Bridge Health Monitoring and Controlling System

Mankar Amol[1], Nagare Amit[2], Gaikwad Rohit[3], Sonawane Parag[4], Jadhav Swapnil[5]
[1, 2, 3, 4, 5] Dept of E & TC
[1, 2, 3, 4, 5] Savitribai Phule Pune University, Nashik, Maharashtra, India

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. Bridge health monitoring systems suggested GSM for long distance (between the bridge and the management centre) data communication is tested. This project focuses on pre-emption system for infrastructure like bridges. The stability of the structure is directly related to the structural strength. The structural analysis of such a bridge can be analysed using vibration pattern and comprehensive study. MEMS based accelerometer is used to analyse the vibration patterns. The vibration signal measured by the node I communicated over WSN. Three levels of vibrations are detected. If the vibrations are in Safe level no action is taken. If the vibrations are in warning level a signal is sent to the monitoring person through RF. If the vibrations are in critical level then the bridge is closed for traffic.*

Keywords- GSM, WSN, MEMS

I. 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. Wi-Fi 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. A wireless monitoring system with MEMS sensors could reduce cost significantly.

Modification -This system includes the Wi-Fi module for long & short distance wireless data communication which is mobile phone carrier network [1]. This system also uses three sensors and interface LCD (Liquid Crystal Display) for displaying output of all sensors [2] and it will show the same message of sensors on android mobile app.

II. METHODS AND MATERIAL

A. Proposed Methodology

The proposed methodology is consist of mainly microcontroller ,ULN, Relays and various sensors for measuring the various parameters like ; if the water level across the bridge exceeds the red line then water level sensor which is interfaced with microcontroller senses it. Due to overloading, ageing and climatic changes strength of material reduces and it leads to vibration in bridges at this instant vibration sensor which is interfaced with microcontroller senses those vibrations. Due to internal structural damages shape of the bridge is slightly inclined or bends over .This bending parameter sensed by flex sensor which is interfaced with microcontroller. All the signals from these sensors will get signal conditioned and the according to programming the data will get send to the controller through the Wi-Fi module. And according to signals the controller will take his actions.

B. Working

Below figure 1 shows the functional block diagram of Bridge Health Monitoring System. For overcoming from environmental flood disasters and physical damages structural damages in bridges we brought technology. The total interfacing is shown in figure above. The operation of bridge Health monitoring system is totally based on sensors. In this system we have used three types of sensors. Water Level Sensor, Flex Sensor, Vibration Sensor. If the water level across the bridge exceeds the red line then water level sensor which is interfaced with microcontroller senses it. Due to overloading, ageing and climatic changes strength of material reduces and it leads to vibration in bridges at this instant vibration sensor which is interfaced with microcontroller senses those vibrations. Due to internal structural damages shape of the bridge is slightly inclined or bend over .This

bending parameter sensed by flex sensor which is interfaced with microcontroller.

PIC F877A Microcontroller IC gives instructions to LCD 16*2 Display and ULN 2803 Driver IC Which is interfaced with pic Microcontroller LCD display shows the bypass root indication .We have also interfaced two dc gear motor through relay1, relay2, relay3 ,relay4 to ULN 2803 Driver IC which drives it. Here one dc motor is used for opening and closingof bridge and second dc motor is used for bridge gate open close control and Red, Green LED indicates signals on those roots which are coming towards bridges.

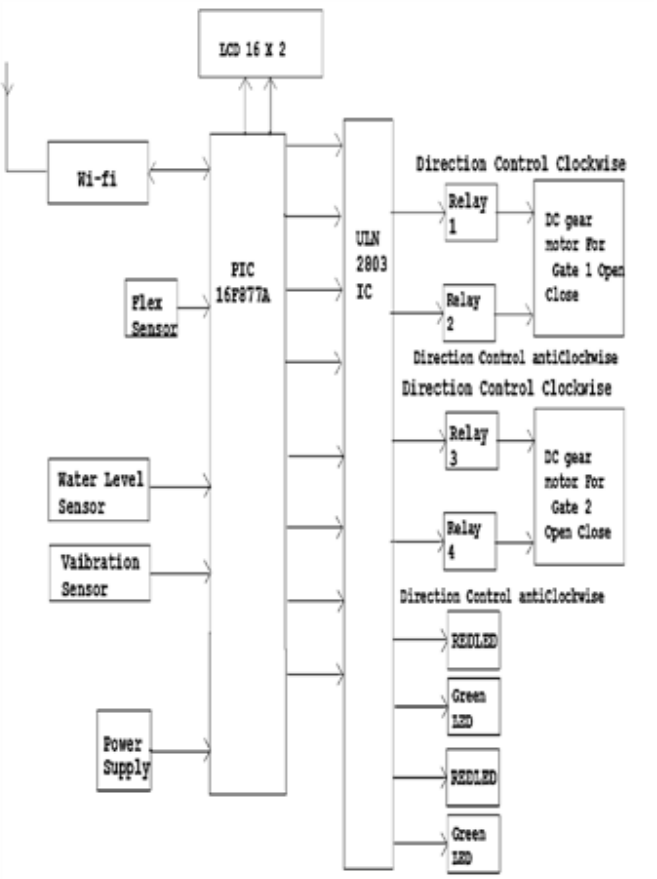

Fig 1. Block Diagram

Below is the flow diagram of our system.The flowchart shows the working of the system in short.

