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IOT BASED BRIDGE SAFETY MONITORING SYSTEM USING ARM CORTEX

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Abstract: IoT based bridge safety monitoring system using ARM Cortex is built using wireless technology. Modern sensor technology has assisted in the development of the automated bridge safety monitoring system. Sensors can be used to collect a variety of information, such as data on vibration, water level, and fire. The main objective of the system being proposed is to create a system that can prevent accidents or structural disasters of flyovers and bridges and knowing the integrity of structures that are now in use on an ongoing, real-time basis enables safety maintenance and increases the lifespan of buildings that are currently in use. Early identification and detection of infrastructure flaws and damage are necessary to carry out preventive maintenance. The technology called the IoT is used to assess the bridge's status in real-time time. Various forms of data, including vibration, water level, temperature, and fire, can be gathered by using wireless sensor nodes. These details would also be helpful for assessing the state of the bridges. In case of emergency situations the gates of the bridge will be automatically closed. The collected information is sent to Thingspeak cloud and database so that administrators can keep track of the state of the bridge in real time.

***Keywords* - Bridge Safety Monitoring, Structural Health Monitoring System, IOT, Crack Detection, Wireless Sensor Network, Bridge Condition, GSM.**

I. INTRODUCTION

In today's world, transportation is extremely important. Because of this, the bridge is a crucial component of the nation's social and economic infrastructure. Bridge construction needs to be extremely robust, and such bridges also need to have their structural health status monitored. Because of overloading, ageing, bending, natural disaster, and several other negligent maintenance practices, bridges suffer from structural deficiencies. This indicates that there are safety issues with the bridge. In such a case, the bridge may collapse, leading to several losses such as accidents, fatalities. This occurs because there is currently no effective system in place to notify users of the bridge's present state when it is not in a safe mode.

Such a problem-solving approach that doesn't depend on humans to interpret inputs is possible with the Internet of Things. A bridge's environmental data can be monitored by an IoT system for bridge safety monitoring, allowing for maintenance of the structure without the need for human interaction.

For this specific issue, a cloud storage system and an IoT system made up of various hardware and software components can be used over the bridge surface. The built-in module can be used to gather various types of information on the structure (in this case, "bridge"). If the sensed data reaches the threshold level, it can be evaluated and sent to the Thing speak cloud.

The primary goals of the Bridge Safety Monitoring System are to:

- Ensure bridge safety.
- To prevent accidents in the event of inclement weather.
- To boost the effectiveness of the bridge.
- To remove the financial and technological constraints.

II. LITERATURE SURVEY

In [1], Tirth Patel, Abhishek Jain, Dharak Gameti, Umang Patel and Rutu Parekh proposed structural health monitoring system for bridges. The accelerometer in the system is used to measure bridge vibration. The Bluetooth module in the Arduino UNO recognizes the vibration's frequency and transmits it to a receiver. To locate the damage and assess its severity, the receiver does the necessary computations in MATLAB. Knowing where and when the bridge needs to be rebuilt can be determined with the help of the damage.

In [2], Pradeep Kumara V.H. and D.C. Shubhangi proposed design is useful for flyovers and bridge monitoring. Monitoring devices in the form of sensors, such as tilt, vibration, load, and water level sensors, are integrated into the design. A database is employed to keep track of a bridge's state. The monitoring devices receive data, which is calculated and analyzed using the CPU. Bridges and flyovers are being monitored in real-time by the design.

In [3], Jin-Lian Lee proposed IoT-based bridge safety monitoring system and developed it using Zigbee technology. The monitoring system consists of a dynamic database that stores bridge condition data, monitoring devices installed in the bridge environment, communication devices linking the bridge monitoring devices and the cloud-based server, and a cloud-based server that computes and analyses data transmitted from the monitoring devices.

In [4], George Mois, Teodora Sanislav and Silviu C. Folea proposed the creation of a cyber-physical system that tracks the ambient conditions in indoor environments at distant places. The system's components communicate with one another utilizing the current wireless network, which is based on the IEEE 802.11 b/g standards.

