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A Review Paper on Bridge and Concrete Structure Health Monitoring Using Wireless Sensors

Rupali S. Jaiswal[1], Raju A. Rathod[2]

[1,2]Electronics and Telecommunication Department,
MSS College of engineering and Technology, Jalna,(India)

ABSTRACT

Monitoring health of Bridges and concrete structure is now become essential to avoid accidental damages cause due to collapse.To avoid such situations wireless sensor network can be used to monitor the bridge condition. WSN monitoring systems also provides information about type of damage in particular area of structure. So it is helpful for repair and maintenance. In this paper different types of bridge health monitoring systems are explore with their advantages and limitations. This paper also gives the information about different types of sensors used in structural health monitoring. The electrical connections, wire are creating difficulty for maintenance and repair of any civil structure. The aim of the paper is to propose the system that does not create difficulty for maintenance. The WSN is best forstructural monitoring system and with development in Internet of things given too many advantages.UsingIoT cloud information about bridge structure can be access from anywhere.

Keywords**: **Bridge health monitoring, Cloud, Internet of things, WSN.

I. INTRODUCTION

The bridges are designed and built by considering different aspects of civil engineering like type of load, maximum strain, Stress etc. But is found that in recent years variations of climates conditions and natural disasters are increased that ultimately affect the life of civil structures. Although bridges are design and built by theoreticallyanalyzing its life but environmental changes can affect it. Another factor that affects life of bridge is accidents occurred on bridge and overloading of bridge. So these are some of the factors that can changes the life time of bridge structure. In today's Information age monitoring mechanisms can help us by threatening ultimate limit state, serviceability, and durabilityof bridge structure. The monitoring system need to sense the physical conditions of bridge and store these parameters. Based on these parameters computational analysis can be done to calculate the bridge health. The monitoring system consists of basically sensors, communication network, data processing and storing unit.

II. RELATED WORK

For monitoring the bridge structures there are different methods, technologies, Sensors are available theseare explained here.TZU-KANG LIN [1] has implemented remote bridge monitoring system and published the paper 'REMOTE BRIDGE MONITORING SYSTEM WITH OPTICAL FIBERSENSORS'.In this paper three

different methods, including the wireless, Ethernet and GPRS system, are evaluated for their feasibility in a remote monitoring system. For the reliability and mobility of data transfer, the GPRS system is picked up and integrated into a Fiber Bragg-grating (FBG) based bridge monitoring system. The evaluation result has shown that the case with the combination of asymmetrical digital subscriber line ASDL system and wireless transmission is fastest one for offering a reliable data conveyance rate while the GPRS system offers the most economic and robust service. Both of the two system can be easily incorporated into the original surveillance system and largely enhance their performance. The integrated system with the remote-control ability can expected to be applied to any existing bridge under harsh environment in the near future.

AtharvaKekare[2] has implemented the Bridge health monitoring system using PIC16F877A microcontroller and four sensors. LCD display is used to display status and GSM is used to send messages. There 4 sensors used in the block diagram namely Temperature sensor Anemometer Accelerometer and strain gauge. The accelerometer is used to detect the bridge tilt. It senses the motion of the bridge in 3-axis.We are going to connect the accelerometer at the middle of the bridge. Then the temperature sensor can measure the temperature of the bridge components. The temperature sensor can be connected to any part of the bridge. There is a strain gauge which can measure the weight the bridge is carrying at the time. We have used a load cell for this purpose. The load cell is connected at the center of the Bridge. The anemometer is a sensor which measures the speed of wind.

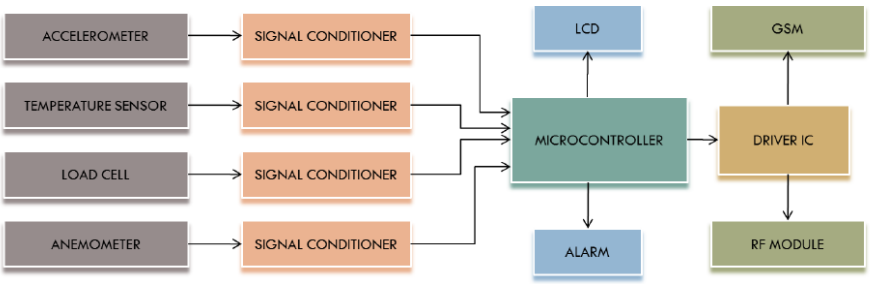

Fig. 1 Block diagram of Bridge health monitoring system.

This system continuously monitors the bridge parameter in PC by visual basic 6.0. RF communication is used for sending bridge data to PC as shown in fig.1. The received data is given to the computer.The computer basically works as a Control Station which stores the data sent by the transmitter side from time to time. Visual Basics is used for making a Module which displays all the parameters in a systematic way.

Fig. 2 Block diagram of receiver unit.

