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REVIEW ON STRUCTURAL HEALTH MONITORING SYSTEM FOR BRIDGES

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ABSTRACT

Transportation is an important aspect of human life and bridge plays an important role in transportation, there are several bridges which used for transportation over the rivers in India and some of the bridges are located in remote locations, so the construction of these bridges should be very strong and they should monitor continuously over some defined period of time to ensure the bridge condition. Bridge faces structural deficiency because of overloading, ageing, bending and improper maintenance. There are more than 89000 bridges in world, few of them are managed by regional management, few of them are managed by national by the management team. Many of them are located in remote areas where it is difficult to manage them. Therefore, random inspection after every few years it's difficult to get the bridge condition in the required period time. In order to overcome this problem, we need a system which continuously monitors the bridge condition and provides the proper alert to the operator at correct time.

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I. INTRODUCTION

Structural health monitoring is a non-destructive technique to monitor the strength of concrete structures such as bridges. Bridge faces structural decay due to overloading, ageing, bending and improper maintenance. Structural health monitoring is a system to be implemented in old buildings, bridges etc., to ensure the safety of citizens. The researchers from various fields took different approaches for monitoring system. In this field major part of work is done by engineers from civil and mechanical field. In this, the approach was to develop a technique to gather a structural data from various sensors and display it on remote devices.

Internet of Things is a network of sensors and devices communicating among various controlling and monitoring devices using internet. The idea behind using IOT for structural health monitoring is to provide a remote monitoring of durability of bridge. The system contains monitoring devices installed on bridge, communicating system establishing communication between sensors and web space/cloud based storage which continuously stores the structural condition of bridge. This system continuously monitors the structural condition and its environment.

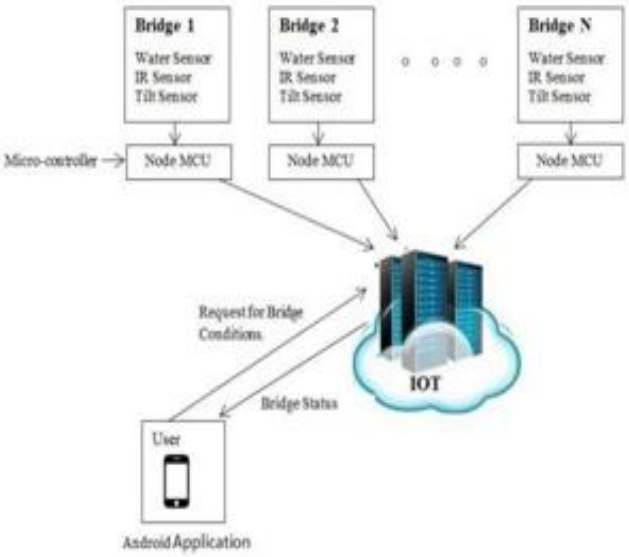

Fig (1): Architecture of IOT based bridge health monitoring system.

II. RELATED WORK

Pooja Patil et.al [1]: Explained wireless sensor network system for bridge. The system is designed for high transmission speed and to transfer the large amount of data. This system is combined of two sensor nodes which collects the structural data of bridges and transmits it to central station via radio channel.

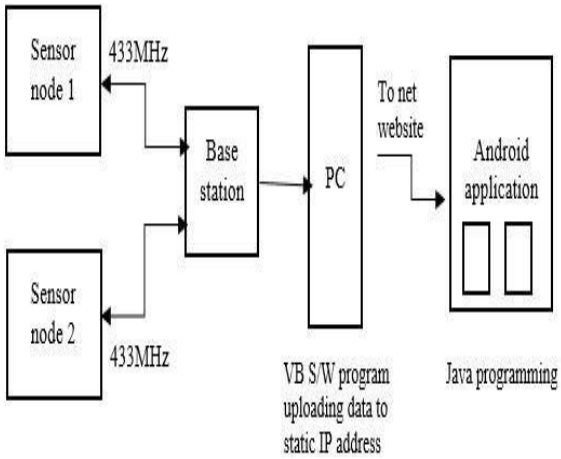

Fig (2): Block diagram of wireless sensor system for bridges [1]

Fig.(2) shows the block diagram of WSN system. First sensor node uses ultrasonic level sensor for level sensing the level of water. Second node has accelerometer for tilt angle sensing of bridge pillar. After the data collection is completed, base station transmits the data to PC. The collected data is then uploaded to website which can be accessed by using android application.

