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STRUCTURAL HEALTH MONITORING USING WIRELESS NETWORK

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Abstract**—** Structural Health Monitoring System (SHM) has been used to monitor the critical buildings to improve structure lifespan and improve public safety. In this system, sensors are embedded into a structure and required information such as vibrations; displacement, moisture and temperature are measured with the help of respective sensors. The sensed information can be sent via short message service (SMS) through the Global System for Mobile Communication (GSM) network at the same time buzzer in the building creates the warning alarm. This system has an ability to reduce the costs associated with the installation and maintenance of SHM systems.

Keywords -- Wireless sensor networks, Structural health monitoring, Sensor placement, Scalability, Energy harvesting, Mobile phone sensing, Global System for Mobile Communication (GSM).

I. INTRODUCTION

Structural Health Monitoring is estimating the state of the structural health, or detecting the changes in structure that affects performance. Two major factors are time scale of change and severity is the degree of changes in the SHM system. In general, SHM requires the installation of a large number of sensors throughout a structure capable of collecting sensed data. The collected data is processed such that decisions about the structure's overall health can be made. This section provides a comprehensive overview of components and processes involved in SHM using WSN. This section begins with an over view of commonly sensed structure health parameters and then overview of the type of sensors used. Wireless sensor network for structural health monitoring gives an advantage of low cost and ease of deployment. In typical WSN based SHM system, sensors are deployed on different locations of the structure to collect the structure responses and ambient or forced excitation. These data are then transmitted wirelessly to a server(Microcontroller) where the program is implemented to extract vibration characteristics. This system has attracted increased attention. Wireless sensor network is consisting of number of nodes. The sensor nodes in a sensor network are capable of collecting information and communicate with other connected nodes in the network. It is also capable of performing some processing parts. Wireless sensor nodes are consisting microcontroller, GSM, power management unit (power source) and one or more sensor. SHM used to measuring the key parameters of the structural and environmental conditions on a continuous base at real time. Wireless sensors are used to monitor physical or environmental conditions like temperature, level of water, acceleration etc. WSN are used for storing and accessing the sensed data. Cheap sensors are able to measure a number of environmental parameters allow continuous monitoring of the environment and real time applications. This system having a collection of sensor nodes and communication system that allows automatic data fetching. It contains sensing enumerate and a communication component. Its aim to give controllers ability to measure, collect and react to occurrences in the monitoring environment. It is like interfaces between the virtual and physical worlds.

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II. BLOCKDIAGRAM

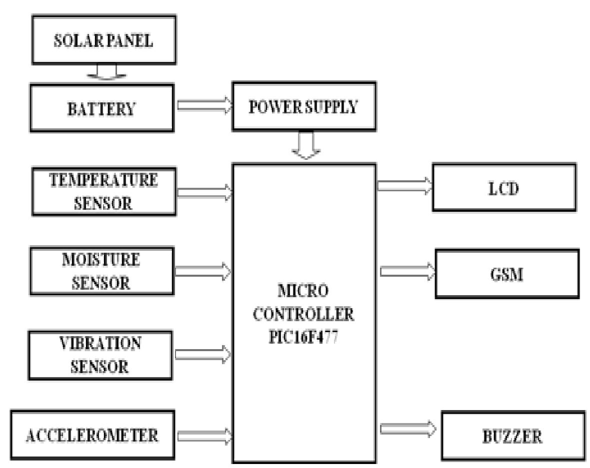

Figure 1

III. MICROCONTROLLER

This powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 40 package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices. The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to Digital(A/D)converter, 2capture/ compare/ PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and a Universal Asynchronous Receiver Transmitter (USART).

Figure 2

The high performance of the PICmicro devices can be attributed to anumber of architectural features commonly found in RISC microprocessors. These include:

- Harvard architecture
- Long Word Instructions
- Single Word Instructions
- Single Cycle Instructions
- Instruction Pipelining
- Reduced Instruction Set
- Register File Architecture
- Orthogonal (Symmetric) Instructions

IV. SOLAR PANEL

Solar panel absorbs sunlight as a source of energy to generate electricity or heat. Photovoltaic (PV) module is a packaged; connect assembly of typically 6×10 photovoltaic solar cells. The solar panel is rated by its DC output power ranges from 100 to 365Watts. Monocrystalline solar panels are more efficient. Solar panel used to produce natural form of electricity to charge the battery in periodical manner. This reduce the usage of current also increase the lifespan of battery without replacement.

