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An Alerting and Monitoring System for Bridges Based on the Internet of Things

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Abstract

Using wireless technology, we build a bridge safety monitoring system based on the Internet of Things. The system consists of monitoring devices, communication devices linking the bridge monitoring devices to the cloud-based server, and a cloud-based server that processes and interprets data from the monitoring devices. The water pressure levels, vibration, and other safety factors near a bridge may all be tracked and analysed by this technology. With the use of mobile communication devices, the discovered data are sent to a server and database, allowing users to keep tabs on the bridge's status in real time. Cities often have a number of bridges over rivers, and many of these spans are in need of regular maintenance since they were built so many years ago. A bridge's collapse might cause a catastrophe because of the weight of cars crossing it, the volume of water flowing under it, or both. Therefore, these bridges need constant surveillance. In light of this, the study suggests a setup that includes the following: a scale, a vibration sensor, a water force sensor, a Wi-Fi module, and an ARM microprocessor. If the system's load detection mechanism determines that a vehicle's load is more than a certain threshold, an alert will sound and the appropriate authority will delegate the responsibility for vehicle repair to the appropriate staff members.

Key words

Network of Things, ARM Microcontroller, Load, Force, and Vibration are some related terms.

INTRODUCTION

This system is made up of bridge-specific monitoring equipment, communication devices that link the monitoring devices to the cloud server, a dynamic database that saves information about the bridge's state, and an analysis server on the cloud. This technology is able to continuously monitor and analyse a bridge's surroundings, such as the water levels around it, pipes, air, and other safety factors, in real time. To allow people to keep tabs on the bridge's status in real time via mobile communication devices, the collected data and photographs are uploaded to a server and database. The information may be utilised for disaster rescue and bridge safety management. Wi-Fi technology, known for its low power consumption, excellent safety, and support for a wide number of network tasks, is used in this system for its monitoring and information exchange. Additionally, solar energy is employed as a backup power source for the system. In giving solutions to the aforementioned issues faced by traditional systems, the system designed in this research may aid in the further development of bridge safety management and control.

ANALYSIS OF READINGS

In 2017, Jinn-Lian Lee et al. detailed the use of ZigBee technology to create an Internet of Things–based bridge safety monitoring system. The components of this system include bridge-specific

monitoring devices, communication devices for exchanging data between the monitoring devices and the cloud-based server, a dynamic database for storing information about bridge conditions, and a cloud-based server for performing calculations and analyses on the data that is transmitted from the monitoring devices. This technology is able to analyse the current circumstances of a bridge and its surrounding environment, such as water levels, pipes, air quality, and other safety factors, in real time. To allow people to keep tabs on the bridge's status in real time via mobile communication devices, the collected data and photographs are uploaded to a server and database. A study by Pradeep Kumara V. H. D. C. Shebang (2020) found that when bridges deteriorate with age or are destroyed by natural disasters, few people take attention. Then crossing bridges is risky since they might give way at any moment. If we care about the long-term condition of our bridges, we need to conduct regular inspections. As a potential solution, a plan for wireless Internet of Things-based 24/7 bridge monitoring has been presented. The suggested layout is useful for monitoring bridges and may be adapted for use with flyovers as well. Specifically, the layout is made from of

machinery for keeping an eye on things

connected sensors that measure things like weight, water level, vibration, and tilt. The condition of a bridge may be recorded in a database. Processing power is being put to work crunching numbers and analysing information gathered by sensors. Bridge and flyover conditions are tracked in real time using this design. The proposal is easily and cheaply executed. According to Lingzi Yi et al. (2020), there has been a growing interest in Internet of Things (IoT) based Bridge Structural Health Monitoring (BSHM) in the civil engineering and computer science research and business areas. This study was written as a collaborative effort between computer science and civil engineering experts, and it focuses on a basic topic inspired by real-world applications of IoT-based BSHM: how to efficiently extend network lifespan while maintaining required coverage.

This research offered a method for ensuring network coverage and extending the lifespan of IoT-based BSHM systems by integrating a promising reinforcement learning model called Learning Automata with the Confident Information Coverage (CIC) model. In order to ensure network connection and partial coverage ratio, the suggested system takes use of cooperation among deployed nodes and alternately schedules the wake/sleep state of nodes. In particular, the proposed technique makes extensive use of the learning automata model to adaptively discover the best sensor scheduling strategy and considerably lengthen network lifespan. The efficiency and efficacy of the proposed method are shown by a series of comparative simulations utilising actual data sets obtained by a functional BSHM system. This is the first research we are aware of that combine the reinforcement learning process with partial coverage to extend the life of an IoT-based BSHM's network.