ShraddhaPandey [4] implementeda low cost wireless platform for remote bridge health monitoring. In this paper, an Arduino based a low cost and flexible BHM using IoT is proposed and implemented. The proposed architecture utilizes API to run as GET request link from Arduino to run the Google script between the remote user and the site devices. An Adafruit Wi-Fi Shield is used to access the Wi-Fi network at site. In future a GSM based shield using mobile cellular networks such as 3G or 4G - LTE can be used to access the system. A network of accelerometers can be fitted on bridges and Arduino based BHM system can be used to collect the real time data. This data can be further processed at Data Centers and assessment of structural integrity of bridges can be done. The resulting output can help in detecting structural damage that affects the performance of a structure.

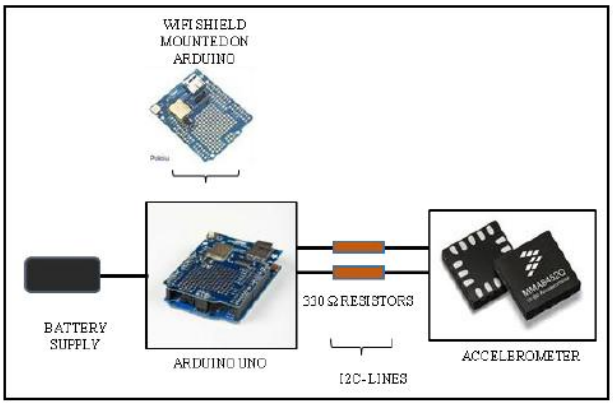

Fig3 Block Diagram of IoT based BHM Implemented Circuit

Chae, M. J. [5] has published the paper on 'BRIDGE CONDITION MONITORING SYSTEM USING WIRELESSNETWORK(CDMA AND ZIGBEE)'. In this paper two types of networks are used CDMA and Zigbee as shown in fig 4.Bridge health condition monitoring in real time has beenpopular issue. The sensor technology iscontinuouslyadvancing and condition monitoring has never beenaccurate and easier before. With the help of the wirelesstechnologymany problems due to data cables and expensiveoptical cable are nowminimized and eliminated. Sensor andZigBee module combined becomes u-node (ubiquitousnode). ZigBee is proved to be excellent solution in shortdistance wireless data communication. For long distancedata transferring CDMA which is a mobile phone carriernetwork is used instead of optical cable which isexpensive in installation and maintenance. The Yong-JongBridge used as the test bed is an excellent example to validatethe USN technology for bridge health monitoring systembecause it has already working wire-based sensors. Theauthors were able to compare the sensor outputs fromwiredand wireless sensors.The USN technology presented in this paper coversbridge health monitoring system only.

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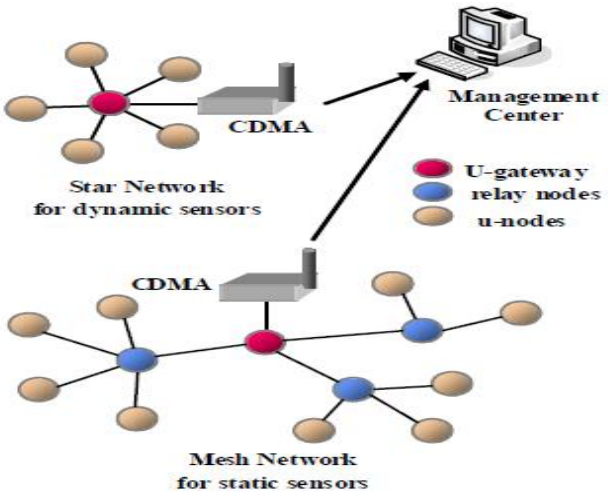

Fig4 Block Diagram of CDMA and Zigbee network for BHM.

However, there arelimitless applications of USN. It is expected to see hundredsof USN application technologies in civil engineering area innear future.M.V.N.R.P.Kumar[6] has implemented bridge monitoring systemusing PIC microcontroller and sensors with GSM interface .Ahmed Abdelgawad and Kumar Yelamarthi[8] Internet of Things (IoT) Platform forStructure Health Monitoring.

