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Bridge Health Smart Monitoring System using IoT

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***Abstract*—Natural Disasters are happening all over the world due to some drastic changes in the behaviour of some natural conditions. Natural Disasters may destroy so many organized structures. They may affect the species on the earth. Disasters like an earthquake and tsunamis have a bad impact on the survival of species on the earth and create so much loss of population. They damage the construction quality of bridges and organizations due to this undoubtedly there will be absolute damage to the life of the architectural structures. To prevent these damages, we have to use the ability to monitor a wide variety of buildings. This process is referred to as health monitoring. This process will be done at a low cost and will be done in long term. We should take continuous measurements from economic factors and life secure points. In order to monitor the conditions on the bridge, we have to monitor the bridge structure by using a bridge monitoring system. By using this bridge monitoring system, we can know about the bridge conditions such as wind speed, temperature, the weight of the bridge, etc. By using different sensors such as crack detection, water level, vibration sensors, etc. we can compare the critical values after comparing generated results of comparison we can alter any disaster before its occurrence. In the proposed system we are using some sensors like vibration sensor, IR sensor, Ultrasonic sensor, and a load cell sensor to know the earthquakes, and weight of the bridge. Based on the values message alerts and buzzer alerts will be given to corresponding numbers.**

***Index Terms*— Monitoring, crack detection, water level, vibration sensor, IR sensor, Ultrasonic sensor, load cell sensor, buzzer.**

I. INTRODUCTION

Large infrastructures like buildings and bridges are the support the civilization and they are important to its daily actions. Civil structure surveyors will generally estimate the lifespan manually, but a computer networked system could make this huge task automatically and can estimate the structural integrity and any damaged location that could be measured a structure's lifetime, reducing its cost, and the overall safety of the public is improved. The strategies of Structural Health Monitoring (SHM) strategies measure the structural response which aims to detect effectively, locate, and assess damage generated by natural disasters and severe environmental damages. Structural health monitoring uses sensors having low cost,low profile, and a power constraints. It also needs the sensors to form a network that can constantly as well as accurately monitor the low-frequency response that often occurs in many infrastructures such as long-span bridges. In the proposed system we are using some sensors like vibration sensor, IR sensor, Ultrasonic sensor, and a load cell sensor to know the earthquakes, and weight of the bridge. Based on values message alerts and buzzer alerts will be given to corresponding numbers.

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Nowadays the stability of huge structures like a bridge, and buildings are monitored manually, and the traffic control of well -built vehicles over the bridge also needs to be done in a manual way. Rather than the traditional structure monitoring system, we can be done with the help of wired technology. Manual controlling of bridges can lead to unnecessary misuse of manpower and it is not much effective during the time of natural or man-made calamities. Also, a wired system is much more expensive, consumes more power, and this system is much more difficult to implement and maintain. In this method, the replica of the bridge has been designed with the same composition of the material as the one used in the bridge. And by performing several tests which are known as destructive testing on the bridge model, the strength and the lifetime of the bridge have been calculated. Ultrasonic C-scan can be done by sending out ultrasonic waves into the material. The reflections of these waves which are sent by the sensor are read by a transducer and sent to a computer program. This program will process the data and creates a two-dimensional map consisting of components of the bridge. In this proposed system we are using sensors like vibration sensors which are also known as piezoelectric sensors are versatile tools for the measurement of various processes. An IR sensor that can measure the heat of an object as well as detects the motion, an Ultrasonic sensor that converts the ultrasonic waves into the air and detects reflected waves from an object, load cell sensor that converts a load or force acting on it into electronic signals. Based on the values message alerts and buzzer alerts will be given to corresponding numbers. The paper aims to enable continuous monitoring of the bridge and ensure longer life spans for structures, we proposed a system i.e., IoT technology. In IoT technology, we make use of IR sensors, water level sensors, etc.It helps to avoid accidents in case of Natural disasters like earthquakes or floods. This system provides an automated system to keep track of the structure's condition and reduce the manual work required. The following sections have been used to implement the paperwork effectively. Initially, the literature survey section contains a base papers methodology where different people's papers works are considered for the proposed system technique which clears drawbacks of the base papers methodology. The related work consists of how the proposed system is implemented and the working mechanism of the system. Here, we have proposed a system that consists of sensors that have threshold values. Based on the values message alerts and buzzer alerts will be given to corresponding numbers. In the section containing the result screen, the output of the proposed system is shown. Finally, the conclusion and the future scope section which consist of what is the goal of the proposed system and any further implementation for the proposed system.

