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Health Monitoring of Bridges using Wireless Sensor Nodes.

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Abstract:
This paper highlights the look & implementation aspects of health monitoring of bridges using Wireless Sensor Nodes (WSN). Structures including civil infrastructures, such as bridges, buildings, dams, among others are major parts of society's economic and industrial success. Bridges are one of the most important points of a country's transport network but their maintenance and construction cost is very high. The major parameters monitored are bending, vibration, overloading and strain. Different sensors are installed at the key locations of the bridges and data from sensor is collected. For short distance (among sensors in the bridge) ZigBee is used as wireless network, and GSM is used for long distance (between the bridge and the management center) data communication. This technology will enable the bridge maintenance engineers to monitor the condition of the bridge in real time. The bending, traffic, weight of the vehicles etc is monitored by various sensors installed in different parts of bridge. At any point of time if any of these parameters cross their threshold value the communication system informs the management center giving an alarm for taking precautionary measures.

Keywords: *Wireless Sensor,* GSM

I. INTRODUCTION

Structures including civil infrastructures, such as bridges, buildings, dams, among others are major parts of society's economic and industrial success. Bridges are one of the important connecting nodes of a country, state, or a city for transport network but their maintenance and construction is quite expensive. Bridges suffer overall structural deterioration due to aging, overloading and lack of proper maintenance. The US Federal Highway Administration has classified over 25% of the bridges in the US as either structurally deficient or functionally obsolete underscoring the importance of Structural Health Monitoring (SHM) to ensure public safety. Hence bridges should have a optimized, economic and reliable inspection in order to protect human lives from structural failure activities from unsafe bridge structures. Traditional SHM requires an onsite evaluator is prohibitively expensive for all but a small fraction of structures and also suffers from the significant drawback of subjectivity. This paper is proposed in accordance with Beam Bridge.

Figure 1: Beam Bridge.

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II. Proposed Method:

2.1. Software -Arduino is a platform combining hardware and software which is very easy to use and it has an vastopen-source electronics community. Arduino boards are capable of reading any kinds of inputs such as output of a sensor, detecting condition of a switch, or a message that could be read online. Based on these inputs arduino can actuate a motor, turn on connected system for correction or modification and also is capable of publishing the required information online. These types of functions can be easily implement using arduino boards which could be programmed using Arduino Software (IDE). Select Arduino/Genuino Unoaccording to the microcontroller on your board. The ATmega328 on the Arduino/Genuino Uno comes preprogrammed with a bootloader that allows you to upload new code i.e. the board has on chip programming capability. It communicates using the original STK500 protocol.

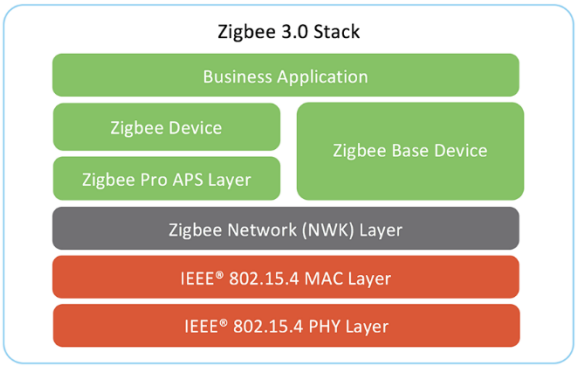

Figure 2: Zigbee 3.0 Layer Diagram.

For networking Zigbee Technology is used with its compatible transmitter and receiver. Zigbee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless IoT networks. The Zigbee standard operates on the IEEE 802.15.4 physical radio specification and operates in unlicensed bands including 2.4 GHz, 900 MHz and 868 MHz. The 802.15.4 specification upon which the Zigbee stack operates is a packet-based radio protocol intended for low-cost, battery-operated devices. The protocol allows to communicate in different types of network topologies and can have battery long lasting life.Zigbee protocol features include:

- Support for multiple network topologies.
- Low duty cycle – provides long battery life.
- Direct Sequence Spread Spectrum (DSSS).
- 128-bit AES encryption for secure data connections.
- Collision avoidance, retries and acknowledgements.

Zigbee 3.0 provides enhanced network security of two types those are- Centralized Security and Distributed Security.