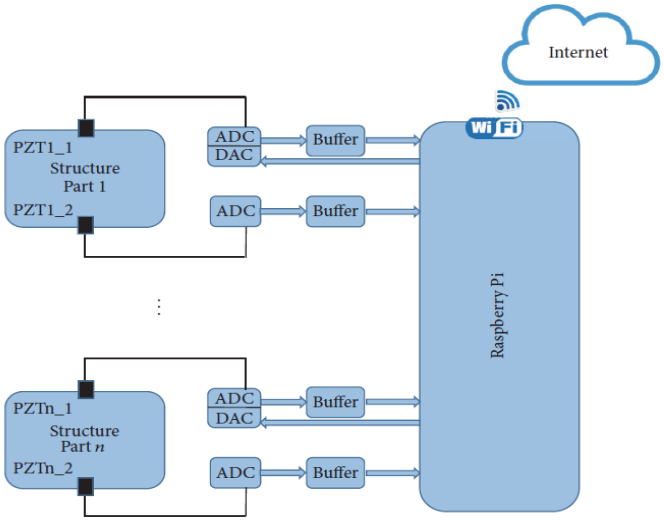

Fig. 5 Block diagram of IoT based BHM using piezoelectric sensor

In this paper, a complete real-time IoT platform for SHMwas proposed. Theproposed platform consists of a Wi-Fimodule, Raspberry Pi, DAC, ADC, buffer, and PZTs. ThetwoPZTs are mounted on the structure and connected toa high speed ADC. A buffer was used as a level conversionand to protect the Raspberry Pi. The Raspberry Pi generatesthe excitation signal and the DAC converts it to analog. Inaddition, the Raspberry Pi was used to detect if the structurehas damage or not.Moreover, theRaspberrywas used to sendthe structure health status to the Internet server.The data wasstored on the Internet server and can be monitored remotelyfrom any mobile device. The system has been validated usinga real test bed in the lab. Results show that the proposed IoTSHM platform successfully checked if the sheet is healthy ornot with 0% error. In addition, the proposed

platform hasa maximum of 1.03% error for the damage location and amaximum of 8.43%error for the damage width.

VeijoLyöri[9] has published the thesis which deals with the developing of fiber-optic instruments for monitoring the health of civilengineering and composite structures.Deformation in a road structure was studied with microbending sensors of gauge-length about 10 cmand a commercial optical time domainreflectometer (OTDR) in a quasi-distributed fashion in the application of fiber optical sensors in structural health monitoring.Andrew Gastineau [10] has published report on Bridge Health Monitoring and Inspections A Survey of Methodsincludes 3-D Laser Scanning, Accelerometers, Acoustic Emission (AE), Chain Dragging, Concrete Resistivity, Digital Image Correlation (DIC), Electrochemical Fatigue Sensing System, Ground Penetrating Radar (GPR).

III.PROPOSE SYSTEM

From this literature survey it is found that wireless sensor network is best in the application of structural health monitoring. It gives lower latency. GSM based wireless system has advantage that we get larger range comparing with Zigbee based sensor network. But GSM can be used only for sending text message at emergency conditions. We need continuously monitoring of parameter for analysis. By using wireless sensor network data can be sent continuously to processing unit. In propose system as shown in fig. 6 camera module is used to capture the images whenever sensor gets large variations in output. As shown in fig Microcontroller receive the physical parameters of bridge structure using sensors. System has vibration sensor, temperature sensor, strain sensor, water sensor connected to controller. The IoT module is connected to microcontroller which will send the data to cloud. Using cloud API we can set threshold values for parameters by which emergency alert can be generated.As it is connected to internet any one can see the details of bridge structure health. The system not only monitors the health of bridge but also inform about natural disaster like floods.

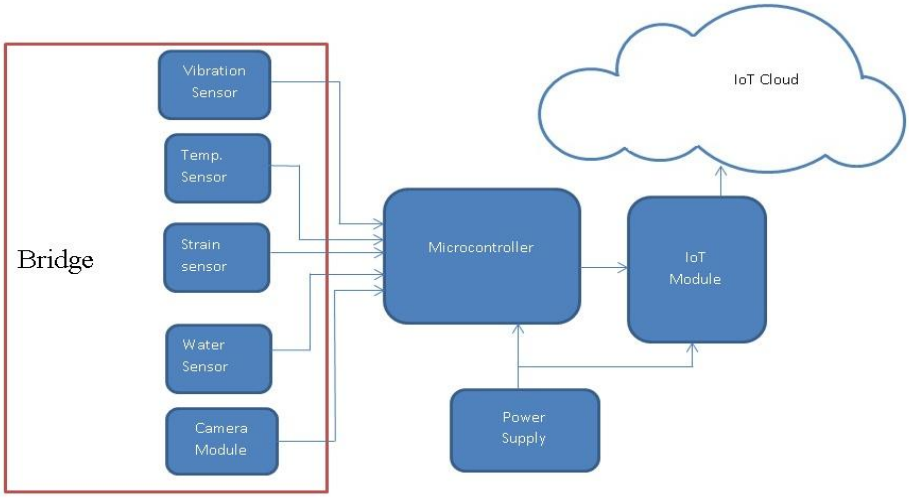

Fig.6 Block diagram of proposed system

IV CONCLUSION

Bridge and concrete structure monitoring is essential for safety and repair maintenance. The propose system is based on wireless sensor network. It does not create difficulty in repairing as there is no wiring required. The individual node sends the data to network hence if any node fails we need to replace that node only. Node does not require too much wiring connection only needs power. Node has water sensor to detect water level that can be used when there in flood. Every node is connected to cloud so we can have large data of bridge which can be used for future development or expansion plan of civil structure.

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