METHODOLOGY

This article presents a circuit that makes use of Internet of Things and wireless sensor network technology to keep tabs on the bridge and sound an alarm if anything goes wrong.

Uno Arduino

Due to its open-source hardware nature, an Arduino may be used either as-is by buying from the vendor or by making one at home using the components. Its primary applications are in communication and the management of various devices. Massimo Bansi and David Cuartillas established it in 2005. The ATmega328 is the basis for the Arduino Uno microcontroller board. It contains a USB port, a power connector, an ICSP header, a reset button, and 14 digital I/O pins (6 of which may be used as PWM outputs). It also has a 16 MHz crystal oscillator. In order to get started, just plug in the included USB cord to a computer or use the included AC-to-DC converter or battery. The Uno is different from its predecessors since it does not include an FTDI USB-to-serial driver chip. The Atmega8U2 is instead used, and it's been specially coded to act as a USB-to-serial converter. Since "uno" means "one" in Italian, it was chosen to signify the imminent arrival of Arduino 1.0. To go ahead, the Uno and Arduino 1.0 will be used as the standard.

A Vibration Detector

Numerous projects, devices, and uses make use of vibration sensors. A vibration sensor is a device used to measure vibrations in order to determine things like the speed of a moving vehicle or the strength of an incoming earthquake. While some may run on their own, others must be connected to an external power source. Different sensors are needed for the wide range of temperatures, magnetic fields, vibration levels, frequencies, electromagnetic compatibility (EMC), electrostatic discharge (ESD), and necessary signal quality that might occur in machines.

Using a Resistive Load Cell

A load cell's operation is based on Piezo-resistance. The sensor's resistance changes in response to external loads, stresses, or loads. When an external voltage is introduced, the output voltage will shift due to the change in resistance. Different configurations of the load or force cell are used for various purposes in science and industry. Strain gauges, either foil or semiconductor, are widely used as the sensing element in modern designs.

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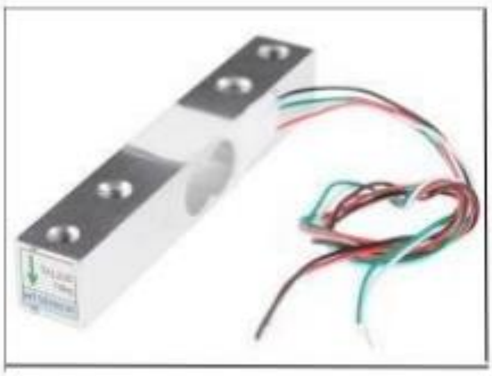

Fig .1 Load Cell

Indicator of Pressure

A substance whose resistance varies in response to the application of a force or pressure is called a force-sensing resistor. A force-sensitive resistor (FSR) is a kind of resistor that changes resistance in response to applied force. A conductive polymer is used in force-sensing resistors because the material's resistance varies in a predictable way when pressure is applied to its surface. They are often sold in rolls of polymer sheeting or as a screen-printable ink 31. The sensing film has both conductive and insulating particles dispersed in a matrix. Sub-micron sized particles are created to lessen temperature dependency, boost mechanical characteristics, and lengthen surface life. When you apply pressure to the sensing film's surface, particles move closer to the film's conducting electrodes, affecting the film's resistance. Force-sensing resistors are similar to other resistive-based sensors in that they function well in somewhat hostile settings with a little amount of fuss. FSRs are advantageous over other force sensors because of their small size, inexpensive price, and high shock resistance.