2.2. Hardware -To design a wireless system for healthmonitoring of highway bridges their functional requirementsshould be satisfied. This paper proposes the method and focuses on parameters such as overloading, vibration, bending and strain. The system should be easy to operate and maintain, send earlywarning indications to the operator mobile devices and the monitoring station.

To satisfy the above requirements the proposed hardware must have two main units first is wireless sensing unit and second is processing and monitoring unit. The block diagram of proposed system is presented in figure 3.

IR sensor detects the vehicles that enter the bridge and keeps count of the number of vehicles on the bridge.Load sensor detects the load on the bridge.Flex sensor detects the cracks and bending. Vibrator sensor detects extreme vibration on the bridge.Stepper motor acts as the gate in our bridge monitoring system.For short distance (among sensors in the bridge) ZigBee is used as wireless network, and GSM is used for long distance (between the bridge and the management center) data communication. This technology will enable the bridge maintenance engineers to monitor the condition of the bridge in real time. The sensors installed on various parts of the bridge monitors the bend, traffic, weight of the vehicles etc. If any of these parameters cross their threshold value then the communication system informs the management

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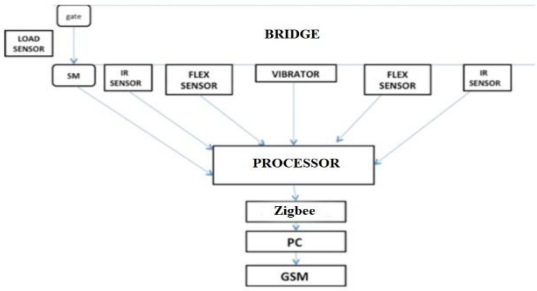

Figure 3: Block Diagram.

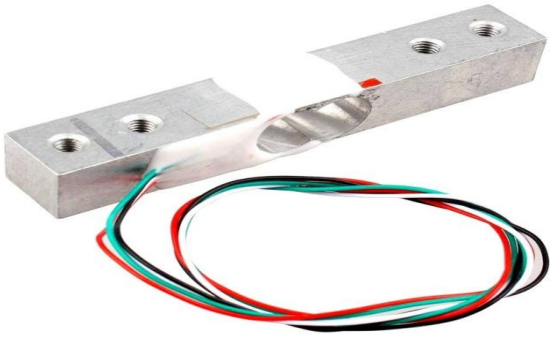

Figure 4:Load Sensor.

Figure 5: Flex Sensor.

Figure 5: IR Module.

III. Conclusion & Future Scope

- Data compression and edge computing can be introduced to save transfer time and data needed to be transferred, thus increasing power savings.
- Keeping in view the futuristic aspects, research for expected estimation of life and time frequency energy analysis can be done upon by Hilbert–Huang transform (HHT) respectively.
- Depending upon futuristic need WSN motes can be madeintelligent enough by tweaking Mac layer 2 in sense of powerprofiling, as most of the energy is taken by transceiver i.e.data should be processed locally at motes, while sendingshould only take place upon breaching a certain threshold asseveral efforts have been made for developing moreaccurateand energy saving algorithms for independent processing tasks.
- We can also exploit with the traffic intelligence system forcorrelating the vibrations signals with traffic load. Cross co-relation and auto co-relation matrices can be formed by thegathered data that can predict more accurately the degradationtrend through the historical data.

  We can create a passive sensor that is normally idle. When you want to interrogate it, you send it a beam of radiation that will be collected by a local antenna close to the sensor. The energy collected by the antenna will be enough to power on the sensor for a fraction of a second, so that it collects a measurement, and it replies to the sender with the reading. Sometimes, it simply modulates the incident wave, and the echo of the wave from the sensor contains the information requested. A common example is a SAW sensor (Surface Acoustic Waves) whereby electromagnetic wave that is sent back to the originating antenna.Any of these approaches holds a lot of promise, and all of them are an absolute necessity for the future Internet of Things to become truly useful.
- The dynamic evaluation and monitoring result can be integrated into current and proposed bridge management system (BMS) databases to provide baseline data for comparison of bridge substructures after catastrophic events.
- the incident wave is converted into a surface mechanical wave, which in turn is modulated by some physical variable (temperature,

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humidity, contamination). The modulated wave is finally converted back into an.

IV. References

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