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Bridge Condition Monitoring System Using PIC Microcontroller

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Abstract-Advancements in sensor technology have brought the automated real-time bridge health monitoring system. Many long span bridges in Korea and in Japan have adopted this real-time health monitoring system. However, current system uses complicated and high cost wired network amongst sensors in the bridge and high cost optical cable between the bridge and the management center, which increases the overall cost of installation and maintenance cost of health monitoring system. The complicated wiring also makes the installation and repair/replacement process difficult and expensive. In this paper, a new idea of bridge health monitoring systems suggested GSM for long distance (between the bridge and the management center) data communication is tested.

Index Terms- Sensors, GSM (Global System for Mobile communication), Bridge Monitoring System, PIC Microcontroller.

1. INTRODUCTION

It has a technology called MBM (Monitoring Based Maintenance) that enables the bridge Maintenance engineers monitor the condition of the bridge in Real time. The sensors installed on main cables, hangers, Decks, towers, etc. Detect the strain, acceleration, Temperature and wind. The sensory inputs are process to Represent the condition of the bridge against seismic loads And wind loads. Sensor technologies have made the monitoring process more Accurate and fast.GSM technology is suggested to send the data to the remote location in which the maintenance office is located. However, regardless the advancements of the sensor and sensor data processing technologies, there is one thing that has not been changed: data communication is through wires and optical cables . The advancement in wireless technology has provided motives to the authors to develop the wireless network based bridge health monitoring system. In this research, sensor devices such as accelerometer, strain gauge, thermometer, anemometer and GSM are combined becoming u-node where "u" stands for ubiquitous.

2. LITERATURE SURVEY

As per with the help of the wireless technology many problems due to data cables and expensive optical cable are now minimized and eliminated. Sensor and ZigBee module combined becomes u-node (ubiquitous node). ZigBee is proved to be excellent solution in short distance wireless data communication. For long distance data transferring CDMA which is a mobile phone carrier network in Korea is used instead of optical cable which is expensive in installation and maintenance[1].

A multi-functional wireless bridge monitoring system has been developed for concurrent deployment of accelerometers, strain transducers, and temperature sensors. The hybrid sensing capabilities of these nodes satisfies the immediate requirements for economic, low-maintenance load ratings and short-term dynamic measurements in addition to providing the hardware functionality for development of a long-term continuous bridge monitoring system[2].

3. MODIFICATION

This system includes the GSM module for long & short distance wireless data communication which is mobile phone carrier network[1]. This system Also uses four sensors and interface LCD (Liquid Crystal Display) for displaying output of all sensors[2].

4. TECHNOLOGY

Development of u-node (Sensor + GSM module). The output data from the sensors are in a form of voltage, or resistance, or pulse depending on the type of sensors. The sensory outputs are analog data which needs to be converted into digital form. An A/D converter for each type of sensor is developed in this

research work. Thus, the A/D converter reads analog data from the sensor and deliver the data to the GSM module which sends the data to other the GSM modules wirelessly. A sensor module with the A/D converter and GSM module is called u-node. Development of USN (Ubiquitous Sensor Network) The term USN (or wireless sensor network) is a combination of the wireless communication network and sensor technology. Sensors and network modules are combined into one unit, which often called ubiquitous sensor, and communication network delivers sensor data wirelessly. Accelerometer sensor can measure level of acceleration where it is mounted. For temperature sensing here we use thermometer LM35 sensor. To measure strain here uses Load Cell which convert a force into electrical signal. Anemometer is used to measure the wind speed.

5. BLOCK DIAGRAM

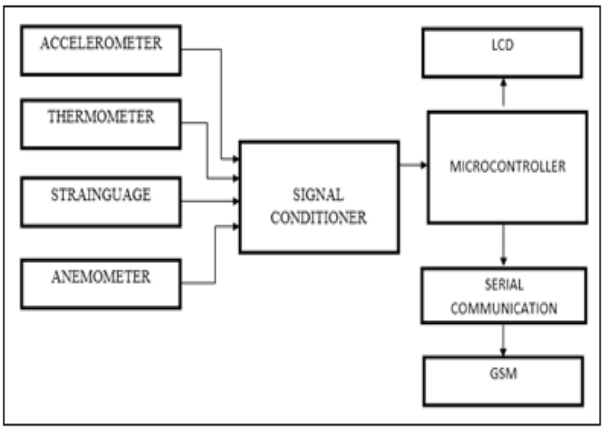

Fig.1 Block Diagram of Bridge Condition Monitoring System.

