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A LOW COST MULTI-SENSOR FOR INVESTIGATING THE STRUCTURAL RESPONSE OF BRIDGE

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***Abstract*— As per the report, as many as 1,217 people died and more than 5,000 people have been injured in incidents of bridge collapses throughout the country in past 15 years. Where in Mumbai around 6 bridges have been collapsed in past 7 years and caused 28 deaths where these are manmade tragedy, where at least one similar incident have been reported in Mumbai since 2010. The proposed system analyses the performance of IoT based bridge health monitoring system to determine the change in structures, overall weight of the vehicles on the bridge, vibration and deformation, also cracks at critical places. The key benefit of using IoT is that it has a higher degree of output quality and the introduction of new technology would make the system smarterand more receptive. IoT network reduces the risk of human errors and harm to the bridge caused by human and natural disasters can be minimized. The surveillance of bridge is complex task, however employing IoT and cloud would make the system simple as stated further. The tracking sensors serves with important values intended for spotting the impending catastrophe and quickly produce excessive acoustic sound over long distance possible to alert about disaster for people using the bridge. Various sensors are used to monitor the health of the bridge and track the same using IOT.**

Keywords—IOT, Blynk mobile application, SHM

I. INTRODUCTION

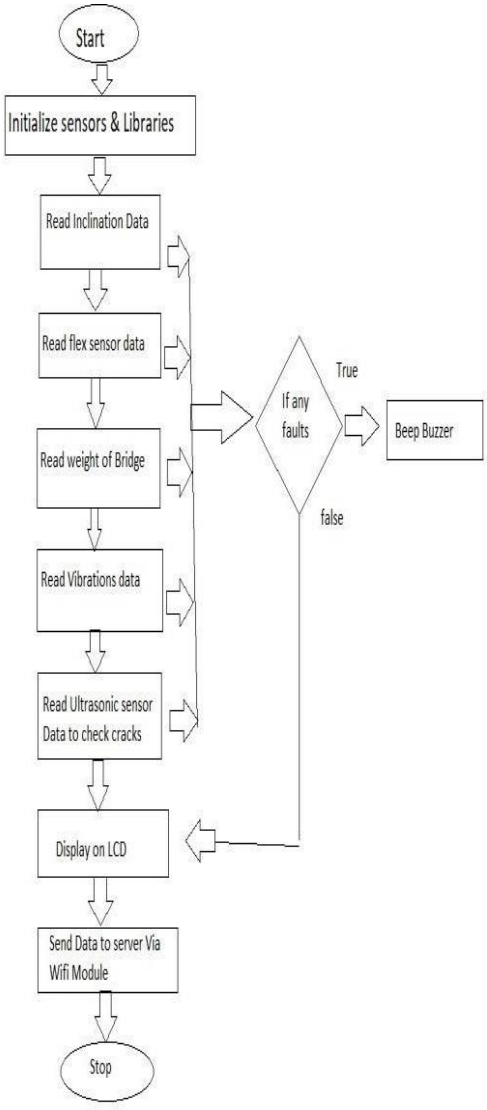
Nowadays, a bridge represents an important part from the transportation infrastructure which is intensively used for the development of social and economic activities of a country. For example, Italy has a lot of long-span bridges used in both ruttier and railway transportation, which need regular monitoring and maintenance. Novel systems, such as those using IoT technology, could be adopted in order to monitor the state of health of the bridges in real-time by a centralized traffic management. Majority of these bridges are located in a remote area therefore a difficulty in data management is present.

A bridge is a physical structure built to overcome an obstacles, such as water body, railway track, or a road, without blocking the path under the bridge. Bridge is built for the purpose of crossing over the obstacle. There are many different types of bridge where each of them serves a purpose and it will apply to different scenarios. Designs of bridge varies according to the usage of the bridge, the environment where the bridge is being constructed.

Given weaker structures, vibration and dynamics are generally more significant. While the bridge response to the loading applied is well understood, the traffic loading applied to the bridge itself is still being investigated. This is a major problem as loading is highly variable, especially for bridges. Loading effects in bridges (stress, bending moments) are designed for the use of load and resistance factor design principles. There are many different methods used for monitoring the bridge condition. Many long-range bridges are now monitored routinely with a wide range of sensors. Many

types of sensors are used, including strain gauges, water level sensors, vibration sensors, ultrasonic sensors and flex sensors.