Md Anam Mahmud et.al [2]: This paper explained the pulse-echo system using piezoelectric exciter and receiver module. This method can used to identify the damage location and size of damage on the metal bstructured bridges. This system uses two piezoelectric sensors one is exciter (PZT1) and other is receiver (PZT2).
The pulse-echo system is established using piezo sensor as a transmitter and receiver. The transmitter transmit the signal through the metal sheet, this signal get delayed if there is damage. The delayed signal is then used to detect the damage size and location.

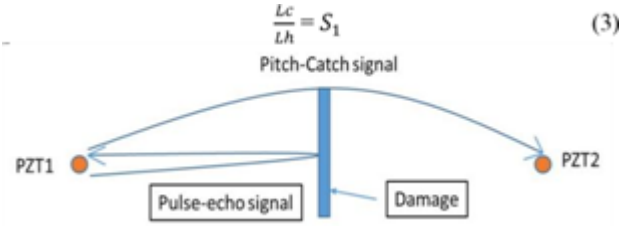

Fig (3): Proposed concept [2]

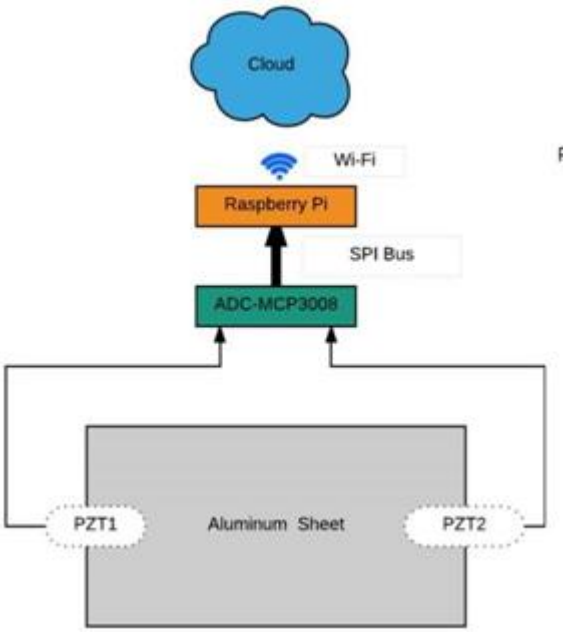

Fig (4): Block diagram of pulse-echo damage detection [2]

Fig.(3) shows the proposed concept and Fig.(4) overall shows pulse-echo system. The exciter-receiver modules data is transferred to Analog to Digital converter, after the conversion the digital data is sent to the raspberry pi module. This signal is processed under the peak detection algorithm to detect the peaks and their occurrence time. These peaks are occurred due to the damage. This data is then transferred to internet for the monitoring from remote location.
Himalay B. Sawant et.al [3]: An Microcontroller based system is explained which comprised of vibration sensor, scour sensor and GSM module. Vibration sensor collects data of excess vibration which can leads to cracks in structure of bridge. Scour of soil around bridge pillar occurs when there is flooding or heavy flow of water. This causes instability of bridge structure. In this paper, various methods are suggested for sensing the intensity of scouring of soil. The data collected by sensors is processed by microcontroller. If any sensed parameter is exceeding the safety parameters then an alert is generated by controller. This alert is transmitted to nearest Regional Transport Office (RTO), police stations. The alert message will also be displayed on the display located both sides of bridge.

Divya Muddala et.al [4]: This project aims to detect the vehicle load on the bridge, water level and pressure under the bridge and deviation from line of sight. The sensors involved are water sensor, IR sensor module and tilt sensor. This is an microcontroller based system which uses Node-MCU wi-fi module to get internet access.

Node-MCU establishes connection between server and controller. If any sensed parameter exceeds the Threshold value, an alert signal is broadcasted by the system to nearby control station, police station and users.