5.1. Accelerometer:

Accelerometer sensor can measure static(earth gravity) or dynamic acceleration in all three axis. Accelerometer sensor measures level of acceleration where it is mounted this enable us to measure acceleration/deceleration of object like car or robot. accelerometer is used to measure the bridge tilt.

5.2. Thermometer:

The LM35 series are precision integrated-circuit temperature Sensors, whose output voltage is linearly proportional to the Celsius (centigrade) temperature. that it will read 10mv=1count. For example if the ambient temperature is 25 deg the generated output will be 250 mv and after ADC the count will be 25.

5.3. Strain Gauge:

Through a mechanical arrangement, the force being sensed deforms a strain gauge. The strain gauge measures the deformation (strain) as an electrical signal, because the strain changes the effective electrical resistance of the wire. A load cell is a transducer that is used to convert a force into electrical signal.

5.4. Anemometer:

Anemometer is used measure the wind speed. It consists of four hemispherical cups each mounted on one end of four horizontal arms, which in turn were mounted at equal angles to each other on a vertical shaft. The air flow past the cups in any horizontal direction turned the shaft in a manner that was proportional to the wind speed.

5.5. Microcontroller :

5.5.1. PIC16F87XA:

28/40/44-Pin Enhanced Flash Microcontrollers This microcontroller since it has 8 channels of 10bit built in ADC ,35 instruction set , lowest cost. Low-power, high-speed flash/EEPROM Technology, fully static design, wide operating voltage range (2.0V to 5.5v),commercial and industrial temperature ranges, low-power consumption. Special Microcontroller

Self-reprogrammable under software control, In-circuit serial programming™ (ICSP™) Via two pins, Single-supply 5V in-circuit serial programming, Watchdog timer (WDT) with its own on-chip RC Oscillator for reliable operation, Programmable code protection, Power saving sleep mode, Selectable oscillator options, In-circuit debug (ICD) via two pins.

5.6 GSM:

GSM is a standard set developed by the European Telecommunications Standards Institute (ETSI), as a replacement for First Generation (1G) cellular networks. This GSM modem can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Advantage of using this modem will be that you can use its RS232 port to communicate and develop embedded applications. Applications like SMS control, data transfer, remote control and logging can be developed easily. The modem can either be connected to pc serial port directly or to any microcontroller. It can be used to

send and receive SMS or make/receive voice calls. It can also be used in GPRS mode to connect to internet and do many applications for data logging and control. In GPRS mode you can also connect to any remote FTP server and upload files for data logging. This GSM modem is a highly flexible plug and play quad band sim900d GSM modem for direct and easy integration to RS232 applications. Supports features like voice, SMS, data/fax, GPRS and integrated TCP/IP stack. In our project we are using sim900 to send alert SMS to the concerned department.

6. BRIDGE HEALTH MONITORING MODULE

The accelerometer, thermometer, strain gauge & anemometer are the sensors which sense bridge conditions these are interface using PIC microcontroller .If there is any changes of bridge parameters sensors sense it & send information to control room by using GSM network which is mobile network .It is also display these parameters on the LCD. It consists of PIC microcontroller,

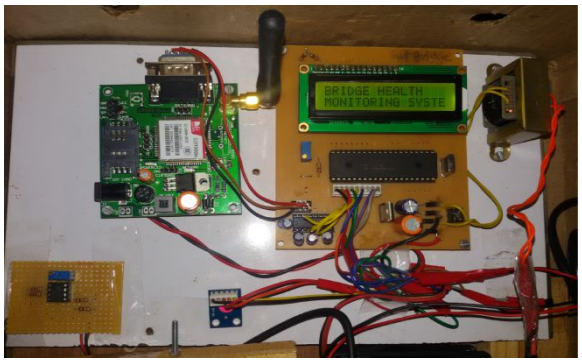

Fig.2 Kit of Bridge Health Monitoring System

GSM module, display, sensors, power supply. Figure 2 shows the kit of bridge health monitoring system. The process of implementing a damage detection and characterization strategy for engineering structures is referred to as Structural Health Monitoring (SHM). Here damage is defined as changes to the material and/or geometric properties of a structural system, including changes to the boundary conditions and system connectivity, which adversely affect the system's performance.