II. METHODOLOGY



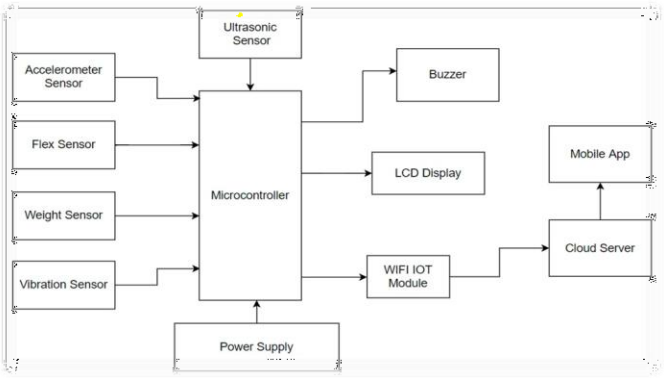
Load upon the bridge is calculated using a load cell. This module uses 24 high-precision A/D converter. This chip is designed for high-precision electronic scale and design, has two analog input channels. This sensor helps in identifying weight of the bridge.

Flex sensors are used in detection of structural bends. flex sensor is a kind of sensor which is used to measure the amount of defection otherwise bending. If any bends are found then it can be easily identified. Dynamic vibrations are sensed using vibration sensor.

Ultrasonic sensor to track any cracks. An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves.

Accelerometer's sensor for any tilt. This sensor helps in identifying is there is any tilt or structural change.

III. BLOCK DIAGRAM



The block diagram of bridge monitoring system using IOT consists of ATmega328P microcontroller to which all the data will be send. Load upon the bridge is calculated using a load cell. This module uses 24 high-precision A/D converter. This chip is designed for high-precision electronic scale and design, has two analog input channels, programmable gain of 128 integrated amplifier. This sensor helps in identifying weight of the bridge. Weight sensor monitors the weight of bridge. It is connected to microcontroller's Analog pin. Vibration sensor checks if there is any vibrations which is greater than threshold. Dynamic vibrations are sensed using vibration sensor. It is connected to microcontroller's Digital pin. Wi-Fi IOT module is an extra module used to connect microcontroller to cloud server. It is connected to microcontroller's Tx and Rx pins. 12v power supply is given to operate this model. If any one of the parameters has discrepancy immediately Buzzer beeps. All the parameters data will be live monitored on app with the use of IOT and displayed on LCD as well.

IV. HARDWARE AND SOFTWARE REQUIREMENTS

A. ARDUINO UNO:

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial

communication, voltage regulator, etc. to support the microcontroller.

B. NODEMCU(WI-FI MODULE):

It is an open source-based firmware for the ESP8266 Wi-Fi SOC from Espressif and uses an on-module flash-based SPIFFS file system. NodeMCU is implemented in C. 128KB RAM and 4MB Flash memory for program and storage just enough to cope with the large strings that make up web pages, JSON data and everything we throw at IoT devices nowadays.

C. ACCELEROMETERS(ADXL335):

It is an electromechanical device that measures the force of acceleration due to gravity in g unit. The ADXL335 measures acceleration along X, Y and Z axes and gives analog voltage output proportional to the acceleration along these 3 axes. The ADXL335 gives complete 3-axis acceleration measurement. This module measures acceleration within range ±3 g in the x, y and z axis.

D. FLEX SENSOR:

The flex sensor is a kind of sensor which is used to measure the amount of defection otherwise bending. The designing of this sensor can be done by using materials like plastic and carbon. The carbon surface is arranged on a plastic strip as this strip is turned aside then the sensor's resistance will be changed. Thus, it is also named a bend sensor.

E .HX WEIGHT SENSOR:

This module uses 24 high-precision A/D converter. This chip is designed for high-precision electronic scale and design, has two analog input channels, programmable gain of 128 integrated amplifier. The input circuit can be configured to provide a bridge voltage electrical bridge (such as pressure, load) sensor model is an ideal high-precision, low-cost sampling front-end module.

E. SW-420 VIBRATION SENSOR:

Vibration Sensor (SW-420). It is a high sensitivity non-directional vibration sensor. When the module is stable, the circuit is turned on and the output is high. When the movement or vibration occurs, the circuit will be briefly disconnected and output low. At the same time, you can also adjust the sensitivity according to your own needs.

F. ULTRASONIC SENSOR(HC-SR04):

It is an instrument that measures the distance to an object using ultrasonic sound waves.

H .LCD DISPLAY 16*2:

It is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

I. BLYNK MOBILE APPLICATION:

Blynk is a platform which was designed for the Internet of Things. It can control hardware remotely; it can display and store data and can also visualize it. The Blynk platform consists of 3 major components, namely, the Blynk Mobile Application, the Blynk server and the Blynk libraries.

V. APPLICATIONS

- The proposed system is for Bridge Monitoring system.
- Can be used to identify water levels as well.
- Can be extended to structural Buildings.
- The same proposed model can be used for protecting Historic monuments.
- The collected Data can be used for analytics to predict life of a structure.

VI. ADVANTAGES

- Assurances of a structure's strength and serviceability.
- Reduction in down time

- Improved maintenance and management strategies for better allocation of resources
- Proposed system will avoid death of people due to bridge collapse
- We notification about which bridge requires for maintenance before it gets unwanted incidence.

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