assessment (SHA) has become one of the urgent research topics all over the world. Because of aging infrastructures and lack of funds to replace them within a short period of time, extending their life without exposing public to excessive risk has become an attractive option. Of course, assessing their health just after major natural events like typhoons and earthquakes also cannot be overlooked. The major objective is to repair defects, in the context of maintenance, as soon as they are detected so that the overall structural integrity and the intended use for which they were constructed are not compromised. We have advanced technological sophistication to study defects in structures if the nature of the defects and their locations are known. Also, many major infrastructures are being instrumented during construction to collect information about the degradation process. In spite of our sincere effort, the success of SHA in practical applications is relatively minor.
The authors and their research team have conducted both theoretical and experimental investigations over a period of time and gained valuable experience. They proposed several novel methods addressing numerous challenges and in a very unique position to discuss them in a comprehensive way. This will be the major theme of this paper.

2. State-of-the-Art in Structural Health Assessment

SHA is an age-old problem. In the past, cracks and cavities were detected in pottery by listening to the sound generated when tapped by fingers, or by hitting structures with a hammer and listening to the sounds they produce, or by conducting simple visual inspection. They are essentially non-model based Non-Destructive Evaluation (NDE) of health of a structure. Several non-model instrument-based techniques were subsequently developed. Their success depends on the knowledge *in priory* the location(s) and types of defects. Instrument-based NDE of defects include Penetrate Testing (PT), Magnetic Particle Testing (PT), Radiographic Testing (RT), Ultrasonic Testing (UT), Eddy Current Testing (ET), Thermal Infrared Testing (TIR), and Acoustic Emission Testing (AE). Many of them required the damage to be exposed or within small depth from the open surface or direct contact [1].