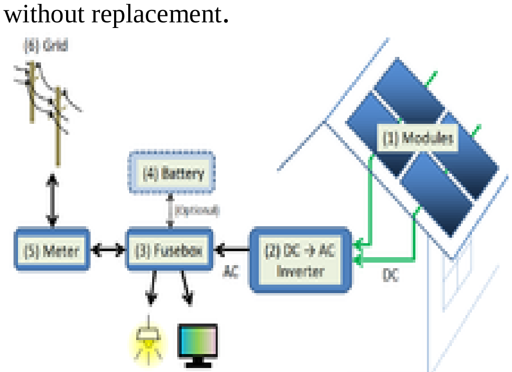

Figure 3

Solar cellsproduce direct current (DC)power, which fluctuates with the intensity of the irradiated light. This usually requires conversion to certain desired voltages or alternating current (AC), which requires the use of the inverters. Multiple solar cells are connected inside the modules. Modules are wired together to form arrays, then tied to inverter, which produces power with the desired voltage, and frequency/phase.

V. TEMPERATURE SENSOR

LM35 can be used to measure temperature with an electrical output comparative to the temperature in C.It generates high output voltage and it has no effect on the medium.It operates from 4V to 20V and ranges from +2˚C to 150̊C. Linear +10 milliVolt per degree Celsius scale factor.Temperature sensor gives an analog output to the microcontroller for measuring temperature level of the building.We are using Thermistor as a sensor to measure temperature. The principle of thermistor is, if the temperature is increases, the internal resistance of the sensor will decrease vice versa.

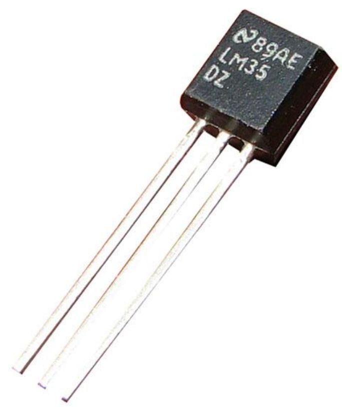

Figure 4

VI. MOISTURE SENSOR

It measures the water content in the soil. The direct gravimetric measurementof free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remotesensing in hydrology and agriculture.Soil moisture sensors typically refer to sensors that estimate volumetric water content.

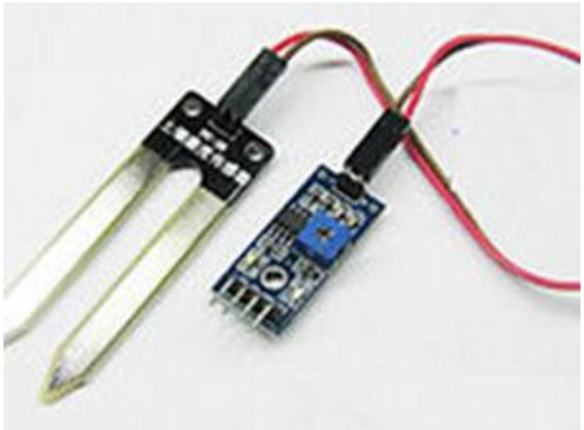

Figure 5

VII. VIBRATION SENSOR

This module features an adjustable potentiometer, a vibration sensor, and a LM393 comparator chip to give an adjustable digital output based on the amount of vibration. The potentiometer can be adjusted to both increase and decrease the sensitivity to the desired amount.

Figure 6

The module outputs a logic level high (VCC) when it is triggered and a low (GND) when it isn't. Additionally there is an onboard LED that turns on when the module is triggered.

VIII. ACCELEROMETER

An accelerometer is a device that measures proper acceleration. Proper acceleration, being the acceleration (or rate of change of velocity) of a body in its own instantaneous rest frame, is not the same as coordinate acceleration, being the acceleration in a fixed coordinate system. For example, an accelerometer at rest on the surface of the Earth will measure an acceleration due to Earth's gravity, straight upwards (by definition) of $g=9.81\ m/s^2$. By contrast, accelerometers in free fall (falling toward the center of the Earth at a rate of about $9.81\ m/s^2$) will measure zero. Accelerometers are electromechanical devices that sense either static or dynamic forces of acceleration. Static forces include gravity, while dynamic forces can include vibrations and movement. Accelerometers can measure acceleration on one, two, or three axes. 3-axis units are becoming more common as the cost of development for them decreases. Accelerometers used for SHM are either Piezoelectric or spring-mass accelerometers. Piezoelectric accelerometers are light, small, and operate over wide acceleration and frequency ranges. On the otherhand, spring-mass accelerometers are relatively bulkyand operate over a limited range of accelerations andfrequencies. However, they are very sensitive to smallaccelerations and provide better resolution than the piezoelectric accelerometer. When the supportingbase undergoes movement, the mass exerts aninertia force on the piezoelectric crystal element. Theexerted force produces a proportional electric charge on the crystal.

