A MEMS BASED SYSTEM FOR MONITORING CRITICAL BUILDINGS

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ABSTRACT: SHM based on wireless sensor networks (WSNs) is been growing technology in current atmosphere. It is due to their low installation and preservation expenses. WSNs are used to allow dense deployment of measurement points on surviving construction structure, facilitating precise and fault tolerant damage identification techniques without installing a fixed wired infrastructure. We introduce a MEMS based SHM system which is used to detect the damage and identify its location. It is flexibility-based damage identification and localization. Flexibility-based methods are accurate identification method and localize damage on a wider range of structures than previous decentralized algorithms based techniques like DLAC, by explicitly correlating data across multiple sensors. In this system nodes are confined into clusters using a novel based multilevel search approach that incrementally enables sensors in the damaged regions, allowing much of the network to remain insensible.

Keywords: MEMS Sensor, Sensor Network, Visual Basics

INTRODUCTION

The design and construction of smart green structures are one of the ultimate challenges to civil engineers now a days. For developing these structures smart structure technology is employed. The smart structure technology is built from innovative sensor and sensor system. Structural Health Monitoring (SHM) represents one of main application for newer sensor technology. The main function of Structural Health Monitoring (SHM) is to provide a information about continuous monitoring structural strength and promptly identify damages. For this, civil engineer needs to observe and monitor continuously the onset of damage of structural health, long term degradation and assessment of structural integrity.

Smart sensor with embedded system and wireless communication can evaluate changes in buildings effectively. Smart sensor is effective device which is useful to get information from object and transmits the signal to main system. The size of smart sensor is decreased with time. MEMS devices are developed using very large scale integration technology (VLSI) and can represent both mechanical and electrical functions. SHM systems are expensive, because of the high accuracy and sensitivity required by the sensors.

The main area of SHM process is feature extraction and compression. Feature extraction method is based on correlating measured system quantities. After extracting feature, data compression is to performed.

In this project we introduce MEMS based SHM monitoring system for critical buildings based on low cost MEMS sensors. Temperature
sensor, Humidity sensor and Ultrasonic sensors are generally used for consumer applications. These sensors play vital role in this project.

The accuracy and efficiency is improved using signal processing pipeline. The monitoring the building in real time applications improves the safety to the public. The ability to monitor damage at initial stage may reduce the cost of the project and repairing period. All sensors are synchronized to each other which leads to deeper analyses of different parameter such as strength of the structure, frequency of the building, stiffness and etc. To investigate both internal and external damage, a dense array of sensors are employed for dense areas. Dense array sensors are designed to be scalable which does not degrade the performance of the system. The system using wireless approach leads the low cost and high efficiency.

**SYSTEM CONFIGURATION**

1. **PIC MICROCONTROLLER**
   PIC microcontroller is the powerful and easy to programmable microcontroller which is fabricated in CMOS. It has separate bus for instruction and data which is allowing simultaneous operation of accessing program and data memory.

   In this paper we used PIC16F877A microcontroller which is built with flash technology, so that data is retained even when the power is switched off. PIC 16F877A has 256 bytes EEPROM data memory and self programming.

2. **MEMS 3 AXIS ACCELEROMETER SENSOR**
   It is Micro-Electro-Mechanical Systems which is used to measure acceleration and force. Most commonly used accelerometer is piezoelectric accelerometer which is capacitive type. This sensor measures acceleration with a minimum full-swing scale of ±3 g.

3. **TEMPERATURE SENSOR**
   Temperature sensor plays a vital role in this paper. Temperature sensor circuit must be reliable over expected operating temperature point. It monitors the ambient temperature and the notify the system. When temperature threshold range is exceeded measurement actions must be taken by the system.

4. **GAS SENSOR**
   Gas leak detection is the process of identifying gas leakage by sensors. Gas sensor senses LPG, methane, alcohol, Hydrogen, smoke and so on. As detector measures the specified threshold level, the sensor responses to the system. Carbon dioxide sensors are installed into buildings as part of this system. In this project gas monitors and alarms play important role.

5. **ULTRASONIC SENSOR**
   Ultrasonic sensor is a device which is used to measure distance to an object by using ultrasonic waves. It measures the distance by sending out a ultrasonic wave at a specific frequency and receives the wave bounces back from the target. Since it is possible to calculate the distance between sensor and object, the accuracy of the sensor depends on temperature and humidity of the air.
6. HUMIDITY SENSOR

Humidity is defined as amount of water present in the air. Controlling and sensing humidity is important in industrial and domestic applications. Capacitive RH sensor is made from air filled capacitor as moisture in the atmosphere. The spaces between capacitor plates is filled with dielectric material whose dielectric constant varies when it is subjected to change in humidity.

7. RF TRANSMITTER & RECEIVER

The RF module comprises of RF transmitter and RF receiver. Its operating frequency is 434MHZ. Transmitter-434 receives serial data and transmits it wirelessly through RF and Receiver-434 receives the transmitted data at same frequency of RF transmitter. The RF module composes pair of encoder and decoder. The encoder is encoding the data for transmission and it is decoded by decoder.

HARDWARE DESIGN

PIC Microcontroller acts as a control unit for the entire system. It usually acts as the interface for all these sensors. The WSNs are programmed to sense and transfer the data when the pulsation due to a seismic event...
exceeds over predefined threshold value, which is considered harmful for the building. When such an event occurs, the sensor module wakes up and transmit data to the base station.

The data thus obtained at each node is observed on the controller. The data from the node is sent over radio link to the base station VB is used to interface the COM port to which the wireless module is connected at the base station. Based on the received data the VB displays the crack detected.

**OUTPUT OF THE SYSTEM**

**SOFTWARE**

1. **EMBEDDED C**

Looking around in this modern world, many electronic gadget has some kind of processor which is functioning inside it. Each processor is associated with embedded C software. In the
embedded hardware, embedded processor acts as main part, and embedded software acts as supporting part. In this process the embedded software maps the functioning of embedded systems and its function.

2. VISUAL BASIC
Microsoft intended Visual Basic is easy to learn and use. Visual Basic was built from BASIC and empowers the Rapid Application Development (RAD) of Graphical User Interface (GUI) applications, access to databases using Data Access Objects, Remote Data Objects, or ActiveX Data Objects, and creation of ActiveX controls and objects.

RESULTS AND CONCLUSION

RESULTS
Software was used for better visualization of the vibration effects on accelerometer. It gives accurate real time plots for different acceleration values. The graph is obtained by connecting serial port data in real time user. The change in acceleration in each axis could be clearly observed in the plots obtained. For each change in vibration applied corresponding changes were observed in the real time plots. Commands were sent from base station to switch to desired node for graphical analysis of the selected node. The switching action was successfully executed and the plot for the selected node was obtained.

CONCLUSION
All the sensor was used for studying certain cracks and flaws in buildings and the corresponding responses received on the software interface in VB. The Ultrasonic sensor system has been found out to be a powerful tool in detecting the presence of cracks and flaws in a structure. Real time structural health monitoring of buildings will improve their reliability and safety and also reduce the maintenance time and cost. The project is cost effective and could be useful in realtime applications and for different types of materials and locations.

FUTURE SCOPE
The future work of SHM is to analyse the data through android mobile applications, the process of analyzing various physical parameters of the buildings make the things complicated in mobile applications.

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