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Bridge Health Monitoring System using IOT

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Abstract - *Internet of Things has always taken up a step forward towards providing solutions with great ease. One such system in which the Internet of Things is emerging as a good solution to some extent is the bridge health monitoring (BHM).Bridges are such Clementine materials which are day-night exposed to extreme climatic conditions causing their wear and tear in various aspects. These factors can be: cracks on the bridge surface, overload on the bridge, flood conditions near the bridges etc.This BHM system would use various sensors (water level sensor, IR sensor, etc.) to collect the data, an algorithm (Rapid screening algorithm, image processing) or technique can be used to solve the cracks detection problem in tough or hard to reach areas of bridge. The data can be analyzed and computed to check whether the bridge has any cracks, or has any flood like conditions near it. If at all there is something wrong with the bridge condition regarding the large number of cracks or rising water level, an alert message can be sent to the concerned person. The result of this system would be used to analyze the real time health of the bridge and to take necessary actions towards safety if there is any negative output.*

Keywords: **Crack detection, Water level detection, Sensors, Bridge health monitoring, etc.**

1. INTRODUCTION

Bridges are our everyday means of traveling for everyone. These bridges are present in various surrounding conditions which can be extreme as well as some slow harm causing factors. The extreme conditions causing harm or degrading the bridges condition can be flooding of water waves, scorching heat, earthquake frequencies, etc. Similarly, the low harm causing factors can be highly loaded vehicles passing more often on through the bridge, Surplus usage of bridge, ignorance of timely maintenance of bridge, etc.

We can see that some bridges in our surrounding are old and safe to use conditions, while there are also some bridges which are newly built but still unsafe due to some ignored factors. This is because the health of any bridge depends on the elements and conditions considered while constructing these bridge. The factors like the climatic conditions throughout the year near the bridge to be constructed, the pattern of heat and water near the bridge, the frequency and type of vehicles passing, the location of the bridge should be considered for its geographical appearance.

In structural health monitoring system, one of the difficult structures to look after is a 'bridge'. Every bridge has some places where a human inspector can't reach because these places are out of human reach. The places like the base surface of the bridge, the huge concrete pillars, etc. There needs a monitoring system which can keep an eye or track of the health at such places of bridge.

The Internet of Things can be such a solution to any problem which doesn't require any human intervention for inputs to be processed. IoT system for bridge health monitoring can be a way through which the bridges can be looked after without any human intervention.

An IoT system consisting of various hardware and software components along with some cloud storage system can be used over the bridge surface for this particular problem. The module built can be used to collect various kinds of data regarding the structure (in this case 'bridge'). This collected data can be analyzed and if at all the system catch holds of any anomalies, then the concerned authorities would receive the alert notification.

This kind of system would reduce many human errors caused during inspection of bridges. An early stage of damage may reduce its maintenance cost and time to be spent on it. The notification sent by the system can result in taking necessary actions towards safety measures. The system would be used for monitoring the bridges remotely without any human interference. The real-time data collected by the system would result in early and effective outcomes for avoiding future harm to many lives.