Athanassios Boulis et.al [5]: In this paper it is explained the monitoring system based on 3G modem. It consists of number of nodes identified as Gateways and sensors connected to each other with USB cable. This USB cable provides power supply and communication between them. The wireless sensor nodes (WSN) collects the structural data from the bridge this data is again transmitted to gateways by control nodes. The data collected by sensor nodes is strain, acceleration and temperature. This data transferred to the offsite server which then runs tests and stores or visualizes collected data.

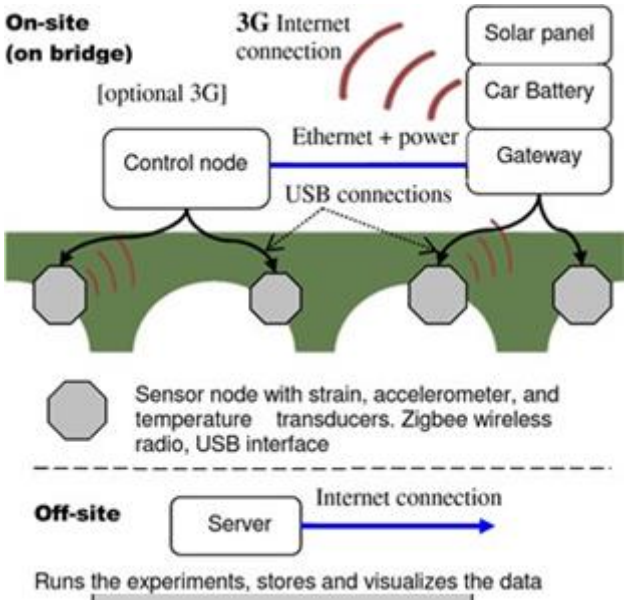

Fig (5): Simplified view of WSN testbed system [5]

Frank X.Li et.al [6]: This system is basically based on connection of wireless nodes from sensors to the centralized server.it is using mesh network technology for communication between sensors and centralized server.all the data from the centralized server is accessed through bridge health monitoring software server.

Ittipong Khemapech et.al [7]: Given approched system using the real time structural health monitoring using stream processing and artificial neural network techniques. strain guage and accelerometer are the sensors used in system they generally measure the Bending strain of the structure for measurement. JAVA messaging server is used for real time data communication as it support streaming data. Here data is forward between the system is using stream processing, it consist of Message orieanted middleware which receives data from the sensors and send to stream processing and compared to pattern by pattern analyzer. The o/p generated is displayed and warning is given to users via web services.

Jingqiu Huang et.al [8]: Here the technique used for monitoring of bridge health is based on vibration. As the test is done on bridge called “NISHIKAWA KOUKA” bridge whose body main structure is steel structure.so,vibration signals are very important in bridge health monitoring as it shows the changing of bridge structure health. For processing vibration signals Fast Fourier Transform , wavelet transform , Independent component analysis is used . Band pass Filter is used here for signal filtering process.

Atharve kekare et.al [9]: Objective of the given paper is to built the cost efficient system for continuously monitoring of bridge. Proposed system is mainly based on microcontroller “PIC16F877” and GSM module. Four sensors are used in given system and the system consist of two sides namely transmitter and receiver side.receiver side consist of Rf module which is directly connected to computer via USB connection.

Shachi P. et.al [10] : This paper mainly focus on health monitoring of Railway bridges. They are mainly using three sensors for continuously monitoring I.e. flex sensor for detecting bend in bridge, load cell is used to measure the excessive load on the bridge and accelerometer is used to measure the jerks in bridge.controller device used here is raspberry pi placed at receiver side. Transmitter side detect the error and send to the receiver side using Zigbee transceiver module .alert massage is further generated using GSM module.

III. CONCLUSION

There are various methods are used for bridge health monitoring, various techniques can be implemented for safety monitoring of bridge . These implementation techniques are varies with respect with surrounding, atmosphere, location of bridge, material used for bridge manufacturing, usage of bridge depending upon above parameters perfect implementation technique can be used which consist proper use of sensors and sensing techniques for monitoring bridge health. At the last main purpose of all the above papers is to monitor bridge health and provide alert massage for any disastrous situations.

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