Design and Implementation of Real time monitoring of bridge

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ABSTRACT

This project system uses wireless network on real time basis for bridge health monitoring purpose. It can transmit the data continuously for several minutes. In that detection of vibrations, crack & water level at the base occurred. Currently Bridge Inspection is done by manually each time and also takes lots of time to find & detect any fault. It requires specialized or experienced man for inspection of bridge. They have to monitor the condition of bridge by visual inspection thoroughly. Conventionally, a technician is responsible to detect and measure vibration in the field. Then implementing the correction process for any water level, auto barrier, and vibration of the bridge is difficult. Also the more attention required at the time of rainy season. In order to test the proposed methodology in this paper, several experiments were conducted in a controlled environment and their results were compared with other methods. In addition, experiments with real structures were conducted. Our proposed project research is focusing of implementation of system having sensors, technique which informs bridge condition to nearby officers. In this system the water level sensor vibration sensor and Ultrasonic sensor will continuously check bridge health if there is fault in these measurement then alert message display on LCD screen and also sense the servo motor and this motor can get automatic close the barrier on bridge. This advance technique is very helpful to human and nation also.

Keyword : - *Water Level Detection , Vibration Sensor, Servo Motor(auto barrier), Ultrasonic Sensor etc….*

1. INTRODUCTION

Bridges are continuously subjected to destructive effects of material aging, widespread corrosion of steel reinforcing bars in concrete structures, corrosion of steel structures and components, increasing traffic volume and overloading, or simply overall deterioration and aging. These factors, combined with defects of design and construction and accidental damage, prompt the deterioration of bridges and result in the loss of load carrying capacity of bridges. The condition of heavily used urban bridges is even worse. There are classified as aging or unable to accommodate modern vehicle weights and traffic volume. Therefore, a significant number of these structures need strengthening, rehabilitation, or replacement, but public funds are not generally available for the required replacement of existing structures or construction of new ones. Bridges can suffer structural deterioration due to aging, misuse or lack of proper maintenance. Among the many factors which have led to the unsatisfactory condition of bridge structures, one factor that has been neglected is the unsatisfactory inspection and monitoring of existing structures. The most common objectives for monitoring a bridge are to obtain quantitative data about the structural behavior in order to

confirm design assumptions and to provide real-time feed-back during construction (especially true for new bridges), and to evaluate the real current condition of the bridge and allows the engineers to take informed decisions about their future and to plan maintenance or repair actions (especially for existing bridges). In the later, the monitoring system is used to increase the safety of the structure and provide early warning of an acceleration of the known degradations that are being monitored. And the application of SHM to existing bridges to perform a controlled lifetime extension of the bridges with known problems has greatly increased in recent years. There are many bridges in Japan and China which are very advanced as compared to the monitoring systems in our country. So our aim is to develop a system that is reliable, cheap and more efficient for Indian bridges. This system will not only be useful for the railway bridges but also for the road bridges, foot bridges.
Our proposed system uses the advanced IOT technique for saving the life of living beings. The main challenge is to ensure that the health condition of the civil infrastructure bridge is able to stand with the cumulative weight of all the vehicles which travel on the bridge and the capacity to bare the speed of flow of water. This system comprises of sensor technology. Our proposed system has many different types of sensors. The data or information of bridge health condition is collected by sensors. According to that data is processed through the programmed microcontroller. If any fault arise in the heath of bridge at the time of inspection or detection.

2. PROBLEM STATEMENT

The transportation infrastructure is quickly aging. Increases in traffic, in both urban and rural areas, puts more strain on the bridge networks than was originally intended. Bridge engineers need a reliable way to assess structural integrity of bridges to maintain the continuous operation of the road network while ensuring the safety of the public. Traditional visual inspection techniques are both time consuming and expensive. They are also qualitative and can only assess outward appearance. Any internal damage may go unnoticed for a long period of time. According to Minnesota Department of Transportation (Mn/DOT) records, as of March 17, 2009, 296 highway bridges are rated as structurally deficient or obsolete. Of these 296 highway bridges, 115 are structurally deficient along with 1,068 local bridges. How does a bridge engineer keep track of these problems? Are inspections conducted every other year enough? A possible solution to these issues is the use of a structural health monitoring system. These systems can detect changes in the bridge superstructure and, in some cases, predict impending failures. These systems can monitor bridges in real time and warn state engineers of possible problems to avoid tragedies like the I-35W collapse in August 2007.

