

Preface

The Motivation for This Book

The past decade has witnessed the emergence of applying wireless sensor networks (WSNs) to monitor the healthy condition of civil infrastructures. Compared to conventional wire-based structural healthy monitoring (SHM) systems, a WSN-based SHM system has the advantages of low cost, ease of deployment, and can obtain fine-grained information about structure's condition.

The main motivation for offering this book stems from the observation that, although many WSN-based SHM systems have been deployed, some real requirements in SHM have not been fully addressed. SHM applications have some distinct features from traditional WSN applications like environmental monitoring. Thus many widely adopted techniques in conventional applications of WSNs, like the event-triggered wake-up, in-network processing, fault-tolerance, cannot be directly applied for SHM applications. In this book, we first give a review of existing WSN-based SHM systems, and then introduce our WSN-based platform called SenetSHM. SenetSHM adopts many techniques that are specially designed to address the unique features of SHM applications. We share our experiences by stepping from the hardware and software design, to in-field experiments of the SenetSHM.

What This Book Is About

This book provides comprehensive coverage and detailed insights into the emerging area of using WSNs for SHM. It helps the readers to understand the specific requirements of SHM applications from other traditional WSN applications, and how these requirements are addressed using a series of systematic approaches. Therefore, it can be seen as a textbook as well as a practical guide for the reader:

- To understand the state-of-the-art technologies in domain-specific applications of WSNs like SHM.
- To learn about the methodologies of how to address the specific requirements for a WSN application. In particular, we provide a guideline for problem formulation, problem solving, and share our experiences and lessons learned from our practices in implementing the SenetSHM.

How This Book Is Organized

This book is divided into seven chapters.

Chapter 1: Introduction. In this chapter, we introduce the background of SHM, some of the existing SHM systems, followed by the challenges and issues in developing the relevant technologies associated with WSN-based SHM systems.

Chapter 2: The Requirements and Design of Wireless Sensor Nodes for SHM. This chapter gives the requirements of SHM applications and an overview of our hardware and software design of wireless sensor nodes.

Chapter 3: Network-Wide and Reliable Event-Triggered Wakeup in WSNs. Wake-up scheduling is an important approach to save energy in WSNs. However, the requirements of wake-up in SHM are different from other applications of WSNs. This chapter provides the details of how to realize network-wide and reliable event-triggered wakeup in WSN-based SHM applications.

Chapter 4: Design of Distributed SHM Algorithms Within Wsns: A Cluster-Based Approach. Another important approach to address the resource-limited WSNs is to embed SHM algorithms within the network. However, typical SHM algorithms are centralized, computationally intensive, and are not easy to be distributed within a network. This chapter provides one typical approach, clustering, to design distributed versions of SHM algorithms.

Chapter 5: Design of Distributed SHM Algorithms Within WSNs: A Networked-Computing Approach. Although the cluster-based approach proposed in Chap. 4 is simple, the accuracy of damage detection obtained may not be guaranteed to be comparable with the centralized one. The goal of this chapter is to design a distributed SHM algorithm which is able to achieve the same accuracy as the centralized counterpart but uses much less wireless transmission cost. We believe the proposed schemes in these two chapters can serve as a guideline for designing distributed SHM algorithms in WSNs.

Chapter 6: Realizing Fault-Tolerant SHM in WSNs. It is well recognized that low cost wireless sensor nodes are likely to exhibit different types of faults, leading to downgrades of system performance. Existing fault-tolerance schemes usually cannot work well in SHM applications because SHM applications are generally data intensive. This chapter provides a series of systematic approaches to address the fault-tolerance issues in a WSN-based SHM system.

Chapter 7: Conclusion and Future Trends. This chapter provides the conclusions of this book.

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