https://doi.org/10.1142/9789811243011_fmatter

Preface

Research activity in health monitoring and assessment of engineered structures has significantly increased in the recent past. Considering the importance and urgency of the topic, Professor Haldar edited a book in 2013 titled *Health Assessment of Engineered Structures — Bridges, Buildings and Other Infrastructures*, published by World Scientific Publishing Co. The interest in the profession prompted the development of this book outlining further advancements since then.

Since the available financial resources are very limited, extending the life of existing bridges, buildings, and other infrastructures has become a major challenge to the engineering profession worldwide. Structural health just after a natural event (strong earthquakes, high winds, etc.) or a man-made event (explosions, blasts, etc.) has also become a part of the overall health assessment protocol. In the context of nondestructive evaluation, the main thrust has been to locate defects in structures at the local element level and then decide what remedial action would be most appropriate, essentially extending their lives. Several advanced theoretical concepts have been proposed to detect defects. At the same time, improved and smart sensing technologies, high-resolution data acquisition systems, digital communications, and procedures related to noise contamination in measured information and high-performance computational platforms have been developed for implementing these concepts. The general areas are now commonly classified as structural health monitoring (SHM) and structural health assessment (SHA). Some of the related

areas are in the development phase. As the area matures, more new ideas are being considered to implement the basic concepts, crossing the typical engineering boundaries. Smartphones, digital cameras with improved capabilities, and interactive holographic features captured by handheld or head-mounted devices are also being increasingly used for this purpose.

Major recent advancements in these areas are reported in this book. The contents of this book are broadly subdivided into five major themes. In Chapter 1, opportunities and challenges in SHA/SHM are presented, and experimental investigations are conducted. A major hurdle is the convergence of most of the iterative theoretical algorithms in the presence of nonlinearity and noise in the measurements used for assessment purposes. Some of the overlooked reasons for non-convergence are identified and their mitigation strategies are discussed in this introductory chapter. In the second subtopic, several recently developed advanced theoretical algorithms are presented in Chapters 2 to 8. They include several Bayesian Updating algorithms, different types of Kalman Filters, Monte Carlo simulations, Markov Chain Monte Carlo and Metropolis–Hastings samplings, and variance reduction using the Rao–Blackwell theorem. There is significant activity in these areas. Case studies are discussed in Chapters 9 and 10 as the third subtopic. In the fourth subtopic, a Modified Social Group Optimization Algorithm is presented in Chapter 11. It demonstrates how SHM/SHA has migrated to different non-traditional areas indicating its urgency and importance. In the fifth subtopic, applications of widely available sensors and technologies for SHM/SHA are presented. Vibration sensors (accelerometer, gyroscope, etc.) inside smartphones can record responses. However, they do not have sufficient sensitivity/resolution/sampling rates to satisfy the needs. The collected information may not be effective for SHM/SHA of full-scale structures. Similarly, vision and Augmented Reality (AR)-based information is also being used for SHM/SHA instead of response measurements. AR is a digital interface that combines interactive holographic components with the real-world environment. The holograms are generated by computers and augmented in the real-world environment created by head-mounted or handheld devices that produce video or optical displays. The capabilities of these approaches are limited for SHM/SHA. The optimal placement of sensors can be very important in these types of approaches.

The engineering community is increasingly interested in applying technology to provide an interface for feedback, visualization, and structural analysis. The last three chapters (Chapters 12–14) discuss the applications of these evolving sensors and technologies in SHM/SHA. They are expected to increase the interest of the readers in the related topics. The literature reviews in these chapters are expected to provide the necessary guidance. These areas need to be developed further for practical applications.

In spite of these developments in analytical and sensor technologies, the implementations of these concepts in SHM/SHA have been limited for several reasons. An attempt has been made here to identify some of the major future opportunities and their merits and demerits. Without this book, the information may not be available in an organized way for interested readers who are not experts in the areas. The information on the leaders who are developing these areas, their thought processes, and the state-of-the-art in the relevant areas are expected to benefit students (undergraduate and graduate), researchers (university and industrial), and practitioners (government and private). This book provides a sampling of some exciting developments.

This book is unique in terms of its content, which addresses many emerging research areas where the available information is scarce or not yet properly formulated or developed. The recent thoughts and opinions of experts presented in this book are expected to accelerate the development of these areas. The book provides the reader with a wealth of insights and a unique global and multidisciplinary perspective. It is hoped that this book will convey to the reader the excitement, advances, promise, and challenges in overall structural health assessment and monitoring.