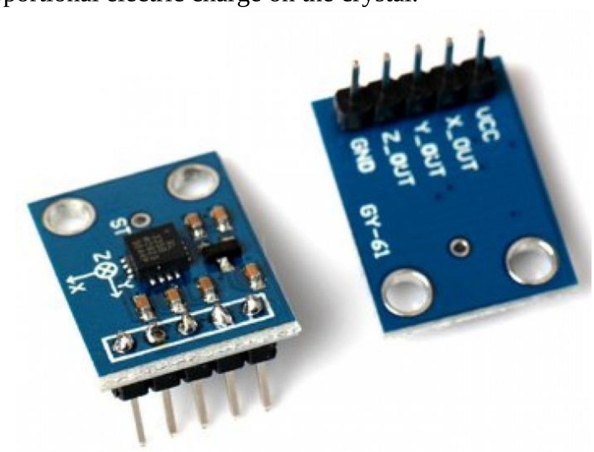

Figure 7

IX. GSM MODEM

A GSM modem is a wireless modem that works with a GSM wireless network. GSM is a cellular network, which means that mobile phones connect to it by searching or cells in the immediate vicinity. GSM networks operate in different frequency ranges. GSM-900 uses 890-915 MHz to send information from the mobile station to the base station (uplink) and 935-960 MHz for the other direction (downlink). 25 MHz band width is subdivided into 124 carrier frequency channels, each spaced 200 KHz apart. The channel data rate is 270.833Kbit/s. GSM has used a variety of voice codec's to squeeze 3.1 kHz audio into between 5.6 and 13 Kbit/s. Originally, two codec's, named after the types of data channel they were allocated, were used, called Half Rate (5.6 Kbit/s) and Full Rate (13 Kbit/s). These used a system based upon linear predictive coding (LPC). In addition to being efficiency with bit rates, these codec's also made it easier to identify more important parts of the audio. There are different sizes in a GSM network such as macro, micro, pico, femto and umbrella cells. The coverage area of each cell varies according to the implementation environment.

Figure 8

X. GSM ARCHITECTURE

The GSM network can be broadly divided into the Mobile Station (MS),The Base Station Subsystem (BSS),The Network Switching Subsystem (NSS),The Operation Support Subsystem (OSS).A simple pictorial view of the GSM architecture.

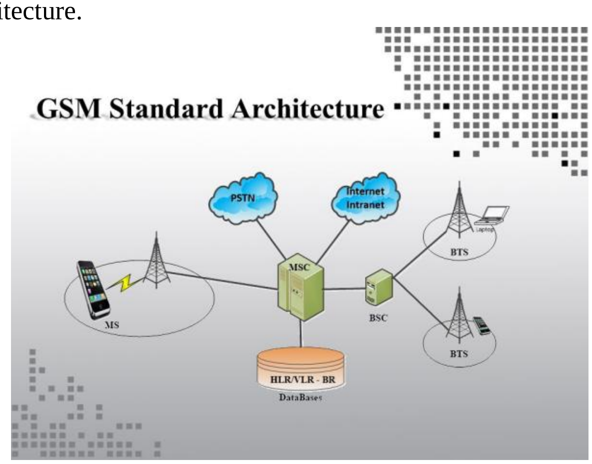

Figure 9

1)Base station:

The base stationsubsystem (BSS) is the section of a traditional cellular telephone network which is responsible for handling traffic and signaling between a mobile phone and the network switching subsystem. The BSS carries out transcoding of speech channels, allocation of radio channels to mobile phones, paging, transmission and reception over the air interface and many other tasks related to the radio network.

2) Mobile station:

A mobile station (MS) comprises all user equipment and software needed for communication with a mobile network. The term refers to the global system connected to the mobile network, i.e. a mobile phone or mobile computer connected using a mobile broadband adapter. This is the terminology of 2G systems like GSM. In 3G systems, a mobile station (MS) is now referred to as user equipment (UE).

3) Network switching:

Network switching subsystem (NSS) (or GSM core network) is the component of a GSM system that carries out call switching and mobility management functions for mobile phonesroaming on the network of base stations. It is owned and deployed by mobile phone operators and allows mobile devices to communicate with each other and telephones in the wider public switched telephone network (PSTN). The architecture contains specific features and functions which are needed because the phones are not fixed in one location.

