International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

# IOT BASED MONITORING AND MAINTENANCE OF HIGHWAY BRIDGES USING WIRELESS SENSOR NETWORK

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**Abstract** - *We present an IOT based bridge monitoring system using WSN technology. The advanced modification of sensor technology have brought the automated real- time bridge health monitoring system such system will help in disaster management. This is developed using wireless sensor network (WSN) technology. This system consist of multiple sensor to monitor the bridge condition continuously via Accelerometer to detect the jerks in the bridge ,vibration sensor to detect the vibration occurs an bridge ,flex sensor to detect the bend in a bridge ,water level sensor to detect level of water. The data from various sensor is processed by microcontroller and transmitted to server and for management system to have real –time monitoring of the bridge condition via mobile telecommunication device through GSM model.*

***Key Words***: **Bridge monitoring using WSN, Microcontroller, GSM module, LCD Display, IOT.**

## 1. INTRODUCTION:

In bridge monitor system structural integrity of bridge is monitor. It is quite difficult to monitor the health of critical bridge items of maintenance and operations are required. The advancement in sensor technology have brought the automated real-time bridge health monitoring system using IOT[1]. In many countries , many bridges have exceeded their 50-year life span. Old bridges can not face to several nature disasters. The bridges in such countries are likely suffer from the damage[2].

Tragic is the famous examples of bridge being monitored by the sensor network on August 1,2007, a bridge spanning the Mississippi river in Minneapolis collapsed suddenly under the weight of the rush hour traffic ,killing 13 people and injuring another 145. The bridge was rebuild shortly thereafter, this time equipped with hundreds of sensors to monitor its health and give early warnings[3]. Many long span bridges in Korea and in Japan have adopted this real-time health monitoring system. Therefore, in this paper, the IOT, Wireless sensor network are adopted for real-time bridge monitoring system[4]. For communication purpose GSM is used for long distance (between the bridge and the management system ) data communication. This technology can be called MBM (Monitoring Based Maintenance).

**Fig.1.**The Charilaos Trikoupis Bridge in Greece[3]

## 2. LITERATURE REVIEW:

A. R. Pawar et al in [5] explained the Structural health monitoring system used to measuring the key parameter of the structural and environmental conditions on a continuous base at real-time. Purposes of SHM (Structural Health monitoring) are detect structure damage, safety, disaster mitigation etc. Wireless sensors to monitor physical or environmental condition like pressure, level of water, acceleration etc. For bridges and dams application, wireless sensor measures the acceleration, tilting angle of bridge pillar and water level. The wireless sensor network is used in industry, urban terrain tracking and civil structure monitoring, security and surveillance, smart buildings etc.

Ren-Guey Lee et al.[6] gives an efficient and reliable backup scheme for bridge monitoring system by using the wireless sensor network (WSN). By collecting the environment parameters transmitting the numerical data to the gateway through the multiple-hop relay, and then it further stores data in the back-end database for the specialized monitoring staffs to analyze and study. This system can able to improve the inconvenience to add or remove sensor nodes in an existing wired bridge monitoring network.

Jin-Linn Lee [7] explained IOT-based bridge safety monitoring system is developed using the ZigBee technology. This system is composed of monitoring devices installed in the bridge environment; communication devices connecting

the bridge monitoring devices and the cloud-based server analyzes data transmitted from the monitoring devices.

Amro Al-Radaideh, A. R. Al-Ali, Salwa Bheiry, Sameer Alawnah [8] developed an "A Wireless Sensor Network Monitoring System for Highway Bridges" which presents an autonomous wireless sensor network system to monitor structural health in highways bridges. The system consists of a wireless Data Acquisition Unit (DAQ), management middleware. The sensors gather the bridge health signs and transmit them promptly via wireless transmitter to the management and evaluation middleware for further processing.

Chih-Chyau Yang and Ssu-Ying Chen [9] developed an "A Rugged Sensor System for Real-time Bridge Safety Monitoring" which presents a rugged sensor system with proposed algorithm to monitor the bridge in real time. The presented rugged sensor system consists of under-water sensor nodes with the wired Ethernet communication protocol, a PoE switch and a data logger. The developed under-water sensor node adopts the vibration sensing mechanism to detect the bridge scour by using the accelerometer sensor.

Shivan Haran [10] discusses the monitoring of bridges using WSN. A heterogeneous network of WSN and conventional P2P together with a combination of sensing devices is to be used on a bridge model. Issues related to condition assessment of the bridge for situations including faults, overloads, etc., as well as analysis of network and system performance is discussed.

## 3. SYSTEM OVERVIEW:

The proposed system is the development of bridge monitoring system using IOT. The system continuously monitors the bridge condition. The sensors are installed on various parts of the bridge to monitor the environmental condition on a bridge. The system uses different sensor to get the bridge information like water level sensor, flex sensor, vibration sensor, Accelerometer and sensor. At any point of time if any parameters cross their threshold value the communication system informs the management system giving an alarm for taking precautionary actions. The system block diagram is as shown below fig.(2).

