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GeomorphologicVigor Monitoring using Smart Wireless Sensor Network

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Abstract—. Major Damage to the building is usually caused by the natural calamities. But there are various other factors which can cause damage to the buildings like Erosion, Earthquake, Violence, Fire and Lack of maintenance. But now a days due to minor earth vibrations and its effects minor undetectable defects are caused to a building, which can magnify with passing time. Hence it is necessary to monitor the minute vibrations and the slope of the building surface to avoid the disaster. In this paper we propose a system which addresses this problem by SHM (structural health monitoring) techniques using MEMS based technologies, which are expected to realize huge and dense sensor network for structures are reported. Hereby the help of Wireless Sensor Network (WSN) Using this technique, monitoring of large structures in civil engineering becomes very efficient including the sensing of temperature, n moisture, strain and other data continuously.

Index Terms— SHM (Structural health monitoring),WSN (Wireless sensor network), MEMS (Micro-Electro-Mechanical-Systems)

1 INTRODUCTION

THE importance of monitoring the health of civil structures has gained considerable attention over the past two decades. Structural health monitoring (SHM) systems have excellent potential to improve the regular operation and maintenance of structures such as bridges, tunnels, buildings, and dams. Through the high level of research interests and activities in structural health monitoring (SHM) in the world, the concept of SHM is incorporated into bridges by installing a lot of sensors. Existing monitoring systems use traditional wired sensors technologies and several other devices that are time consuming to install and relatively expensive as compare to value of the structure. Typically they are using a large number of sensors (i.e. more than ten) which are connected through long cables and will therefore be installed only on few structures. A wireless monitoring system with MEMS sensors could reduce cost significantly. MEMS are small integrated devices or systems combining electrical and mechanical components that could be produced for 50 euro each. Therefore, there is a strong need to establish objective and effective SHM techniques for existing bridges. Deterioration or damage of a structure leads to the change of stiffness or mass. The change appears in dynamic characteristics such as natural frequency of the structure. Therefore, vibration based SHM is quite effective. SHM techniques using MEMS based technologies, which are expected to realize huge and dense sensor network for structures, are reported; a new wireless accelerometer based on MEMS technology was applied to field measurements of bridges. Recently there has been much interest in the use of wireless transceivers to transmit sensor data without the use of cables in order to address the costs and inconvenience of disturbed cable based sensor networks. The wireless bridge monitoring system developed in this study has been designed specifically as a tool to address the immediate needs of short term monitoring through strain based load rating with the advantage of complementary measurement of dynamic properties and modal analysis, while satisfying the anticipated needs of a concurrently developing distributed bridge management system for long term vibration based monitoring. MEMS technologies are well suited to improve the performance, size, and cost of sensing systems. MEMS can be used in both monitoring and testing of transportation infrastructure systems. Several applications of MEMS in bridge engineering field are reported. Differential settlement between bridges and pavements causes bumps or uneven joints at the bridge ends. When vehicles, especially heavy trucks, approach and leave bridges, the bumps cause large impact loads to the bridge and pavements. To automatically adjust forces among the bearings, system adopted a two-way memory effect of shape memory alloy (SMA) material to make SMA actuators that can rise and fall to adjust their heights. SMA can also be used to manufacture smart strands. The application of smart bearings and smart strands can be used to develop a smart bridge

The smart bearings will adjust their heights through the shape memory effect of the SMA. This height adjustment will correct the unevenness problems as well as internal forces induced from differential settlements, time dependent deformations, and temperature changes. The pre stress forces can also be adjusted to deal with cracking issues in both positive and negative moment zones. With the combined application of the smart bearings and smart stands, the bridge can adjust its internal force distribution and mobilized each element to adopt itself to different environmental loads.

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This paper is further organized as follows. In section- 2, the Geomorphologic Vigor Monitoring system is described. In section -3, the salient features of the proposed system and various advantages are described. We finally conclude this paper in section- 4.