Fig .2 Force Sensor

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BLOCK DIAGRAM

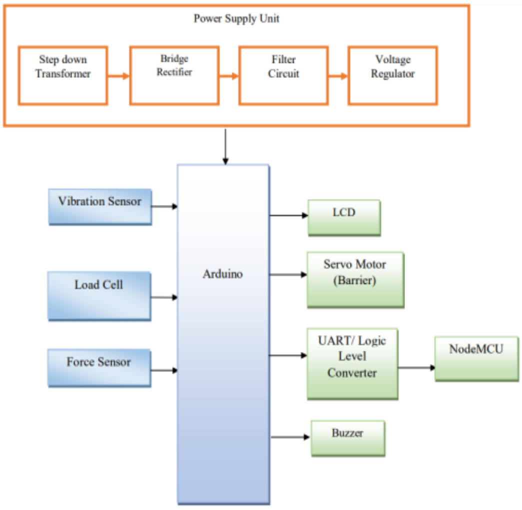

Fig .3 Block Diagram

FACTORS AND OUTCOMES

A Functional Arduino

Each of the Uno's 14 digital I/O pins may supply or drain 40mA. Pins 0 and 1 are used for receiving and transmitting data via a serial connection, pins 2 and 3 are external interrupts, pins 3,5,6,9,11 offer PWM output, and pin 13 is used to connect an LED. A polarizer might be used to activate and highlight certain text on an LCD by rotating the light beams travelling through the screen. It is recommended that the power supply be +5v with no more than 10mv of transients. If the display's contrast is too low, you may fix it by changing the voltage at pin 3. So that voltage may be generated in the ground terminal of the power supply, it must be adequately separated. The module has to be adequately insulated to prevent the induction of stray voltages that might result in a flickering display. A servo has a DC or AC motor, a potentiometer, a gear set, and an electronic controller. To begin, the motor's RPM is slowed while the torque is increased by use of a gear assembly. Let's pretend the servo motor shaft is in its starting position and the potentiometer knob is set such that there is no electrical signal produced at the output. Now, electricity is sent to the error detector amplifier's second input terminal. Now the feedback mechanism will take the difference between the potentiometer signal and the other signal and output it as an error signal. Input to the motor from this error signal causes the motor to begin turning. Now that the motor shaft is attached to the potentiometer, the signal generator will respond to the motor's rotation. Eventually, you'll be able to set the potentiometer such that its output is identical to the signal you feed into it from the outside. When there is no difference between the externally supplied signal and the signal produced at the potentiometer, the amplifier's output signal to the motor's input is null, and the motor stops turning.

Results

We've covered the many strategies the scientist used to keep tabs on the bridge's health. Life and money might be saved with the aid of such a system since it would allow for precise regulation of the bridge's dynamic properties in the case of an emergency. This technology is one of a kind since it can monitor environmental conditions on a bridge, share that information with other devices through wireless connection, and immediately notify the bridge's management team of any problems that arise. This technology may allow for timely and adequate bridge safety management around the clock. Reactions in times of crisis. The technology constantly checks the parameters of the bridge and determines whether it is safe to cross. When the parameter values exceed the set limits, an alarm will ring. It's quite helpful that this was implemented. The Internet of Things and Wireless Sensor Network technologies were used to create the suggested system. The hardware module of the proposed system includes a variety of sensors, including a scale, a vibration sensor, a water force sensor, a Wi-Fi module, and an ARM microprocessor. When a vehicle's load exceeds a certain amount, an alert is triggered by this mechanism. When the value exceeds the threshold, an alert is sent and the data is shown on the LCD screen. If there is an emergency on the bridge, the barrier gate will shut using a DC motor.

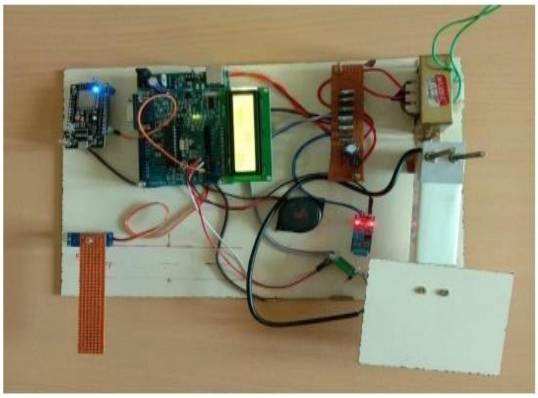

Fig. 4 Prototype Model

CONCLUSION

When there are warning indicators of a bridge collapsing, the information may be shown on an LCD screen and the Internet of Things, as described in this study. Future severe calamities will be avoided because to this method. Many people's lives might be spared thanks to this technique. The Internet of Things (IoT) and sensors working together provide a way to identify bridge degradation. The suggested technology has the potential to provide data on the bridge's angular movement. Because of the importance of bridge safety, a monitoring system is required. TCP/IP may be used in the construction of such a system to establish a network between the sensor and the Arduino, Wi-Fi module. The primary goal is to use sensor networks to identify bridge degradation. Damage in bridge health monitoring has an answer in the form of the Internet of Things, when combined with the sensors.

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