II. Literature Survey

Wang Xuejun, Zhang Yan [1], The purpose of the present paper is to develop pre-processing of the images, in order to transmit image data with the help of 3G or wired networks. And it uses high- level image servers to analyze the images. According to the characteristics of bridge crack images, this method selects the best processing algorithm and implements it in the system, as well as detects and recognizes the true bridge cracks. Finally, bridge cracks are classified using Deep Belief Network (DBN). It analyses the experimental data, and the system can find all bridge cracks beyond the expected and can identify the type of fractures that occurred in the bridge efficiently.

Mr. Pradeep kumara V H, Dr.Shubhangi D C [2], This system consists of sensor technology and GSM technology. The data or information on bridge health conditions is collected by sensors. According to that data is processed through a programmed microcontroller. If any fault arises in the heath of the bridge at the time of inspection or detection. It sends the data or informs the respective data related to nearby RTOs, Police Stations, and Hospitals. The Result of processed data is displayed on the LCD display, which is placed on both sides of the bridge for the understanding people. Also gives an indication to the people in the form of Red & Green signals for the transportation of vehicles on the bridge.

B Dhanalakshmi, A Prakadeesh, R Roshan Kumar[3], This system will check the water level and also the position in which the bridge is there from the ground. In case of any earthquake, floods, or any natural disasters the broadcasting of message is added. This system has a significant ability to monitor the environment of the bridge and the data is passed through the wireless communication and sends all the alerts regarding bridge health to the bridge management.

Elmer R. Magsino, John Robert B. Chua, Lawrence S. Chua, Carlo M. de Guzman, and JanVincent L. Gepaya[4], In this paper, the devices of Data acquisition act as an interface between both sensors and computers. The acquisition comes into the picture in a structural health monitoring system it captures the signals which are produced by a sensor and then it converts those signals into data which in turn is transmitted over a network via offsite computer.

III. RELATED WORK

An Embedded system is a kind of computer system which is used to design to perform several tasks like accessing, processing, storing, and controlling the data in various electronics-based systems. Embedded systems are generally a combination of both hardware and software where software is generally known as a firmware that is embedded in hardware. The most significant characteristic of these types of systems gives the result within the time limits. Embedded systems aim to make the work more perfect and convenient. So, embedded systems can be seen used in simple and complex devices too. In our real life, we can observe the applications of embedded systems like microwaves, calculators, and TV remote control, etc.

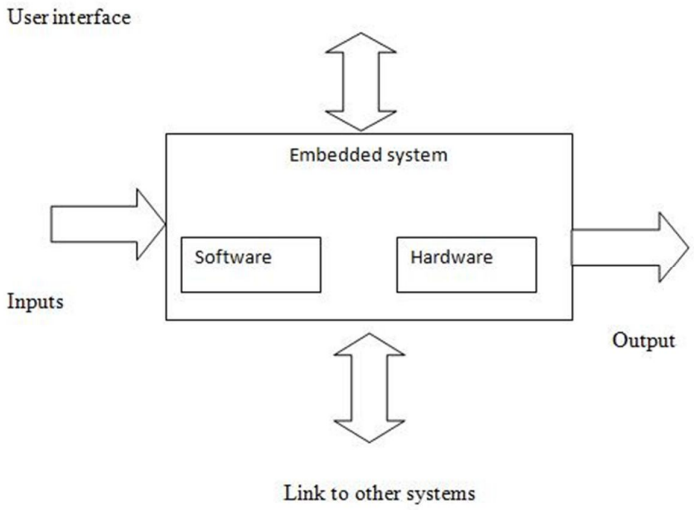

Fig. 1. Overview of the embedded system

To make the software [4][5] work with the embedded systems we need to bring both software and hardware together. So, for this purpose, we need to dump our source code into the microprocessor or microcontroller. This microcontroller will take care of all operations which need to be done by the embedded system according to the source code.