In [5], Ittipong Khemapech, Watsawee Sansrimahachai and Manachai Toah choodee proposed several sensor platforms, including a strain gauge and an accelerometer, are used in this work to monitor the deformations or motions of the bridge structures. Apart from the specific goal data, the technical and physical characteristics of the structural member, such as the support type and shape, are the main factors that influence the choice of sensor platform. Pre-stressed concrete bridge girders, which are important parts of an expressway in Bangkok, were examined in this study. The Microstrain sensor platform is built with the LXRS network protocol. It is compatible with the 2.4 GHz frequency band of the IEEE 802.15.4 standard. Time synchronization can be accomplished, according to, in 32 microseconds. Up to 2 kilometers can be communicated over open space with line-of-sight.

In [6], Christian Lazo, Paulo Gallardo and Sandra Cespedes proposed a wireless bridge health monitoring system. Zigbee is utilized as a wireless network for short-range (among sensors in the bridge) IEEE 802.11 wireless communication, while GSM is used for long-range (between the bridge and the management Centre) data connection. This system, also known as MBM (Monitoring Based Maintenance), enables bridge maintenance engineers to continuously monitor the state of the bridge. The bend, traffic, vehicle weight, and other factors are monitored by sensors placed at various points along the bridge.

In [7], Ashwini R, Sneha Shivan and Mesta, Varsha A U, Ravichandran G and Haritha K, Sivaraman proposed The Bridge Health Monitoring System adopts a three-level distributed topology with a central server, intelligent acquisition node, and local controller. The acquisition node is an intelligent gadget with a potent ARM processor at its core. In the acquisition node, signals from multiple sensors are examined and the data is compressed in real-time. Through wireless networks, the local controller just receives the processing results. This procedure can lessen a central server's workload and the need for communication bandwidth.

In [8], Mr M.V.N.R.P.Kumar, Ms B.Hombal, Miss. J.D. Kadam, Mr.A.B.Yadav and Mr.B.M.Pawar proposed new idea of bridge health monitoring systems suggested GSM for long distance (between the bridge and the management centre) data communication is tested. Bridge conditions are sensed by sensors such as the accelerometer, thermometer, strain gauge, and anemometer, which are interfaced by PIC microcontroller. Since the sensors on the bridge communicate information to the control centre over the mobile GSM network, they may detect any changes in those parameters. These parameters are shown on the LCD as well. It is made up of a PIC microcontroller.

III. SYSTEM ARCHITECTURE

The internet of things is the technology utilized to assess the bridge's condition in real time. The proposed system is created utilizing a sensor unit that consists of an ultrasonic sensor, a vibration sensor, an IR sensor, a fire sensor, and a temperature sensor. All of these sensors in this system are linked to a microcontroller, which is in charge of sensing data (condition of bridges in terms of some parameters like water level below bridge and temperature). These data are subsequently sent to a microcontroller, who is in charge of acting in response to the data received. The moment sensing data exceeds the threshold value; the microcontroller triggers the buzzer, displays a warning message on the LCD, operates the gates and barricades, and then transfers the data to the GSM module for transmission to the Thing Speak cloud. The information is gathered in the real-time database thingspeak cloud, which offers real-time information.