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2. GEOMORPHOLOGIC VIGOR MONITORING

2.1 Design And Architecture

The proposed system consists of the following components.

1. Wireless Sensor networks (WSN),
2. Microcontroller unit.
3. Communication layer.
4. Monitoring unit

2.2 HARDWARES

A. MEMS Accelerometer
B. FSR Sensor
C. IEEE 802.15.4RF Transceiver
D. PIC18f45J11Microcontroller
E. 16*2 LCD
F. GSM Modem
G. LED Indicator
H. Buzzer

2.1.1 Wireless Sensors Network

MEMS Accelerometer- Existing monitoring systems use traditional wired sensors technologies and several other devices that are time consuming to install and relatively expensive as compare to value of the structure. Typically they are using a large number of sensors (i.e. more than ten) which are connected through long cables and will therefore be installed only on few structures. A wireless monitoring system with MEMS sensors could reduce cost significantly. MEMS are small integrated devices or system

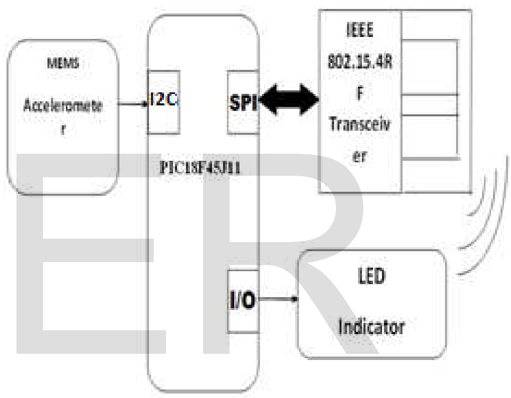

Fig-1 IEE802.15.4 Network 2.4GHz

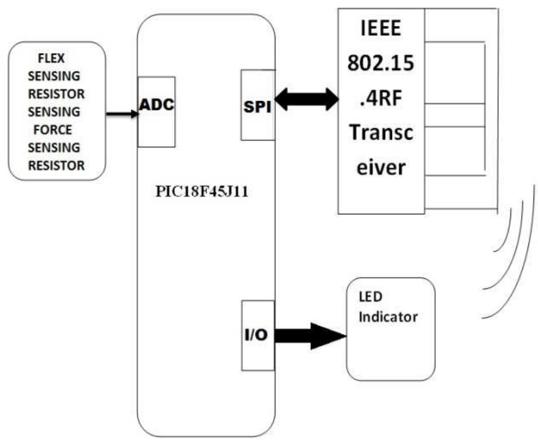

Fig-2.IEE802.15.4 Network 2.4 GHz

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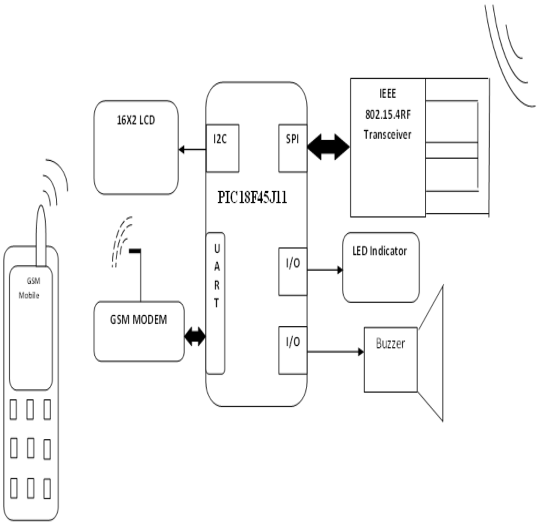

Fig-3.Block diagram of geomorphologic vigor monitoring system

Combining electrical and mechanical components that could be produced for 50 euro each in this system various MEMS sensors such as the MEMS accelerometers and pressure sensors used to monitor the vibration and loads on bridges. A wireless MEMS sensor network using radio frequency transmission technique for large structural monitoring is developed. This wireless monitoring system with MEMS sensors could reduce installation and maintenance cost dramatically. This system has a series of wireless accelerometers embedded into the pavement on the bridge. These low cost accelerometers continuously measure the acceleration of the bridge in axis and wirelessly send the data to data collection center. The acceleration data are then analyzed to obtain bridge and load conditions.