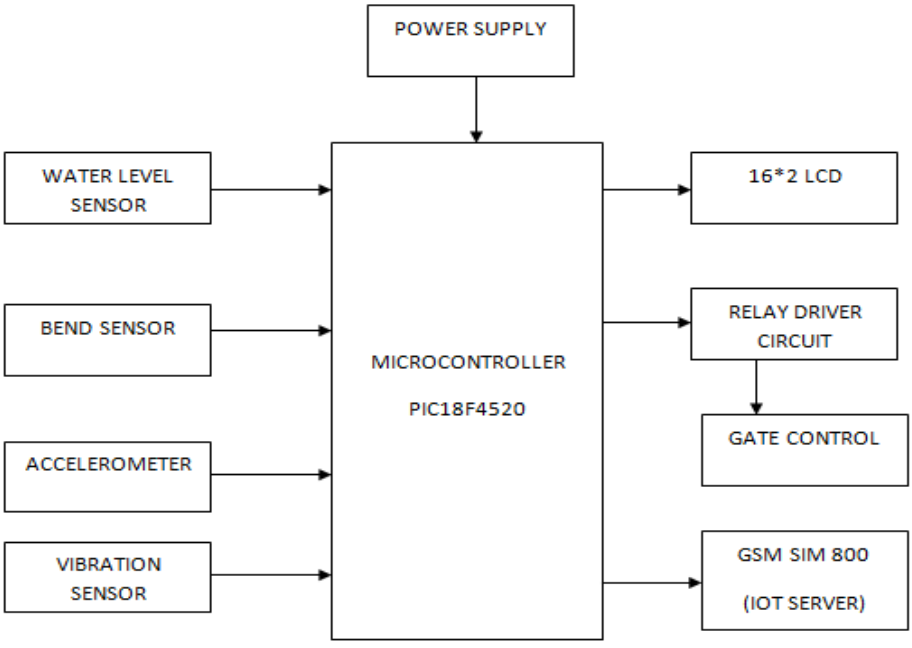


**Fig.2.**Block diagram of Bridge Unit

This system consist of one master unit & no of slave units .The slave unit consist of no. of sensors which will use to sense the different parameter like acceleration, bend, vibration and level of water .The data collected by the sensors is processed by the microcontroller and this data is also store to the cloud through IOT. If any of the parameter cross their threshold value then controller automatically close the gate on bridge and the communication system (.i.e. GSM module) inform the management system. Master unit consist of LCD display which display difference parameter or status of all sensors of slave unit. The bridge collapse detects by using different sensor. The safety level buzzer will blow &GSM will send SMS to management system .