Arduino is the central part of this system which is a microcontroller that takes the periodical data from all the sensors i.e., Load cell, Vibration detector[6][7], Water level sensor, the ultrasonic sensor at totally different parts of the bridge. The data are collected from the system with the help of a microcontroller, and it is then passed to the wireless network. The current data at the transmitter is sent to the receiver and is analyzed by the Arduino Uno**.**

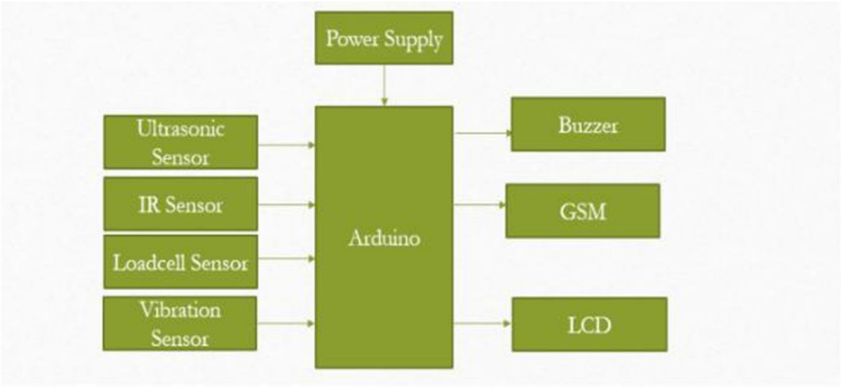

Fig. 2. Circuit diagram of bridge health monitoring system

Each sensor has its respective threshold value. If any of these sensors crosses the threshold value (which is already programmed and hold on to the Arduino controller) then we can view the amount of damage that can be

occurred in the bridge in LCD, and the warning sound is going to be made through the buzzer thereby it can be updated with this bridge condition[8][9][10].

System Execution

Firstly, we need to download Arduino's software from the main website. It is looked as shown below.

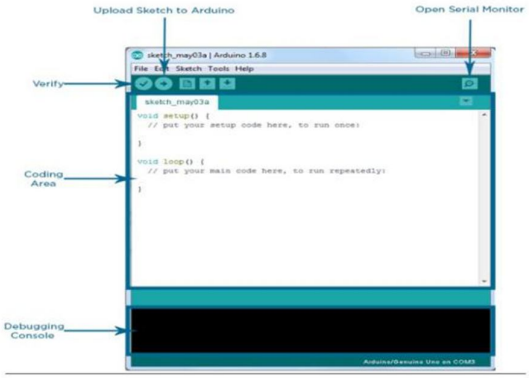

Fig. 3. Arduino Software

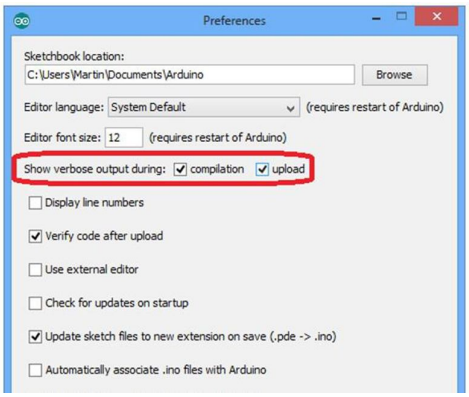

Fig. 4. Preferences section in the Arduino

Secondly, in the preference section and check for the section of compilation, the Output Pane will show by the code of compilation as you click the upload button. At the end of the compilation, the hex file will be shown at the end, and it has been generated by the recent sketch that will send to the Arduino board for the specific task that aims to achieve. In the menu board, the required code will be written that helps to execute the system.

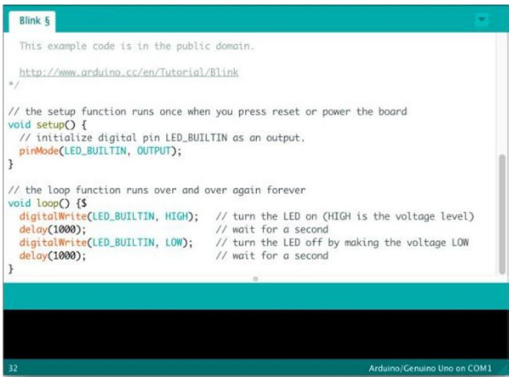

Fig. 5. Writable code

Fig. 6. Arduino Uno

The Fig 5. Describes that the code which is executed in the Arduino software already consists of threshold values, if the sensors in the system cross the threshold values the alert will raise. Fig. 6 is the Arduino uno which is the main part of the system that helps to collect and transmit the data. The threshold limits or values of each sensors are already stored in the Arduino and based on the increase in values the alarm will be triggered. Fig. 7 is a ultrasonic module is connected to the Arduino microcontroller which helps to determine the distance between the water level from the ground.

