SECURING BRIDGES WITH ARM CORTEX: IOT-BASED SAFETY MONITORING SYSTEM

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ABSTRACT: Wireless technologies are used to build an Internet of Things bridge safety monitoring system using the ARM Cortex. The autonomous bridge safety monitoring system was built with cutting-edge sensor technologies. Sensors can collect a wide range of data, including information about fire, water level, and vibration. The fundamental goal of the proposed system is to provide a mechanism to prevent structural disasters, as well as overpass and bridge accidents. Furthermore, it enables continuing, real-time safety maintenance and offers information on the integrity of existing structures, extending their lifespan. When infrastructure damage or faults are identified, preventive maintenance must be initiated immediately. The state of the bridge is routinely checked using Internet of Things technology. Wireless sensor nodes can capture a wide range of data, including vibration, water level, temperature, and fire. Furthermore, the status of the structures might be assessed using these details. The bridge's automatic gates will close in the case of an emergency. The accumulated data is sent to both a database and the Thingspeak cloud, allowing managers to monitor the bridge's status in real time.

KEYWORDS :Bridge Safety Monitoring, Structural Health Monitoring System, IOT, Crack Detection, Wireless SensorNetwork, Bridge Condition, GSM.

1.INTRODUCTION

Transportation is a vital part of modern life. As a result, the bridge is critical to the nation's economic and social infrastructure. It is critical that bridges are built with strong materials and that their structural soundness is consistently checked. Bridges are prone to structural flaws caused by aging, overload, bending, natural disasters, and a variety of other poor maintenance methods. This shows that concerns about the bridge's safety exist. Under such conditions, the bridge could collapse, causing catastrophic losses such as accidents and fatalities. This is due to the lack of an effective system that immediately warns users when the bridge is not operating securely.

The Internet of Things offers problem solving without the use of human data analysis. An IoT system developed for bridge safety monitoring that can observe environmental data on a bridge may enable automatic structural maintenance.

For this scenario, an IoT system with a variety of software and hardware components, as well as a cloud storage system, might be distributed throughout the bridge surface. The built-in module allows you to collect a wide range of data about the structure (in this case, the "bridge"). Data that exceeds a predefined threshold may be analyzed and then communicated to the Thing Speak cloud.

The primary objectives of the Bridge Safety Monitoring System are to ensure bridge safety.

The goals are to improve the bridge's efficiency, reduce accidents during extreme weather, and overcome budgetary and technological obstacles.

2.LITERATURE SURVEY

Abhishek Jain, Tirth Patel, Rutu Parekh, Umang Patel, and Dharak Gameti proposed a system for monitoring the structural health of bridges (1). The accelerometer in the system measures bridge vibration. The Arduino UNO's Bluetooth module detects and communicates the vibration frequency to a receiver. The computations required for the receiver to find the damage and assess its severity were done in MATLAB. Deterioration might serve as a signal of when and where the bridge needs repair.

Pradeep Kumara V.H. and D.C. Shubhangi's proposal [2] is useful for monitoring bridges and flyovers. The design features a variety of sensors for monitoring, including those that detect burden, tilt, vibration, and water level. The bridge's state is monitored using a database. The CPU evaluates and processes the information sent to the monitoring devices. The design team monitors bridges and flyovers in real time.

Jin-Lian Lee, as stated in [3], developed a bridge safety monitoring system that made use of Zigbee technology and the Internet of Things. A dynamic database stores bridge condition data and is linked to a cloud-based server that computes and analyzes data sent from monitoring devices, monitoring devices installed in the bridge environment, and communication devices that connect the bridge monitoring devices to the cloud-based server.

George Mois, Teodora Sanislav, and Silviu C. Folea proposed [4] to create a cyber-physical system capable of remotely monitoring interior environmental conditions. The system's components are interconnected via the existing wireless network, which follows the IEEE 802.11 b/g standards.

This study uses a strain gauge and an accelerometer, two of the sensor platforms described by Ittipong Khemapech, Watsawee Sansrimahachai, and Manachai Toah choodee in [5]. In sensor platform selection, the technical and physical characteristics of the structural component, such as its shape and kind of reinforcement, are more important than the specific objective data. This analysis focused on pre-stressed concrete bridge girders, which are key components of a Bangkok expressway. Integration of the LXRS network protocol into the Microstrain sensor platform. The IEEE 802.15.4 standard specifies a frequency spectrum of 2.4 GHz. It is claimed that time synchronization can be completed in 32 microseconds. Line-of-sight communication can be established at distances as far as two kilometers.

Christian Lazo, Sandra Cespedes, and Paulo Gallardo introduced a wireless bridge health monitoring system [6]. Zigbee is used to provide IEEE 802.11 wireless communication across short distances, particularly between sensors within the bridge. In contrast, GSM is used to send data over long distances. This system, known as MBM (Monitoring Based Maintenance), allows bridge maintenance engineers to carefully monitor the condition of the bridge. Sensors are strategically placed along the bridge to monitor traffic, vehicle weight, the bend, and other features.