## 4. PROPOSED ALGORITHM:

### 4.1. Flowchart:

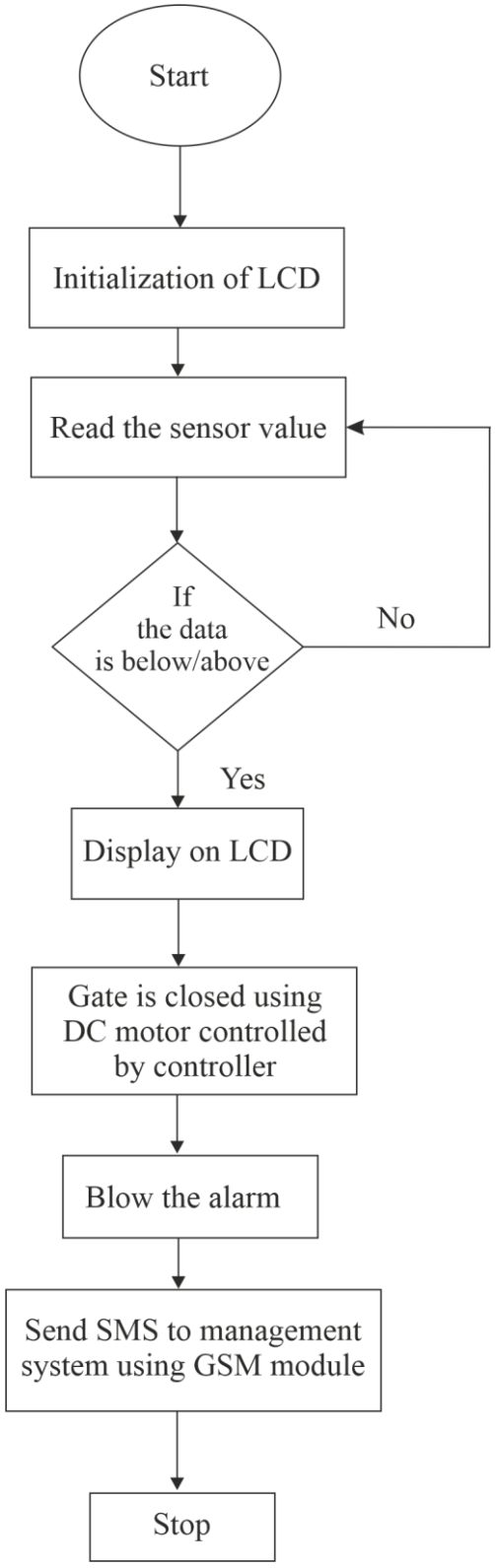


**Fig.4.1.**Flowchart of system

## 5. RESULT:

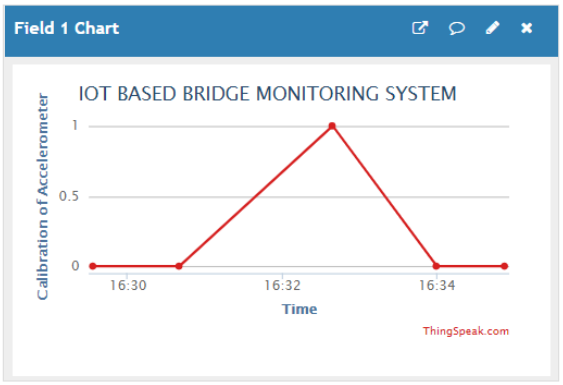


**Fig.5.1.**Graph of Calibration of accelerometer vs Time

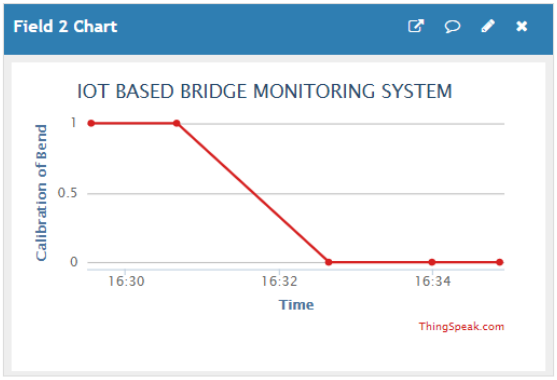


**Fig.5.2.**Graph of Calibration of bend vs Time

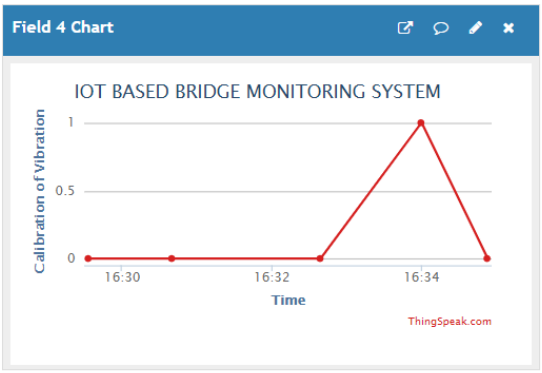


**Fig.5.3.**Graph of Calibration of vibration vs Time

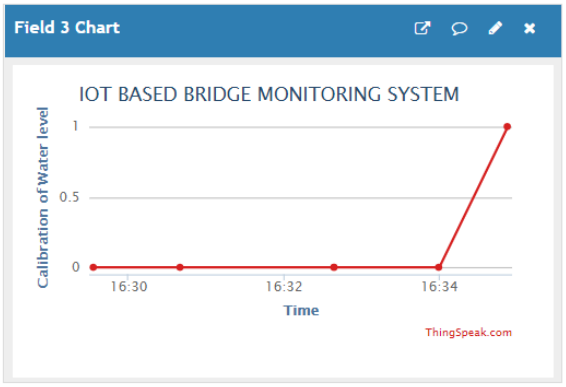


**Fig.5.4.**Graph of Calibration of water level vs Time

- The above graphs shows the analysis of data based on Calibration vs Time
- In the graph point 1 shows some moment occurs on the bridge with respect to time . And point 0 shows no any moment occurs on bridge.
- Graph is the simplest data structure to show the analysis data.
- Web Application is built to show the real time bridge monitoring system analysis of data.
- The Fig.5.1 shows that at 16.31 tilt is occurs on bridge. This is the analysis of calibration of tilt at particular time.
- The Fig.5.2 shows that at 16.33 jerk is occurs on bridge. This is the analysis of calibration of bend at particular time.
- The Fig.5.3 shows that at 16.34 vibration is occurs on bridge. This is the analysis of calibration of vibration at particular time.
- The Fig.5.4 shows that at 16.35 water level is raised above the threshold . This is the analysis of calibration of water level at particular time.

## 6. CONCLUSION:

This System proposed using a wireless sensor network. The system uses a sensor network for data collection and the collected data is also store to the cloud through IOT. The GSM module is for communication link between the bridge and management center. In this system obtained results are matched with the threshold value if the obtained value are below or above the threshold value then appropriate action will be taken by management. This method has advantages of real-time alarming and little computation, which provides an efficient and effective algorithm for real-time alarming of extreme events in structural health monitoring.

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