The most common reason for bridge collapse are Crack the element of bridge & level of sand at the base of bridge Monitoring the health condition of the bridge is an increasing concern for the benefit of all living beings. Our proposed system uses the advanced GSM technique for saving the life of living beings. The main challenge is to ensure that the health condition of the civil infrastructure bridge is able to stand with the cumulative weight of all the vehicles which travel on the bridge and the capacity to bare the speed of flow of water. This system comprises of sensor technology and GSM technology. The data or information of bridge health condition is collected by sensors. According to that data is processed through the programmed microcontroller. If any fault arise in the heath of bridge at the time of inspection or detection. It sends the data or informs the data related to nearby RTOs, police Stations & Hospitals. The Result of processed data is displayed on the LCD display, which is placed on the both side of bridge for understanding of people. Also gives an indication of the Red & Green signals for transportation of vehicles on the bridge. The role of bridge is very important in the nation's economic & infrastructure development for the conveniences to the people, transportation and for connecting & communicating two areas. For the security of the Bridge point of view purpose to monitor the health condition of bridge, especially monitoring the sand level at the bottom of bridge pillar, any crack detection in the bridge is the main topic in any research. Safety is an major issue after the big incident happened such as Earthquake, Flood, Tsunami for examining purpose to determine the damages in what extent. The surface of the bridge deck is affected by different environmental condition as well of direct vehicles so the bridge deck surface is the first component to be inspected and maintained. Inspecting and correcting minor deficiencies like cracks while the structure still in good condition will ensure the structural reliability and small repairs, activities will be performed to keep the bridge in good condition. Crack detection

during experimental testing may require researchers to mark crack on the specimens, whereas researchers can take photographs of the specimens from a safe distance and have the reconstructed model digital crack detection.

3. LITERATURE SURVEY

Some failures are sudden and catastrophic, and some failures just take their time. Structural Health Monitoring (SHM) can be very helpful in serving as an alarm system for preventing both types of failures. Bridge Engineers need scientific tools which can give quick information about the health of a bridge. Such instrument shall supplement the periodical manual inspections. But when failures happen with any kind of structure there is loss of human lives, money and many more, most of the times. For example, during the bridge construction boom of the 1950's and 1960's, little emphasis was placed on safety inspection and maintenance of bridges. This changed when the 2,235 foot Silver Bridge at Point Pleasant, WV, collapsed into the Ohio River, on Dec. 15, 1967. 46 people were killed. Hence to ensure the safety of bridges, the Bridge Health Monitoring System was introduced. Some of the existing technologies/methods for Bridge Health Monitoring System are as described.

Prof. Ms. B. Hombal developed by Bridge Condition Monitoring System using micro-controller. In this paper they describe as per with the help of wireless technology many problems due to data cables and expensive optical cable are now minimized and eliminated. GSM is proved to be excellent solution for data communication. Edward Sazonov Developed by Self Powered Sensors for Monitoring Of Highway Bridges. In this paper he describe Structural Health Monitoring (SHM). We see the recent news of bridge collapse due to some weather conditions and massive traffic. We see the bridge collapse in Mahad (Maharashtra) due to sand mining, Shimla (Himachal Pradesh)due to massive traffic and Kolkata(West Bengal). A multi-functional wireless bridge monitoring system has been developed for concurrent deployment of accelerometers, and scour sensor. 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. A. Result An added feature to automated crack detection is the ability to perform digital crack measurements with increased safety. Crack detection during experimental testing may require researchers to mark cracks on the specimens, whereas researchers can take photographs of the specimens from a safe distance and have the reconstructed model digital crack detection. Automated crack detection along with digital crack measurements will increase the quantity of cracks observed and measured. Increased quantity could reduce cost of field inspections by reducing inspection time.

4. SYSTEM ARCHITECTURE

This system describes the application of a probabilistic structural Bridge monitoring method to detect global damage in a highway bridge in Connecticut. The proposed method accounts for the variability associated with environmental and operational conditions. These damage measures, including thermal effects, are shown to be random variables and associated P values are calculated to determine if the current probability distributions are the same as the distributions of the baseline bridge data from 2001. Historical data measured during the settling of the bridge is used to verify the performance of the bridge, and the field implementation of the proposed method is described.