Haritha K suggested in [7] with Ashwini R. Sivaraman, Sneha Shivan, Mesta, Varsha A. U., and Ravichandran G. The Bridge Health Monitoring System has three levels of distributed topology: a central server, an intelligent acquisition node, and a local controller. The acquisition node is an intelligent gadget powered by a powerful ARM processor. The acquisition node uses a large number of sensors to perform real-time signal processing and data compression. The local controller only obtains the results of processing via wireless networks. By using this technology, both the load on a centralized server and the bandwidth requirements for chats can be decreased.

B.M. Pawar, A.B. Yadav, Ms. B. Hombal, Ms. J.D. Kadam, and Ms. M.V.N.R.P. Kumar proposed a novel approach for bridge health monitoring systems [8]. It was suggested that GSM be used to send data across long distances (between the bridge and the management center). Bridge conditions are assessed by attaching sensors to a PIC microprocessor, which includes an anemometer, temperature, strain gauge, and accelerometer. The bridge's sensors may detect any changes to these parameters and relay the information to the control center over the mobile GSM network. Additionally, these parameters are displayed on the LCD panel. The component is a PIC microcontroller.

3.SYSTEM ARCHITECTURE

The Internet of Things refers to the technology used to monitor the bridge's status in real time. The recommended system is built around a sensor unit that includes an infrared, vibration, temperature, fire, and ultrasonic sensor. All of these sensors are linked to the microprocessor in this system, which is in charge of sensing data (such as water level and temperature below the bridge) about the state of bridges. Following that, the data is received by a microcontroller, which is responsible for generating an appropriate response. The microcontroller sends the data to the GSM module, which then sends it to the Thing Speak cloud, activates the gates and barricades, sounds the alarm, and displays a warning message on the LCD screen when the instant sensing data threshold is exceeded. The data is saved in the Thingspeak cloud's real-time database, which updates in real time.

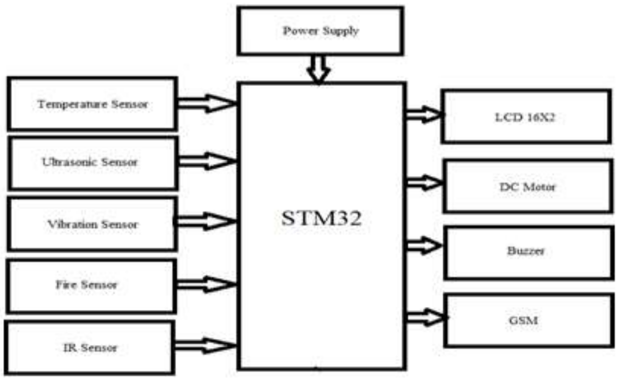

Figure 1: block diagram

- The components of this system are as follows:
- The SIM900A GSM Module consists with The monitoring system collects the bridge's status via the GSM module. The GSM module facilitates the transmission of feeling data to the "Thing Speak Cloud" for storage.
- The vibration sensor determines the bridge's condition by measuring vibrations.
- Water is detected using an ultrasonic sensor.
- Infrared sensors are capable of detecting boundaries.
- A fire sensor serves as an instrument for detecting and locating flames.
- A temperature sensor is used to measure the bridge's temperature.
- DC-powered barriers can retract in reaction to a variety of circumstances, such as vibrations above the bridge's predetermined threshold, rising water levels, or a fire.
- LCD: Both sensor data and alerts are shown.
- STM32F103C8T6, the Blue Pill Development Board, is powered by a 32-bit RISC ARM Cortex-M3 CPU. Twenty-seven GPIO ports, ten analog inputs, and 64 KB of flash memory are supplied. The STM32F103C8T6 microcontroller manages both the hardware and software programming for the bridge monitoring system. This tiny module enables communication between microcontrollers, a GSM network, and a variety of sensors.

4.RESULT

The vibration, temperature, and ultrasonic sensors provide companion monitoring results. We create communication channels in the "cloud" to receive data detected by sensors. Graphics are used to show the results. Figures 2, 3, and 4 show several sensor readings saved in a "cloud database." Additionally, the water level in the system and the condition of the bridge were evaluated. In the event of an emergency or when data volume exceeds a specified threshold, the GSM module sends the necessary information to the cloud database. The cloud interface allows remote access to sensor data stored in a 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: GSM responses

5.CONCLUSION

In addition to ultrasonic, vibration, infrared, temperature, fire, and microcontroller sensors, the proposed system's sensor unit includes a GSM module for processing and transmitting sensed data to the cloud. Temperature and water level beneath the bridge are just two of several criteria considered while evaluating the bridge's condition. The microprocessor activates the barriers, opens the gates, and sounds the alarm when the sensor data threshold is exceeded. In addition, a warning notice appears on the LCD. The GSM module then retrieves the data and sends it to the cloud for analysis over the internet. The primary goal of this system is to protect individuals and save lives.

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