2. LITERATURE SURVEY

SR. NO.	PAPER NAME	AUTHOR NAME	PUBLISHED YEAR	ADVANTAGES	DISADVANTAGES
1	A case study of integrating IoT technology in Bridge Health Monitoring.	Zu and Xingyu Xu Qiaohong	2020	The system gave accuracy, timeliness and accessible outcomes over the conventional approach of use of sensors.	In spite of having the key features satisfied, the system had fewer applications due to the complexity of modules which in future might result in degradation of the outcomes.
2	Bridge Safety Monitoring System using IOT	B Dhanalakshmi, A Prakadeesh, R Roshan Kumar	2020	The system helps to monitor and maintain the condition of the bridges in the water bodies and to prevent the public on the bridge at the emergency situations.	High power consumption
3	Design and Implementation of Real time monitoring of bridge using Wireless technology	Mr. Pradeep kumara V H, Dr.Shubhangi D C	2020	The traffic can routed to avoid major damage to the property.The bridge damage can be detected very early. So that quick action can be taken on that situation.	The app updation must be done for better user-friendly data analysis.
4	IoT Based Bridge Health Smart Monitoring System	Akshata Dhuri, Snehal Kadam, Pratiksha Jogale, Latika Kawade	2020	Useful to avoid accident and the status of the bridge is displayed on LCD	This system is implemented on high cost.
5	A continuous Water Level Sensor Based on Load cell and Floating Pipe	Sheng-Wei Wang; Chen-Chia Chen, Chieh-Ming Wu, Chun-Ming Huang	2018	The feasibility of the method changes in the water level of 1mm, which can be easily grasped and used to immediately control the water level.	The cell calibration is susceptible to change in environment temperature.
6	The Detection and Recognition of Bridges Cracks Based on Deep Belief Network	Wang Xuejun, Zhang Yan	2017	The system gave automatic classifications of bridges cracks and types of fractures according to the needs.	For accurate detection, large data set of images was the main need which in turn requires large storage and then the process becomes time consuming.

7	A Rapid Screening Algorithm Using a Quadrotor for Crack Detection on Bridges	Elmer R. Magsino, John Robert B. Chua, Lawrence S. Chua, Carlo M. de Guzman and JanVincent L. Gepaya	2016	Local dark regions of an image of cracks are also located.	Not every image has the same file size so the delays vary with respect to its size.

3. PROPOSED SYSTEM

3.1. BLOCK DIAGRAM

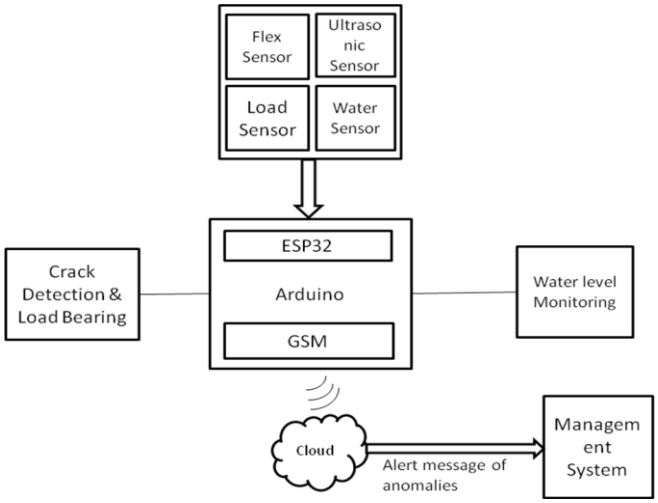


Fig. 1

3.2. WORKING

The internet of things is the technology used for evaluating the real time condition of the bridge. The proposed system consists of sensors like flex sensors, ultrasonic sensor as sensing devices. In this system, the controller used will be connected to sensors for collecting data. This data will passed through Wi-Fi module by TCP/IP stack. Collected data will be processed to take decision & finds out the condition of the bridge i.e. 1. Normal 2. Heavy 3. Critical. In the critical condition either water level or crack or load, controller turns on the GSM module and sends SMS continuously to authorized person so they will take action regarding infrastructure of bridge. The data collected by the sensors will get converted into a electrical signal to be send to the esp32. The electrical signal will get transmitted to esp32 microcontroller. The data is collected in the real time database thingspeak cloud which provides real time data.

