Structural health monitoring

Karthikeyan B. 
karthib011@gmail.com
SRM Institute of Science and Technology, Chennai, Tamil Nadu

Jagatheswaran S. 
jagatheswarans_sa@srmuniv.edu.in
SRM Institute of Science and Technology, Chennai, Tamil Nadu

ABSTRACT

In the past decade, we have seen growing interest in SHM based on wireless sensor networks and the reason for this is the poor installation and expenses of maintenance. WSNs allow a deep deployment of measurement points on an existing structure, facilitating exact and fault-tolerant damage identification techniques without installing a fixed wired infrastructure. We provide a hierarchical decentralized SHM system that executes flexibility-based damage identification and localization. Flexibility-based methods exactly identify and localize damage on a wider range of structures than the previous System, by externally correlating data across various sensors. Our hierarchical system organizes nodes into clusters using a novel multilevel search approach that incrementally activates sensors in the damaged regions, allowing much of the network to remain asleep.

Keywords — WSN (Wireless Sensor Networks), SHM (Structural Health Monitoring)

1. INTRODUCTION

Structural Health Monitoring (SHM) depicts the uniform monitoring of civil and industrial buildings to increase safety and to minimise maintenance costs. The SHM system enhances detail about the alterations in a single part or in the complete structure caused by materials ageing, the reaction of the environment, or accidental moments. SHM systems are created mainly for the purpose of monitoring: humidity, temperature, accelerations, tensile stress, compressive stress, and building materials degradation. All these methods used are non-conventional and require the need for sensors in checkpoints well defined by the experts. The information from the sensors is required to examine the structure safety.

Structural health monitoring data analysis is basically a logical inference problem, wherein we attempt to gain information on the structural state based on sensor responses. These sensors may operate in static and dynamic regimes, depending on the physical principle that is employed in monitoring the structure. Structural health monitoring (SHM) systems are being deployed to collect measurements of structural responses originating from ambient and/or external disturbances and to draw conclusions about the state of health of a structure based on the measurement data.

2. OBJECTIVE

SHM is a vital tool to improve the safety and maintainability of critical structures such as bridges and buildings. SHM provides real-time and accurate information about the structural health condition. It is a process of nondestructive evaluations to detect location and extent of damage, calculate the remaining life, and predict an upcoming accident. SHM has become a challenging task with the increase in development and construction of structures along with the complexities involved in them. The demand for SHM has also increased due to an increase in the necessity to ensure the safety of the structures as well as the human lives associated with it. SHM is capable of detecting the damage early and make it feasible to take action before any loss occurs. Diverse theories have been proposed and implemented to meet distinct requirements of structures. Integration of the diverse theories has helped not only to improve the efficiency and performance of the SHM systems but also to reduce the computational time and costs. In order to share data and ensure reliability, SHM systems use networks.

We begin to coexist and interact with smart interconnected devices that are known as the IoT. IoT brings new opportunities for our society. With the maturity of the IoT, one of the recent challenges in the structural engineering community is the development of the IoT SHM systems that can provide a promising solution for rapid, accurate, and low-cost SHM systems. Moreover, the combination of SHM, cloud computing, and the IoT enabled ubiquitous services and powerful processing of sensing data streams beyond the capability of traditional SHM system. Cloud platform allows the SHM data to be stored and used intelligently for smart monitoring and actuation with smart devices. In this paper, a complete SHM platform embedded with IoT is proposed to detect the size and location of damage in structures.

3. RELATED WORKS

3.1 Review Stage

The intelligent security monitoring of buildings and their surroundings has become increasingly crucial as the number of
high-rise buildings increases. Building structural health monitoring and early warning technology are key components of building safety, the implementation of which remains challenging, and the Internet of things approach provides a new technical measure for addressing this challenge. This article presents a novel integrated information system that combines the Internet of things, building information management, early warning system, and cloud services. Specifically, the system involves an intelligent data box with enhanced connectivity and exchangeability for accessing and integrating the data obtained from distributed heterogeneous sensing devices. An extensible markup language (XML)–based uniform data parsing model is proposed to abstract the various message formats of heterogeneous devices to ensure data integration.

3.2 Applications of IoT
The proposed IoT platform consists of a Wi-Fi module, Raspberry Pi, ADC, DAC, buffer, and PZT. The two piezoelectric sensors are mounted on the structural and connected to a high-speed ADC. In the real case implementation, we will deploy the sensors in a way to catch all the possible damage. A buffer is used as a level conversion and to protect the Raspberry Pi. The Raspberry Pi generated the excitation signal and the DAC converted it to analog. In addition, the Raspberry Pi, using the proposed SHM technique, is used to detect if the structure has damage or not and the location of the damage if it is existing. Moreover, the Raspberry sends the structure health status to the Internet server. The data is stored on the Internet and can be monitored remotely from any mobile device. Moreover, the Internet server sends an alert if there is damage to the structure.

4. SYSTEM ANALYSIS
SHM process incorporates sensors, signal processing, and hardware implementation. Many sensors, for example, accelerometer, ultrasonic, laser, vibration, camera, fiber optical, and piezoelectric have been used. Terrestrial Laser Scanning (TLS) technique uses a laser sensor to get the three-dimensional coordinates of the target structure and monitor its health. Laser Doppler velocity meter is also used in SHM using noncontact and low-frequency lamb-wave detection. The detection of the structural damage can be made more robust by using a triaxial, multiposition scanning laser vibrometer. A displacement measurement model has been incorporated with it to reduce the error of TLS by using linear variable displacement transducer (LVDT), electric strain gages, and long-gage fiber optic sensor. To monitor the structural health, a 3D finite element model takes the periodic measurement of the deformation structure and performs inverse structural analysis with the measured 3D displacements.
4.5 Existing System
- Each unit has its own monitoring section.
- More life losses and destroy historical structure easily.
- Highly expensive

4.6 Disadvantages
- Manual operation
- More life loss
- Take more time.
- Less reliability
- Less knowledge about building condition
- Low efficiency
- The higher rate of cost

4.7 Proposed System
- One monitoring section is enough to monitor the whole unit.
- Sensors are used to monitor the health of the structure.
- If the sensor value crosses the threshold level, it will send alert the user.
- And also ON the alert system to intimate to the nearby peoples.

4.8 Advantages of the proposed system
- Wireless sensor network
- We can avoid life losses.
- To save a historical structure
- Highly reliable

5. REFERENCES
[6] Electronic Publication: Digital Object Identifiers (DOIs)