Force Sensing Resistors (FSR) are a polymer thick film (PTF) device which exhibits a decrease in resistance with an increase in the force applied to the active surface and sensitivity is fed to the microcontroller unit.

2.1.2. Microcontroller Unit.

This unit consist of an ADC (Analog To Digital Converter) as major part, which converts analog signal received by MEMS accelerometer and FSR sensors and analyzed by the microcontroller. This analyzed data is fed to the IEEE 802.15.4RF Transceiver .

2.1.3. Communication Layer

It is a major component of the monitoring system. Wireless communication could be unreliable when wireless systems have packet collisions because they use a share trans- mission medium. When the distance between nodes is too far, packets may not reach the destination. If packets carrying measurement data are lost, destination nodes cannot fully reconstruct the sender's data. There- fore, packet loss may cause a system to be in an unknown state and may degrade measurement signals. As SHM requires a great quantity of raw data to measure the state of the structure, it is important to take the scalability of the system into account. If the number of nodes increases, the system has to send large amounts of data over the air.

Each sensor has its own local clock, which is not initially synchronized with the other sensor nodes. Some time synchronization errors can cause inaccuracy in SHM applications. There are two primary sources of jitter: temporal jitter and spatial jitter. Temporal jitter takes place inside a node, and spatial jitter occurs between different nodes due to variation in node oscillator crystals and imperfect time synchronization.

M i-W i P2P Protocol. The M i W i P2P protocol modifies the IEEE 802.15.4 specification's Media Access Control (MAC) layer by adding commands that simplify the handshaking process. It simplifies link disconnection and channel hopping by providing supplementary MAC commands. However, application-specific decisions, such as when to perform an energy detect scan or when to jump channels, are not defined in the protocol. Those issues are left to the application developer.

2.1.4. Monitoring Unit

Monitoring unit Proposed in this paper consist of 16X2LCD (Liquid Cristal Display), LED Indicator, Buzzer and GSM Modem. LCD displays the structural health fed by the microcontroller.

GSM Modem In the absence of monitor, the data of structural health is been send to that monitor

In this paper, a complete wireless system for structural identification under environmental load is presented. Our contribution ranges from the hardware to the graphical front end. This system places special attention on avoiding the main limitations of WN for SHM particularly focusing on reliability, scalability, and synchronization.

3. FEATURES AND ADVANTAGES OF PROPOSED SYSTEM

In the current situation the number of sensor used are large in numbers, the number of sensors increases with the dimensions of the structure in question. A huge civil structure spans across several hundred meter in dimension, hence the system requirements goes up. The proposed paper focuses on reduction of the sensor quantity. Less numbers of sensors makes the system more manageable in terms of system complexity and economically more efficient. This proposed system will reduce the establishment cost. It is perfectly compatible with large civil structure such as bridges, dams, tunnels e t c. Accuracy

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of the proposed system enhances the durability of structural health. The data optimized by the proposed system will be analyzed quickly and hence further decision is sent to the monitor. This work has three main contributions. To meet the necessary requirements in order to obtain quality data of real scientific value for civil engineering developers , to allow for a system with enough nodes to measure real-world structures. And to provide reliable and lossless communications over a large network with minimal overhead.

4. CONCLUSION

The proposed system is significantly capable to structural health of the civil structure over large scale. Using wireless network, the optimized data through MEMS sensor and FSR sensors, is analyzed accurately. Thus the further structural health is maintained safely. Thus the priceless and accurate monitoring of structural health of bridges, dams and tunnels will be possibly analyzed using this proposed system

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