Fig. 7.IR sensor

Ultrasonic module is connected to the Arduino microcontroller which helps to determine the distance between the water level from the ground. Fig. 7 is an IR sensor which has a capability to measure the heat of an object as well as detects the motion.

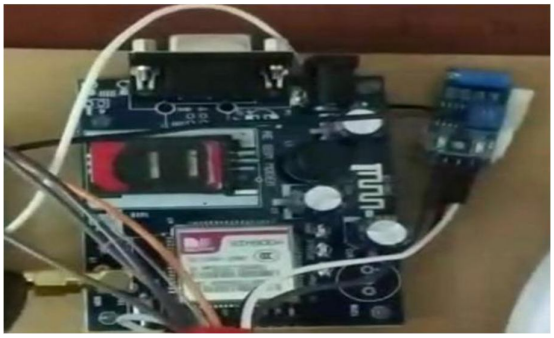

Fig. 8. GSM

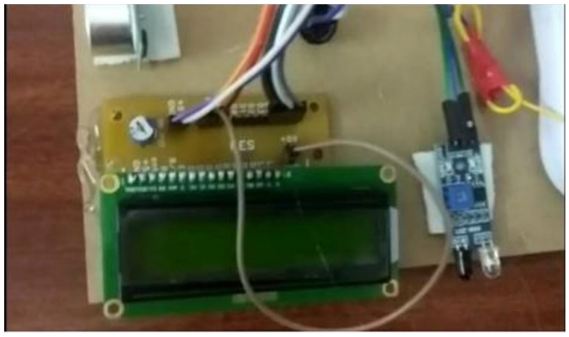

Fig. 9. LCD display

Fig. 8 is a GSM modem which is a device that can be either connected to a mobile phone device that is used to make a computer to communicate with each other over a network.Fig. 10 is an 16X2 display which displays 16 characters in two lines. In this system the LCD is used for displaying purpose.

IV. Result Screens

The result can be viewed on the LCD display. Fig 14. Displays the channel which is created in Thing speak cloud and sets it as private view because it cannot be viewed by other parties. In this channel, we created fields for the sensors which are used in this system.