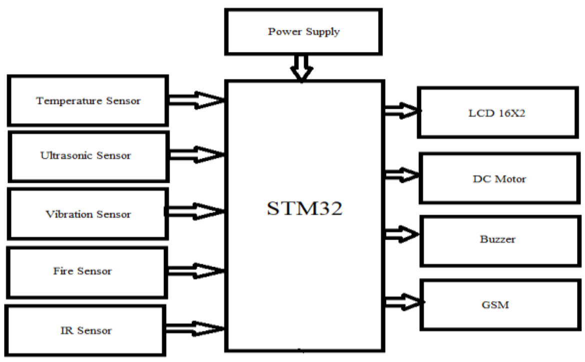

Figure 1: block diagram

The components of this system are as follows:
1. GSM Module (SIM900A) - The monitoring system will receive the status of the entire bridge through the GSM module. GSM module that sends sensed data to the "Thing speak cloud," for storage.
2. Vibration sensor - This device detects vibrations to determine whether or not the bridge is in good condition.
3. Ultrasonic sensor - The presence of water is detected using an ultrasonic sensor.
4. IR sensor - An IR sensor is utilized to determine whether or not barricades are present.
5. Fire sensor - A fire sensor is utilized to find fires.
6. Temperature sensor- This device measures the bridge's temperature.

7. Barrier with DC motor - Barriers with DC motor will close if fire is discovered; the water level rises or the bridge vibrates above the default level.
8. LCD - It shows sensor data and display warning messages.
9. STM32F103C8T6 Blue Pill Development Board - It contains a 32-bit Cortex-M3 RISC ARM core. It has 64Kbytes of flash memory, 20Kbytes of SRAM, 37 GPIO pins and 10 Analog pins. The STM32F103C8T6 microcontroller is utilized to handle all hardware and software programming for the bridge monitoring. This small module allows micro-controllers to connect to a GSM and various sensors.

IV. RESULT

The temperature, vibration, and ultrasonic sensors produce the results of the subsequent monitoring. We design channels in the thing speak cloud to receive sensed data from the sensors. Graphs are used to represent the results. The results from numerous sensors are represented in Figure 2, Figure 3 and Figure 4 and are kept in the thing speak cloud database. We also looked at the bridge's condition and the water level in this system. Information is sent to the cloud database using the GSM module in an emergency situation, or if data exceeds a threshold value. The sensor data, which can be viewed remotely via the cloud dashboard, is stored in the cloud database.