In proposed system the water level sensor senses the fluid level in bride it also work with vibration sensor and tilt/flex sensor also. Water level sensor like ultrasonic sensors send out sound waves to determine fluid levels, whether your organization is monitoring chemicals in tanks or measuring river water levels from a bridge. Ultrasonic sensors measure how much time it takes for the echo to hit the target (e.g., water) and return to the sensor.

The vibration sensor is inbuilt in bridge it vibration monitoring device with the vibrating-wire sensor as the basic measuring device is designed to solve some problems in the application of the traditional engineering vibration measuring technologies into bridge monitoring, and a remote monitoring system is established with the wireless

network technology, with hardware and software design integrating the single chip. The tilt sensor's main purpose of the installation is to monitor operation of the rocker bridge bearings as well as monitoring strain in the bridge's steel girders. Correct tilting of bearings (resulted by temperature change) is a primarily monitored. When bearings are functional and responsive, the possibility of overstrain and fatigue crack formation is relatively small; however, non-functional bearings cause cyclic strain (caused by temperature), which in turn leads to fatigue crack formation. The strain sensors provide accurate monitoring of the bridge's critical members.

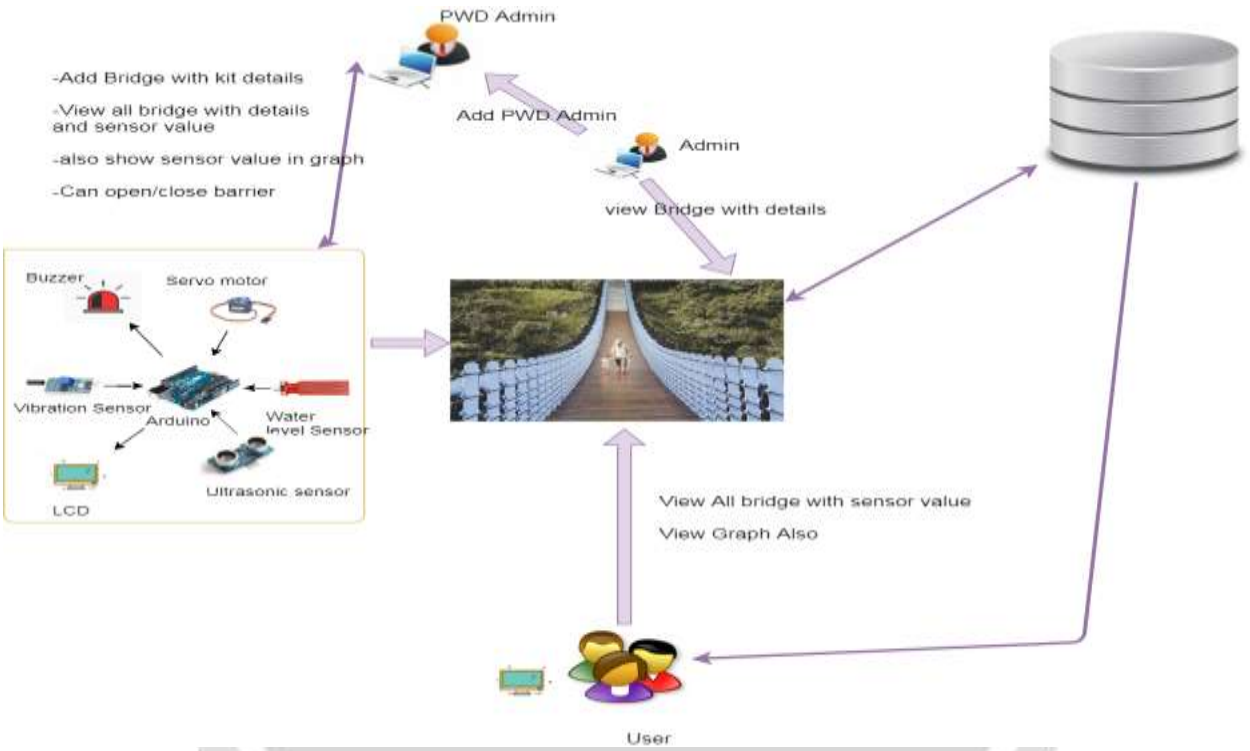

Fig-1 : System Architecture

5. OBJECTIVES

Our research focuses on using bridge vibrations created by passing traffic to power a sensor permanently deployed on a highway bridge. Vibration is one of the most accessible ambient energies; vibration levels are substantial most locations along the span and sensors can be placed in hard-to reach places or even embedded into the structure. Energy harvesting of vibration energy has been utilized in a variety of applications and studied for feasibility of use on bridge structures.