Algorithm

1. Start
2. Initialize lcd, timer,interrupt,wifi gate ,sensor
3. Check fault
4. If vibration sensor =1; display on lcd vibration is detected ;red led on,green led off; gate1 closed (delay)gate2 closed. if vibration sensor=0; check next fault.
5. If flood sensor =1; display on lcd flood is detected ;red led on,green led off;gate1 closed (delay)gate2 closed. if flood sensor=0; check next fault.
6. If Tilt sensor =1; display on lcd vibration is detected;red led on,green led off ;gate1 closed (delay)gate2 closed. if Tilt sensor=0; check next fault.
7. If no fault is detected;display on lcd system is healthy; red led off ,green led on ; gate1 open,gate2 open.
8. Goto step 4
9. End

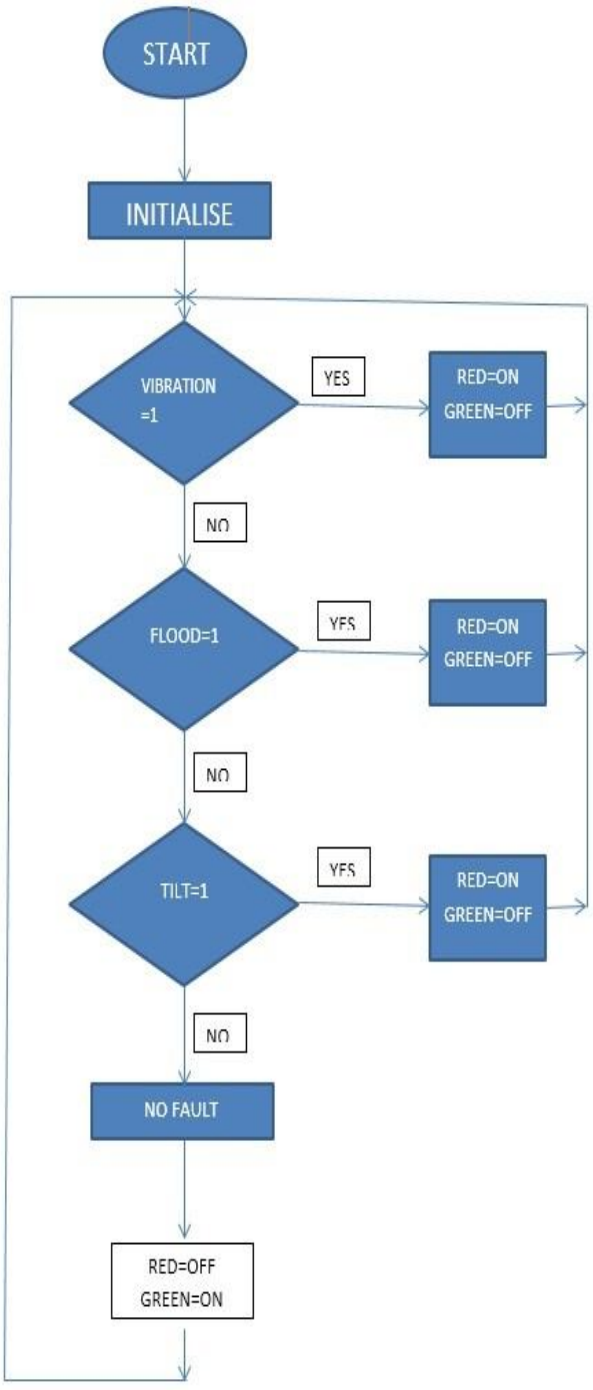

Fig 2. Flowchart

III. RESULTS AND DECLARATION

This is the working prototype of our developed system.We have also tested our system on Android App Simple Socket Tester. The results of the same is shown below.

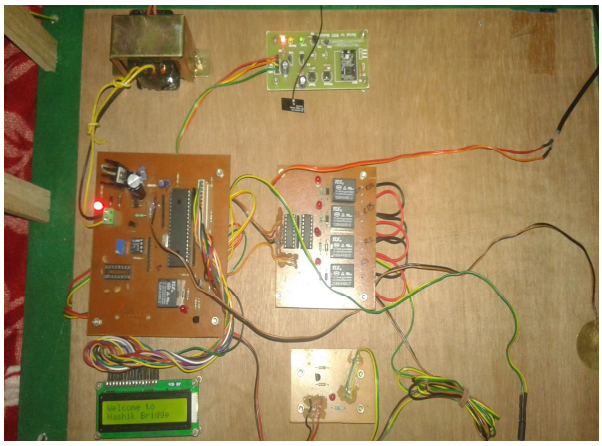

Fig 3. Kit of Bridge Health Monitoring System.