3.3. ALGORITHM

1. Initialize all the peripherals and TCP/IP stack.

2. Connect to GSM module for range.

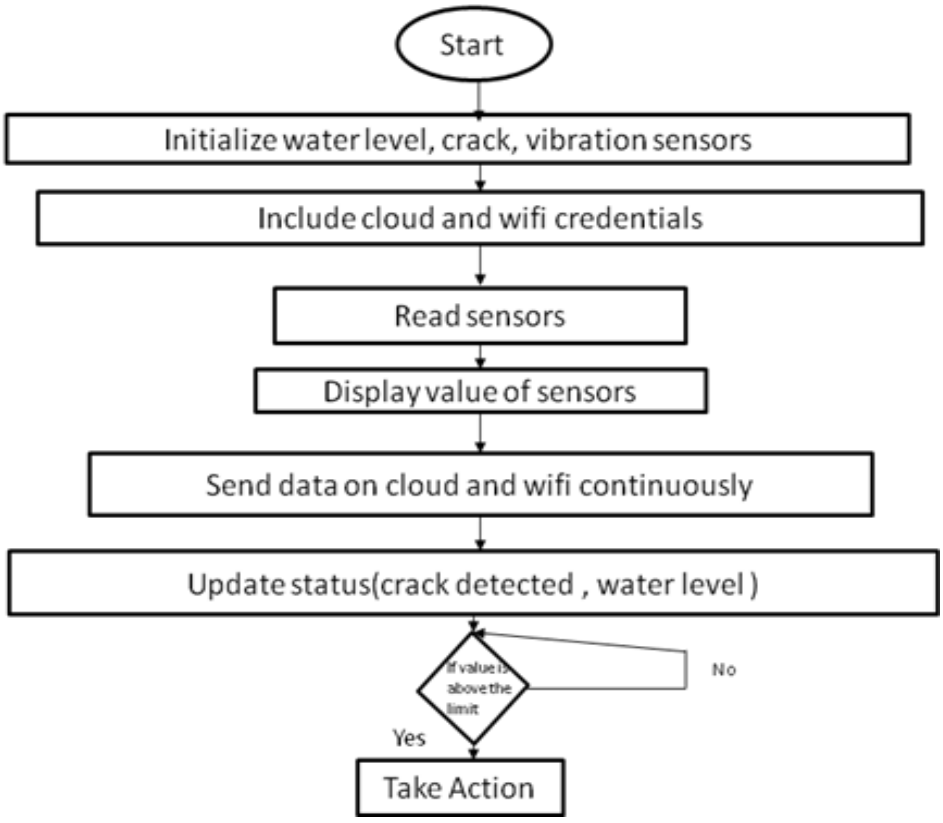
3. Connect with server.

4. Start sensing data from sensors.

5. Process raw data & take decision i.e. condition of bridge.

6. If condition is critical it sends alert message.

7. Similarly, with this it will upload sensor data on cloud.



4. RESULTS

The subsequent monitoring outcomes are obtained by flex sensor and ultrasonic sensor. These real times monitoring outcome are recorded on web server. In thingspeak cloud we create the channels for receiving the sensed data from the sensors. Each channel having own API keys for specific destination address.