4) Operations support:

Operations support systems (OSS), or operational support systems in British usage, are computer systems used by telecommunications service providers to manage their networks (e.g., telephone networks). They support management functions such as network inventory, service provisioning, network configuration and fault management. Together with business support systems(BSS), they are used to support various end-to-end telecommunication services. BSS and OSS have their own data and service responsibilities. The two systems together are often abbreviated OSS/BSS, BSS/OSS or simply B/OSS.

5) WORKING

Figure 10

In SHM system the sensors from the various places of the building are used to collect the information about the status of the building through vibration, temperature, moisture and acceleration. Then the collected datas are given to the PIC microcontroller for ensuring the particular level.

In microcontroller coded using embedded that are used to compare the current value of the parameter to the correct value. The deviation produces the safety wanted message. The information from the controller is sent to the user who is the owner of the particular building. Here GSM is used to send the message via mobiles.

XI. CONCLUSION

Structural Monitoring system provides better solution to save the structure of the building using wireless technology. It is the simple and effective technique of finding the current

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status of the building. The detection of damage in the building is done by the sensor network. We can know the problem about the damages at the earlier stages. This also the useful system and provide the ease of installation and maintenance. The method proposed here is used to overcome the problem occurring due to the usage of wired systems. The communication from these devices is more efficient and the result will be more accurate. Structural Health Monitoring system ensures lifespan of the building and public safety.

XII. RESULT

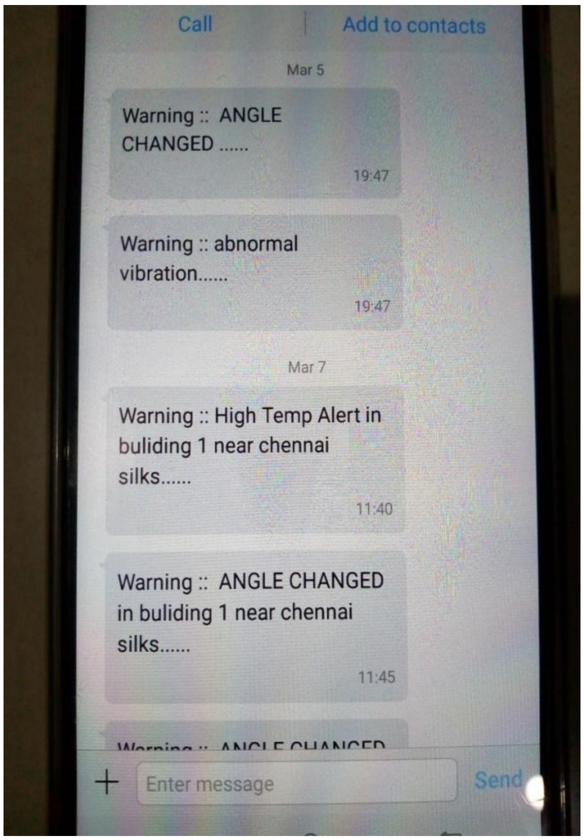

Figure 11

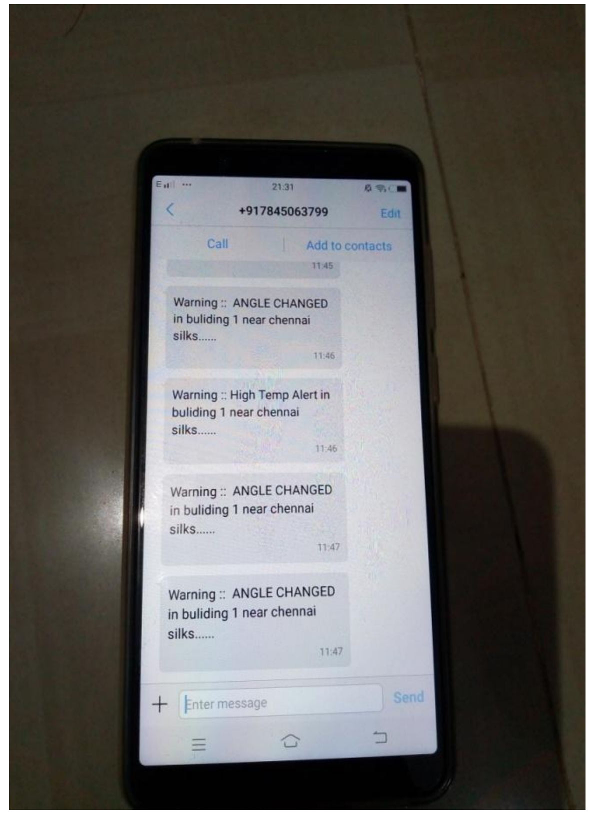

Figure 12

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