Vibration sensor:

A bridge vibration monitoring device with the vibrating-wire sensor as the basic measuring device is designed to solve some problems in the application of the traditional engineering vibration measuring technologies into bridge monitoring, and a remote monitoring system is established with the wireless network technology, with hardware and software design integrating the single chip. The monitoring data is aggregated to the coordinator node via wireless communication and is finally transmitted to the host LCD screen. It is indicated in site applications that the system has such advantages as strong instantaneity, high reliability and easy networking, and can be preferably applied for the remote monitoring of health conditions of dams, highway bridges and other large building structures

Water level sensor:

Typically, ultrasonic sensors send out sound waves to determine fluid levels, whether your organization is monitoring chemicals in tanks or measuring river water levels from a bridge. Ultrasonic sensors measure how much time it takes for the echo to hit the target (e.g., water) and return to the sensor.

Ultrasonic Sensor:

An ultrasonic sensor was proposed to monitor scour in real time. The ultrasonic sensor was installed. The ultrasonic sensor worked on the principle that the ultrasonic pulse is reflected at the boundary between water and soils due to the different acoustic impedance. inferring that the distance between the water and soils can be measured if a returning signal is received.

6. FUTURE SCOPE

Based on the potential combinations of different available sensors and systems, the range of applications is virtually endless. Application of structural health monitoring technologies to bridges has seen great increase in the past decade. Initial results from these applications have shown the capability of available SHM technologies in monitoring, analyzing and understanding the health of the monitored bridges. Since most of case studies and applications are just in past recent years, it is necessary to examine their performance and results over a long time by continuous monitoring to determine the durability and reliability of these systems. In India hundreds of bridges are built every year in which the importance given to maintenance is very less. There are no Health Monitoring Systems used on any bridges of India. Around 70% of bridges in India are old and need repairs and 57% are over 80 years old. In such bridges the need for monitoring is very high, but they are neglected. According to a survey in 2003, around 23% of bridges in India need repairs and they should be monitored. The cost of bridge health monitoring system is negligible as compared to the total cost of the bridge. So there is need for installing Bridge Health Monitoring Systems on all Bridges. There are many bridges like the British-era Hancock bridge in Mazagaon which has been listed as a dangerous structure years ago where the need for such health monitoring system becomes obligatory. Hence we have developed a new Bridge Health Monitoring System especially for the Indian Bridges which is especially very cheap as compared to optical fiber systems. This will certainly prevent the catastrophes occurring due to deficient bridges and also due to natural disasters. As has been demonstrated through the information presented in the previous sections, SHM offers an enormous range of options to engineers who are interested in characterizing the short and long-term behavior of their structures. SHM is increasingly seen as an important tool in the maintenance of sustainable infrastructure systems, and it is reasonable to assume that ongoing advancements will continue well into the foreseeable future. In particular, two interesting emerging technologies are worthy of note: smart structures and live structures.

7. TECHNOLOGY NECESSITY

The significance of implementing long-term structural health monitoring systems for large-scale bridges, in order to secure structural and operational safety and issue early warnings on damage or deterioration prior to costly repair or even catastrophic collapse, has been recognized by bridge administrative authorities. Developing a long-term monitoring system for a large-scale bridge—one that is really able to provide information for evaluating structural integrity, durability and reliability throughout the bridge life cycle and ensuring optimal maintenance planning and safe bridge operation—poses technological challenges at different levels, from the selection of proper sensors to the design of a structural health evaluation system. This paper explores recent technology developments in the field of structural health monitoring and their application to large-scale bridge projects. The need for technological fusion from different disciplines, and for a structural health evaluation paradigm that is really able to help prioritize bridge rehabilitation, maintenance and emergency repair, is highlighted.

