A New Type of Intelligent Wireless Sensing Network for Health Monitoring of Long Span Bridges

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Summary

Structural health monitoring of long span bridges is important for the safety and maintenance of bridges. In this paper, a new type of wireless monitoring network is proposed for monitoring large span bridges. Hardware design and software architecture of the wireless monitoring system are introduced. The wireless monitoring network has a two-level cluster-tree architecture. The software and network architectures proposed emphasize the distributed computational capacity for parallel data processing in the network wireless monitoring network so as to reduce the amount of data transmission. A distributed computing strategy for modal identification of large span bridges is proposed. Numerical example of distribute computing the modal properties of three-span continuous beam illustrates the distributed out-put only modal identification algorithm based on NExT and ERA techniques. The distributed computing strategy can be incorporated into the new wireless monitoring network for automated modal identification of large span bridges.

Keywords: wireless sensing network; intelligent sensor; structural health monitoring; modal identification; ambient vibration.

1. Introduction

With the development of wireless communication, wireless monitoring systems have been proposed to eradicate the extensive lengths of wires in the tethered systems. Some innovative wireless monitoring systems have been proposed in recent years [1-2]. While wireless sensing network provides an economical data acquisition technology for monitoring large size structures, an enormous advantage of the wireless sensor network over their tethered counterparts is its distributed computational resources collocated with the sensor nodes [2-3]. Such resources can be leveraged to allow the sensor to perform its own data interrogation tasks. The ability of wireless sensors to autonomously collect and analyze data has led to these devices being labeled as “smart” sensor [3]. This capability is particularly attractive within the context of SHM for large size structures. Already, some data processing algorithms have been embedded in wireless sensors for autonomous execution [4-6]. However, all these algorithms are typically been performed independently at sensing node, without direct sharing of data between nodes of a wireless sensing network. These relative simple algorithms are not sufficient for structural identification and damage detection of large span bridges.

In this paper, a new type of wireless sensing units and sensor network is proposed for the heath monitoring of large-size structures. Hardware design and software architecture of the wireless monitoring system are introduced. The sensor network has a two-level cluster-tree architecture with Zigbee communication protocol built on IEEE802.15.4 wireless communication standard. The communication of sensing nodes in a cluster with the cluster head forms the lower level while the communication between the cluster heads forms the upper level [7]. Each cluster head in the network is embedded with some computational algorithm, granting the wireless monitoring network with intelligent characteristics. The software and network architectures proposed emphasize parallel

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