7. EXPERIMENT RESULT

Fig.3 Initial Condition Of The Bridge System

This display roll is main of the system. Display shows the message is bridge health monitoring system. It can be used for structural health, bridge safety, damage detection. Figure shows the display in initial condition of bridge monitoring system.

Fig.4 Display Shows The Value Of Different Sensors

TM- Temperature sensor, TLT- accelerometer sensor, STR- strain gauge sensor,WS- wind speed. There are four sensors are available in this system & such as temperature sensor (LM35), tilt sensor (Accelerometer), strain gauge (load cell), wind speed sensor (anemometer). Figure 4 shows the next operation of the health system. After initial condition this display shows the output values of sensors. It is used to show for changes to the material and/or geometric properties of a structural system, including changes to the boundary conditions, which adversely affect the system's performance.

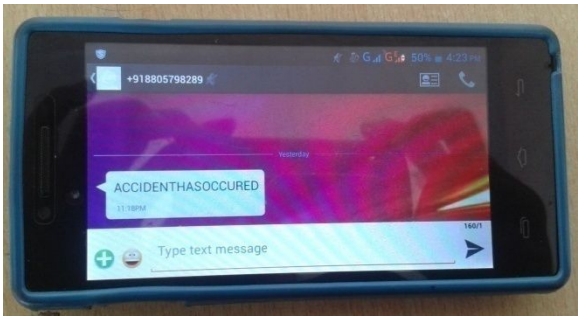

Fig.5 Shows The Output Message Of The GSM Network On Mobile.

On the mobile we get the message when accident or any damage of the bridge is occurred through the GSM network. The message is shown in fig. the message is like "ACCIDENT OCCURED" . This information provide to maintenance department of

engineers. After taken information of message they take action quickly against it.

8. APPLICATIONS

1. It is used to find out the mechanical strain on the bridge.
2. It is used to measure the bridge tilt.
3. It is used to read ambient temperature.
4. It can be used for structural health, bridge safety, damage detection.
5. The wireless sensor system enables remote damage detection and structural health monitoring for bridges and other structures.
6. It detects steel corrosion and concrete deterioration.
7. It can avoid accidents caused by the extreme weather conditions.
8. It is useful for monitoring the faults of bridge occurred.
9. It has a technology called MBM (Monitoring Based Maintenance) that enables the bridge maintenance engineers monitor the condition of the bridge in real time.
10. It reduces the huge complications because of wireless connections.
11. Current system use easy and low cost wired network amongst sensors in the bridge.
12. Low cost wireless network between the bridge and the management center, which decreases the overall cost of installation and maintenance cost of health monitoring system.

9. CONCLUSION

A multi-functional wireless bridge monitoring system has been developed for concurrent deployment of accelerometers, strain transducers, temperature sensors and anemometer. The sensing capabilities of these nodes satisfies the immediate requirements for economic, low-maintenance load ratings and short-term dynamic measurements in addition to providing the hardware functionality for development of a long-term continuous bridge monitoring system. Extensive laboratory and field testing and development has been performed to produce a reliable radio transmission protocol capable of sustaining a large number of nodes with high data throughput in real-time. Field deployments have verified the ability of the system to capture natural frequencies and construct clear modes shapes even for a relatively stiff bridge. The ability of this wireless sensor network to replicate the performance of cable-based deployments, in terms of number of sensors and sampling rates as well as successful data analysis, signals a breakthrough in wireless sensor network development. Such emerging technology is now capable of performing the bridge monitoring tasks that have been highly proposed and promised, though seldom demonstrated.

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