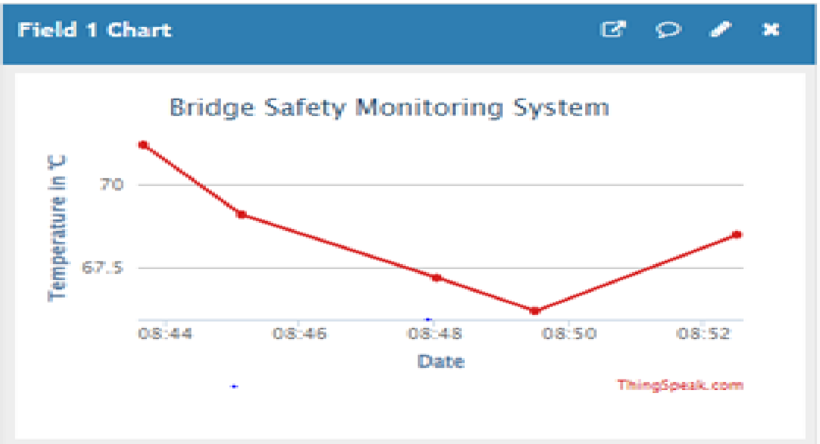

Figure 2: thingspeak graph for temperature sensor

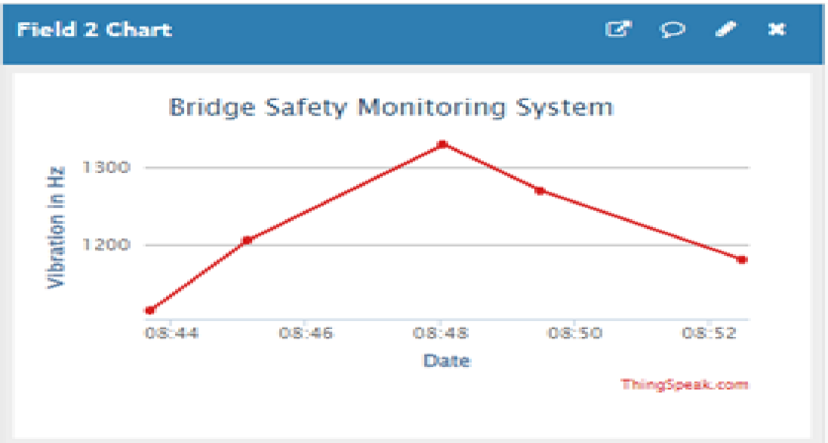

Figure 3: thingspeak graph for vibration sensor

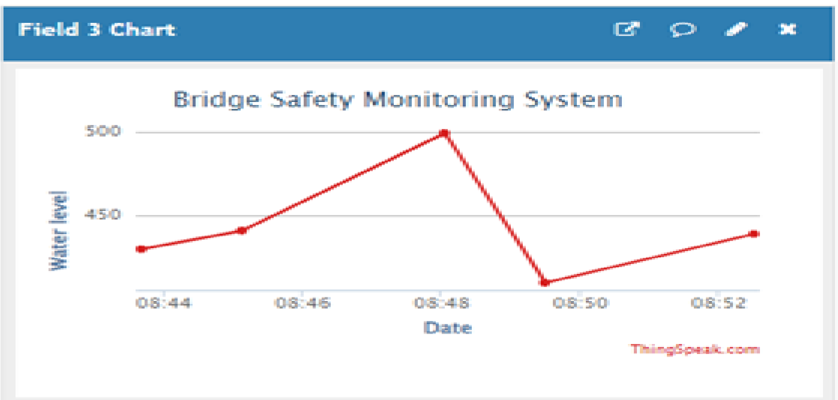

Figure 4: thingspeak graph for ultrasonic sensor

Figure 5 shows GSM responses on the serial monitor.

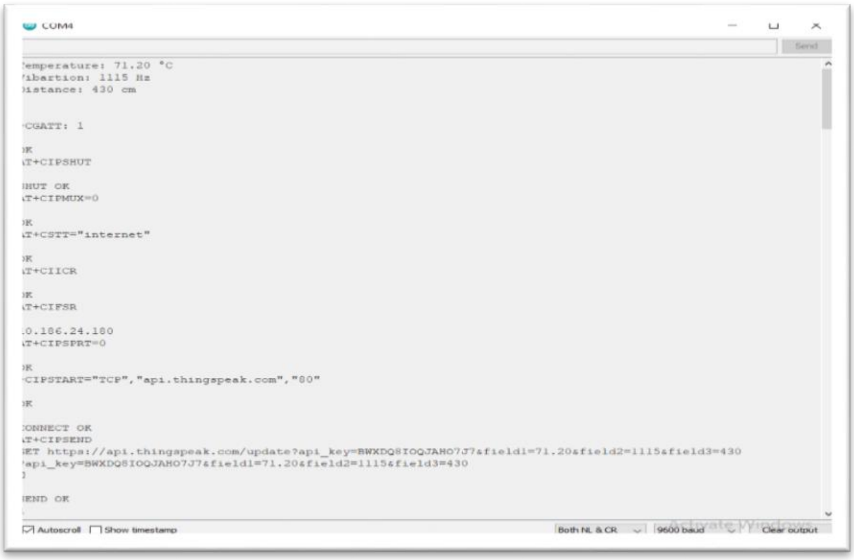

Figure 5: GSM responses

V. CONCLUSION

The sensor unit for the proposed system is composed of an ultrasonic sensor, a vibration sensor, an IR sensor, a fire sensor, a temperature sensor, a microcontroller, and a GSM module that processes and transmits sensed data to the cloud. It evaluates the state of bridges based on a number of factors, including temperature and water depth below the bridge. When the threshold value for sensed data is exceeded, the microcontroller activates the buzzer, turns on the barricades' operation, operates the gates, and displays a warning message on the LCD. These data are then given to the GSM module, which sends them to the cloud via the internet for analysis. The major goal of this system is to safeguard people from accidents and save lives.

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