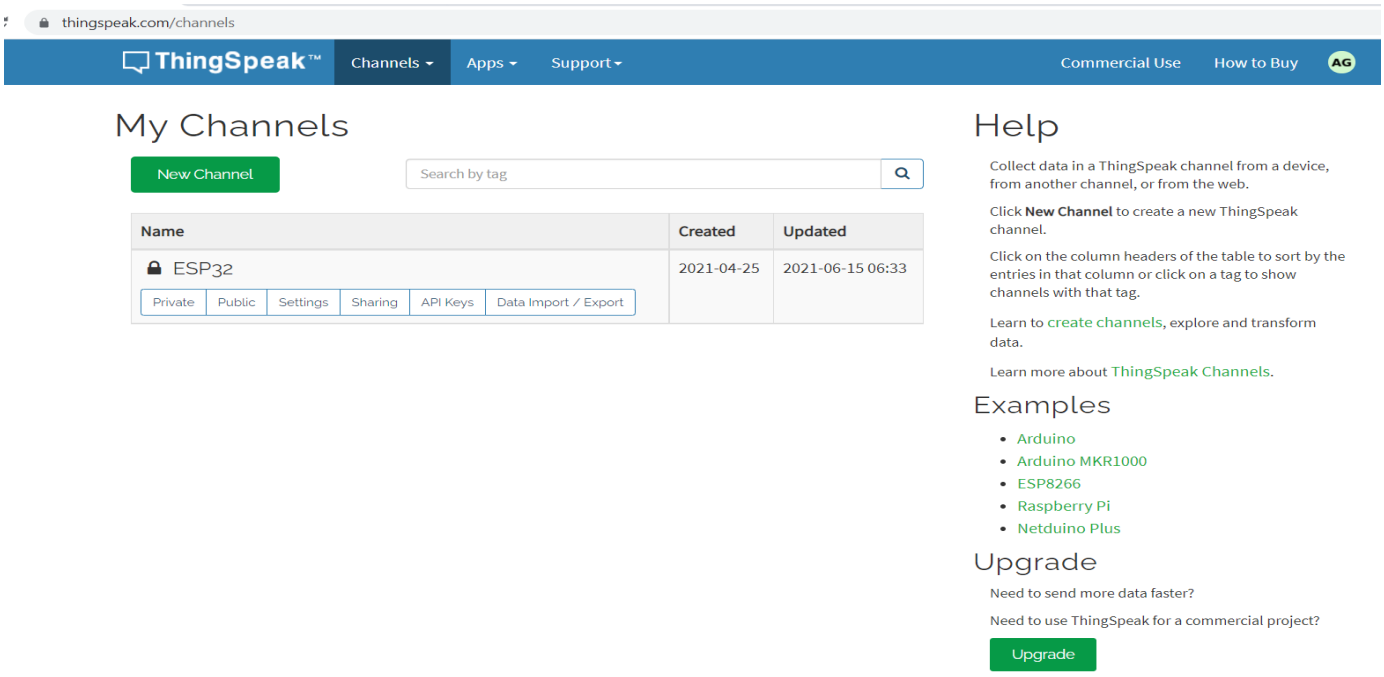


Fig. 2

The results are acquired in the form of graphs. The outputs from various sensors stored in thingspeak cloud database are as shown in Fig 3. The flex sensor gathers information about load content. The information is sent to cloud database by utilizing ESP32 Wi-Fi module. The cloud database stores the esteem originating from sensor which can be pictured remotely in the cloud dashboard. The information originating from ultrasonic sensor is sent to the cloud database using Wi-Fi through HTTP protocol. The cloud database stores the esteem originating from sensor which can be pictured remotely in the cloud dashboard. Fig demonstrates the graphical form of information in the cloud, sensed by the sensor nodes.

