Mobile Agent Computing Paradigm for Building a Flexible Structural Health Monitoring Sensor Network

Bo Chen*
Department of Mechanical Engineering—Engineering Mechanics, Department of Electrical and Computer Engineering, Michigan Technological University, Houghton, MI, USA

&

Wenjia Liu
Department of Electrical and Computer Engineering, Michigan Technological University, Houghton, MI, USA

Abstract: Wireless structural health monitoring research has drawn great attention in recent years from various research groups. While sensor network approach is a feasible solution for structural health monitoring, the design of wireless sensor networks presents a number of challenges, such as adaptability and the limited communication bandwidth. To address these challenges, we explore the mobile agent approach to enhance the flexibility and reduce raw data transmission in wireless structural health monitoring sensor networks. An integrated wireless sensor network consisting of a mobile agent-based network middleware and distributed high computational power sensor nodes is developed. These embedded computer-based high computational power sensor nodes include Linux operating system, integrate with open source numerical libraries, and connect to multimodality sensors to support both active and passive sensing. The mobile agent middleware is built on a mobile agent system called Mobile-C. The mobile agent middleware allows a sensor network moving computational programs to the data source. With mobile agent middleware, a sensor network is able to adopt newly developed diagnosis algorithms and make adjustment in response to operational or task changes. The presented mobile agent approach has been validated for structural damage diagnosis using a scaled steel bridge.

1 INTRODUCTION

Structural health monitoring (SHM) is an emerging technology in civil, mechanical, and aerospace engineering to detect damage in structures (He et al., 2008; Li and Wu, 2008; Moaveni et al., 2008; Psimoulis and Stiros, 2008; Sohn et al., 2008). The SHM process typically involves the observation of the dynamic response of a structure from a group of sensors, the extraction of damage-sensitive features from these measurements, and analysis of these features to determine the current state of the structure (Kolakowski, 2007). Because the structural damage is an intrinsically local phenomenon, responses from sensors close to the damaged location are expected to be more heavily affected than those far away from the damage site (Nagayama et al., 2009). For complicated structures, a sensor network, with onboard computation and wireless communication capabilities, densely deployed over the entire structure has the potential to provide rich information for effective damage diagnosis and localization.

Although sensor network approach is suitable for SHM, the design of wireless sensor networks presents...