It shows the error detected on the system i.e. Earthquake, Tilting of the Bridge and Vibration on the bridge**.**

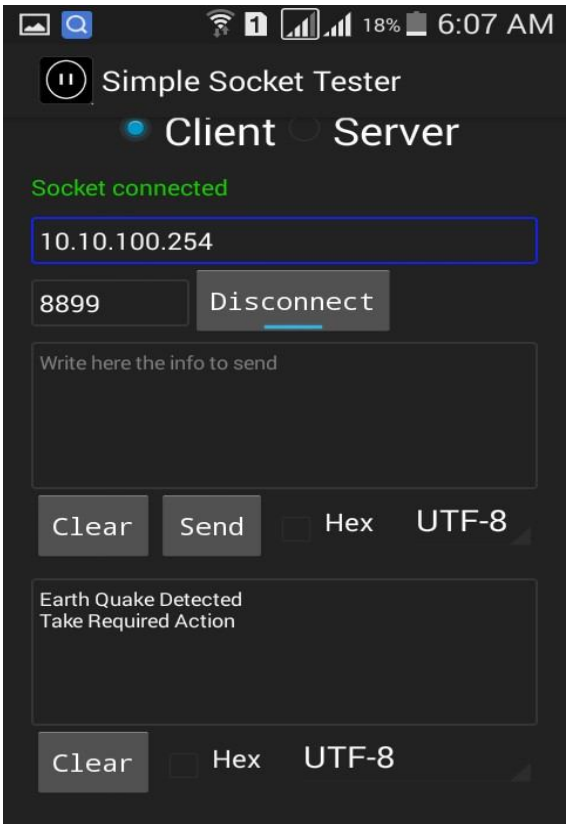

Fig 4. The Output Message of the Wi-Fi Network on Mobile.

IV. 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.

V. CONCLUSION

A multi-functional wireless bridge monitoring system has been developed for concurrent development 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. The result is also shown on Android Mobile App.

REFERENCES

[1] Vinodini R, Nalini S, Muthumurugesan D, Assistant Professor, Anna University, Thiruchirappalli,Detection Of Structural Damages In Bridge Based On ZigBee Networks Using Sensors.

[2] F. Cerda, J. Garrett, J. Bielak, R. Bhagavatula, and J. Kovaevi, ”Exploring indirect vehiclebridge interaction for bridge SHM,” Proc. International Conference Bridge Maintenance, Safety Management, Philadelphia, PA, Jul. 2010.

[3] Manoranjani.S , Lavanya.S , Lakshmi Priya.A U.G Students,, Raja College of Engineering and Technology, Madurai, Tamilnadu, (India),Detection and monitoring of Bridge Health Status.

[4] F. Cerda, J. Garrett, J. Bielak, P. Rizzo, J. A. Barrera, Z. Zhang, S. Chen, M. McCann, and J. Kovaevi, ”Indirect structural health monitoring in bridges: scale experiments,” Proc. Int. Conf. Bridge Maint., Safety Manag., Lago di Como, Italy, Jul. 2012.

[5] S. Chen, F. Cerda, J. Guo, J. B. Harley, Q. Shi, P. Rizzo, J. Bielak, J. H. Garrett and J.Kovaevi, ”Multiresolution classification with semi-supervised learning for indirect bridge structure health monitoring,” Proc. IEEE Int. Conf. Acoust., Speech Signal Process., Vancouver, Canada, May 2013, pp. 3412-3416 .

[6] Z. Wang, S. Chen, G.Lederman, F. Cerda, J. Bielak, J. H. Garrett, P. Rizzo and J. Kovaevi, ”Comparison of sparse representation and Fourier discriminant methods: Damage location classification in indirect lab-scale bridge structural health monitoring,” Proc. Structures Congr., Pittsburgh, PA, May 2013.

[7] G. Lederman, Z. Wang, J. Bielak, H. Noh, J. H. Garrett, S. Chen, J. Kovaevi, F. Cerda, and P.Rizzo, ”Damage

quantification and localization algorithms for indirect SHM of bridges.

[8] Kim, C. W., Inoue, S., Sugiura, K., McGetrick, P., Kawatani, M. (2016). Extracting bridge frequencies from dynamic responses of two passing vehicles.

[9] Matthew J. Whelan, Michael P. Fuchs, Michael V. Gangone, Clarkson University, Development of a wireless bridge monitoring system for condition assessment Using hybrid techniques.

[10] Mr.M.V.N.R.P.Kumar, Ms.B.Hombal, Miss. J.D. Kadam, Mr. A. B. Yadav, Mr. B.M. Pawar. Dept. of ETC, L.N.B.C.I.E.T. Raigaon, Satara.(Maharashtra) Bridge Condition Monitoring System Using PIC Microcontroller.

[11] S. Chen, A. Sandryhaila, J.M.F. Moura and J. Kovaevi,"Adaptive Graph Filtering:Multiresolution Classification on Graphs" Proc. IEEE Glob. Conf. Signal Information Processing, Austin, TX, Dec. 2013.