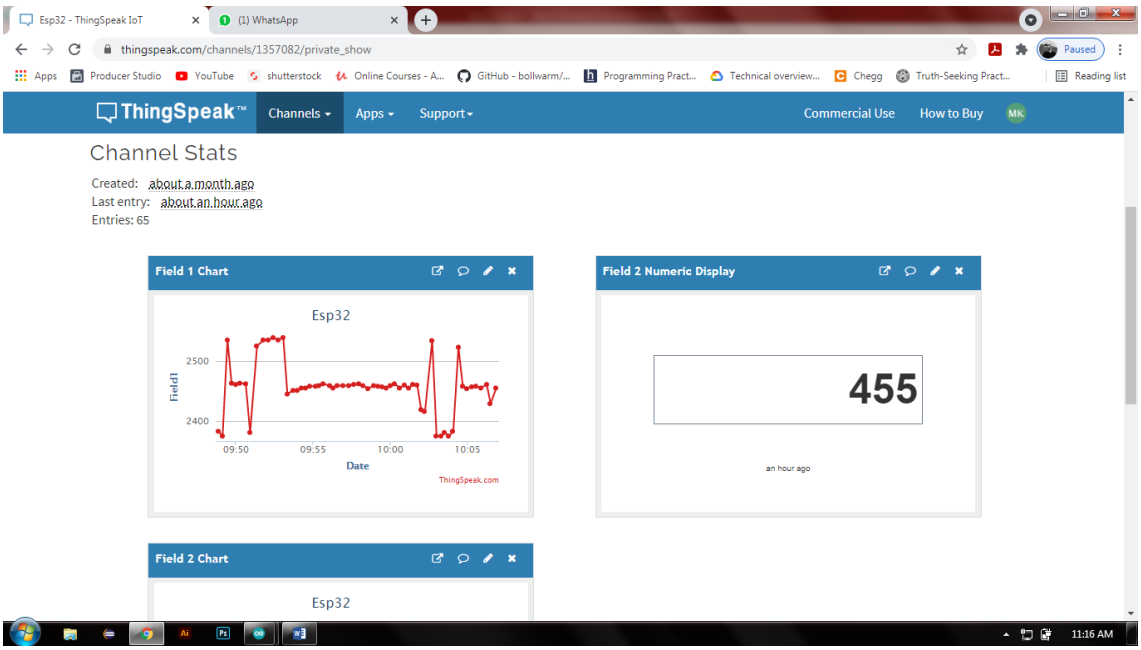


Fig. 3

After the collection of all the data, if sensor reaches the threshold value then it creates a trigger. A message regarding the condition of the bridge with particular sensor value is generated and sends to the bridge authorities. The message describes the sensor value and hence alerts about the danger. Fig 4 and fig 5 shows the message generated at the time of danger.

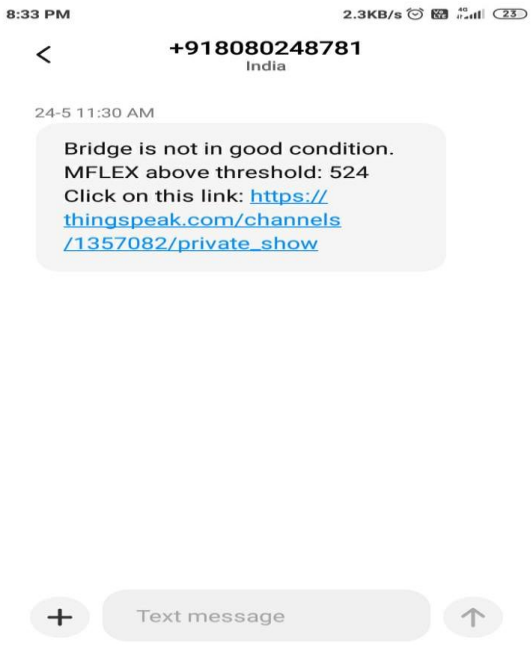


Fig. 4

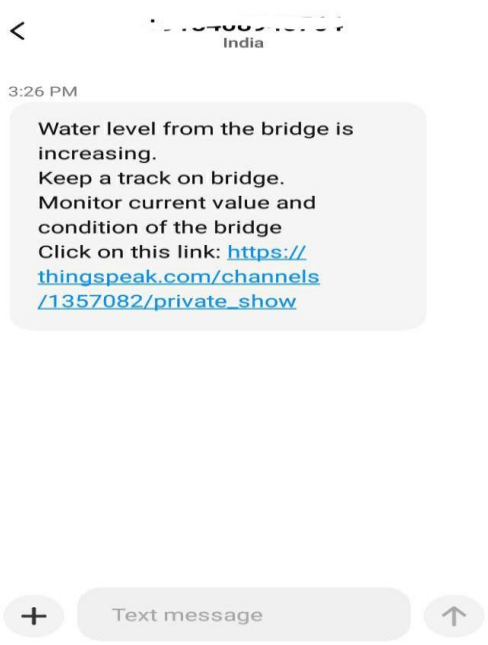


Fig. 5

5. ACKNOWLEDGEMENT

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6. FUTURE SCOPE

In future , the prototype of the system can be implemented as various structures like giant walls, other than buildings and bridges which makes it robust, portable and more user friendly than the already existing technologies.

7. CONCLUSION

The purpose behind the IOT based Bridge Health Monitoring System is to solve the various problems of bridge safety and its management. In this proposed system we will be able to detect and monitor the cracks , load , and water level of the bridge . It will transmit environmental data through sensors to the server and send alert to the management center in real time. The system will help to save the lives of the people and avoid accidents.

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