Another important application of Structural Health Monitoring is to improve reliability of existing infrastructure. Existing infrastructures in North America are rapidly approaching the end of their design service life. Owners and maintenance managers of capital-intensive assets are looking for cost-effective and reliable inspection and monitoring solutions to ensure safety and reliability of these structures. Modern design codes are now looking in a much longer service life.

8. ADVANTAGES

- Data/information can be collected/used as frequently as desired (must be cautious to not get overwhelmed by data volume).
- Improved structural behavior
- No subjectivity in the data and/or information.
- It can make decisions with greater confidence.
- Early damage detection Bridge Monitoring System
- Assurances of a structure's strength and serviceability
- Reduction in down time
- Improved maintenance and management strategies for better allocation of resources

9. EXPECTED OUTCOME

Bridge health monitoring is a concern in the world. The proposed system manages to collect the data from all the sensors. The real-time sensors data is sent to the server using the wifi module. The processor and server both come to know if the bridge needs any servicing when the sensor data crosses the threshold. The server data can be accessed by the user using an application. The server sends the alert message to the company head of the company which constructed the bride if the bridge needs any servicing with the help of real-time sensor data. Many bridges sensors are continuously monitored and the data are stored in the server. If any bridge sensor data needs alertness then the alert signal is sent to the company head of that particular bridge. The gates of the bridges get closed by servo motors if the bridge needs servicing and sensor data crosses more than the peak value. The proposed system can help to save many lives.

10. CONCLUSION

Live structures represent the cutting edge of civil engineering design and analysis. These are, at present, largely theoretical types of structure that will be possible one day in the not-so-distant future. Live structures are not only able to sense loads, deformations, and/or damage (through sophisticated and analysis systems), but they are also able to respond to the sensory input and take action to counter or correct the effects of loading. Recent developments in the area of self-actuating materials – materials which can change in shape and mechanical properties on command – are allowing civil engineers to consider the day when intelligent structures will both sense and respond to external loads and environmental influences. This paper presents a prototype of a novel self-powered wireless system for android applications of structural health monitoring of bridges. Conducted theoretical analysis facilitates selection of a natural frequency with the highest energy content and quick estimation of parameters for an electromagnetic harvester. Field tests sensor show the feasibility of the proposed approach for applications of structural health monitoring.

11. REFERENCES

[1] I. Khemapech, W. Sansrimahachai, and M.Toahchoodee, "A real-time Health Monitoring and warning system for bridge structures," *IEEE Reg. 10 Annu. Int. Conf. Proceedings/TENCON*, pp. 3010–3013, 2017, doi: 10.1109/TENCON.2016.7848598.

[2]. Y. T. Liu, J. H. Tong, Y. Lin, T. H. Lee, and C. F.Chang, "Real-time bridge scouring safety monitoring system by using mobile wireless technology," *Proc. -4th Int. Conf. Genet. Evol. Comput. ICGEC 2010*, pp. 501–504, 2010, doi: 10.1109/ICGEC.2010.131.

[3] https://www.hindustantimes.com/mumbainews/british-era-mumbai-goa-highway-bridgecollapses-over-savitri-river-due-to-rains/storybX3MCDs0swzmBKqjfrjPPI.html.

[4]. J. Zhang and W. Chen, "Design of a monitoring system of airport boarding bridge based on ZigBee wireless network," *26th Chinese Control Decis. Conf.CCDC 2014*, pp. 2486–2491, 2014, doi:10.1109/CCDC.2014.6852591.

[5] S. Xi, "Notice of Retraction The research of Bridge state monitoring system based on IOT technology," *Adv. Manag. Sci. (ICAMS), 2010 IEEE Int. Conf.*, vol.3, 2010, doi: 10.1109/ICAMS.2010.5553282 M4 –Citavi.

[6]] M. A. D. Sonawane, and M. N. Ms. Pooja. P.Vichare, Mr. Shubham. S. Patil, and P. Chavande,"Bridge Monitoring System Using IOT," *MAT Journals, J. Adv. Electr. Devices*, vol. Volume 3, no.Issue 2, pp. 1–3, 2018.

[7] S. K. P. Muddala, Divya, Dhanashree Kamble, Pooja Nimbalkar, Ravina Patil, "IOT Based Bridge Monitoring System," *Int. J. Res. Appl. Sci. Eng.Technol.*, vol. 5, no. 2, pp. 2044–2047, 2019, doi:10.22214/ijraset.2019.4420.