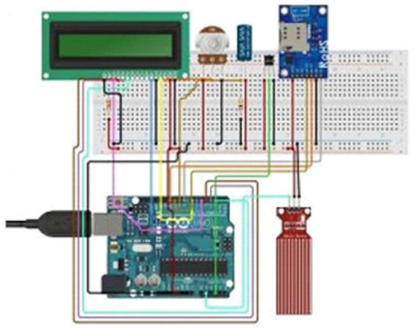

Fig. 10. The complete model of the Bridge health Monitoring system

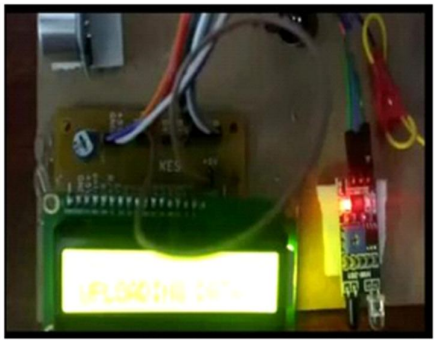

Fig. 12. Output of LCD

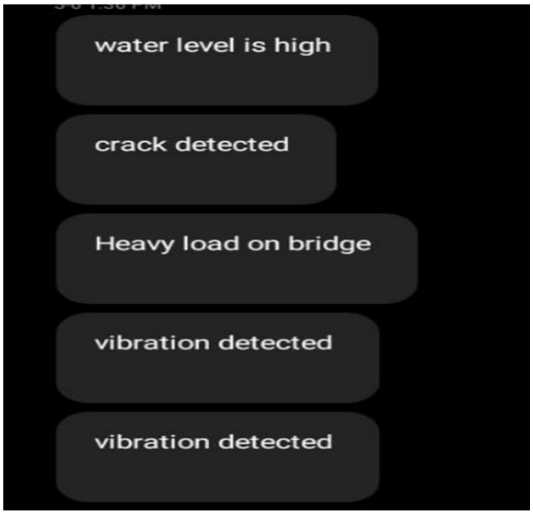

Fig. 11. Message viewed by the bridge management

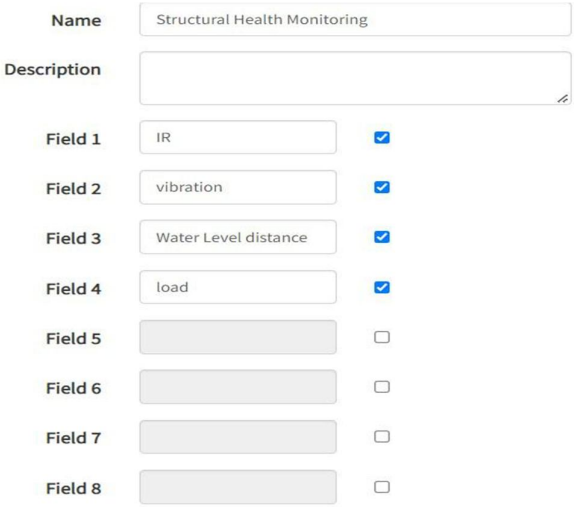

Fig. 13. Channel in Thing speak cloud

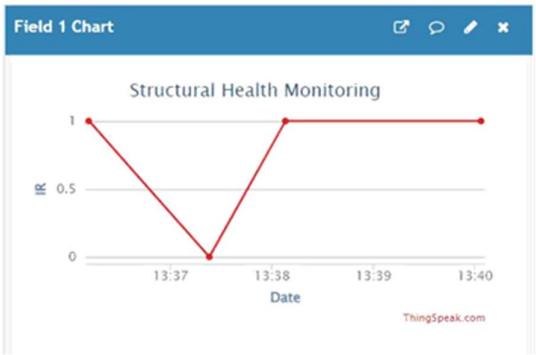

Fig. 14. IR Sensor output

Fig. 15. Vibration Sensor Output

Fig 15 whenever the cracks are identified by the system the IR sensor will be activated along with that the buzzer alarm is raised. Once the IR sensor is triggered the data is uploaded into the thing speak cloud and the resultant is a graph which is displayed above.

Fig 16 whenever the vibrations are detected by the system the vibration sensor will be activated along with that the buzzer alarm is raised. Once the Vibration sensor is triggered the data is uploaded into the thing speak cloud and the resultant is a graph which is displayed above. Fig 17 whenever the water level distance is increased in the bridge the system having an ultrasonic sensor will be activated along with that the buzzer alarm is raised.

Fig. 16. Ultra-Sonic Sensor output

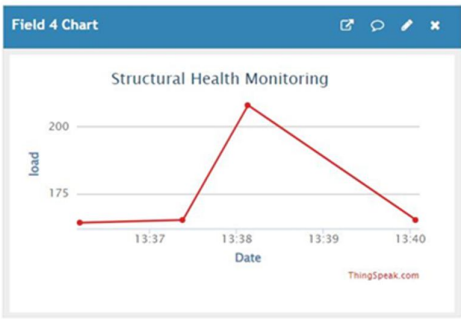

Fig. 17. Load Sensor Output

Once the ultrasonic sensor is triggered the data is uploaded into the thing speak cloud and the resultant is a graph which is displayed above. Fig 18 Whenever the load on the bridge is exceeded by the increase in the amount of vehicles the system the load cell will be activated along with that the buzzer alarm is raised. Once the load cell is triggered, the data is uploaded into the thing speak cloud and the resultant is a graph which is displayed above.

V. Conclusion & Future Scope

In real -time, structural health condition monitoring is a crucial and popular issue. Earlier the sensor technology is continuous, and the condition monitoring hasn't that much accurate and easy to implement in real-time. Using wireless technology and some sensors, a smart system can be developed for securing bridges. This system will check the water level, detects cracks, can calculate the maximum load applied on the bridge for safety purposes. In emergency situations like earthquakes, floods, etc. broadcasting of messages is also added. The current System is significant as well as unique because it has its own ability to monitor the environment of the bridge, it passes the data of the environment of the bridge through wireless communication it sends alerts to the bridge management staff i.e., In real-time Monitoring Centre in for prompt action also to users. The main motive of the structural health Monitoring System is to save the lives of the people and to protect them from accidents.

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