BRIGDE MONITORING SYSTEM USING WIRELESS NETWORKS

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ABSTRACT

This project is based on highway bridges and railway tracks monitoring system using wireless networks. A 3-level distributed structure is adopted in this system which includes central server, intelligent acquisition node and local controller. Acquisition nodes are located across the bridge. All the acquisition nodes are managed by one local controller. Every acquisition node has 8 channels which can sample displacement, acceleration and strain of bridge. Compared to the traditional method, the proposed architecture has two features. The acquisition node is a smart device based on powerful ARM processor. Signals of various sensors are analyzed and real time the data is compressed in the acquisition node. Only the processing results are sent to local controller through wireless networks. This operation can relive load of central server and decrease demand of communication bandwidth.IOT is utilized to provide enough bandwidth for real time data transmission between local controller and central server. The sensors installed on various parts of the highway bridge and railway tracks monitor the cracks, bend, beam sustainability, weight of the Train etc. At any point of time if any of these parameters cross their threshold value the communication system informs the management centre giving an alarm for taking precautionary measures. IOT is used for long distance data transmission between the local controller and central server. This technology can be called MBM (Monitoring Based Maintenance) that enables the highway bridge and railway track maintenance authorities monitor the condition of it in real time.

Keyword: -*ARM Processor, Acquisition node, MBM etc.*

1. INTRODUCTION

Akashi Kaikyo Bridge is not only famous for world longest suspension bridge but also for its advanced monitoring system. It has a technology called MBM (Monitoring Based Maintenance) that enables the bridge maintenance engineers monitor the condition of the bridge in real time [1]. In the railway industry, Wireless Sensor Network monitoring provides continuous and near real-time data acquisition and autonomous data acquisition, hence no manual supervision is required; increased frequency of monitoring compared with manual supervision; improved management of data , data accessibility, and data use compared with non-networked systems as all data can be collected and processed centrally the ability to combine data from a wide variety of sensors [2]. Railway systems and highway bridges are critical in many regions, and can consist of several tens to thousands of bridges, being used over several decades. It is critical to have a system to monitor these bridges and report when and where maintenance operations are needed. Many long span bridges in Korea and in Japan have adopted this real-time monitoring system. However, current system uses complicated and high cost wired network amongst sensors in the bridge and high cost optical cable between the bridge and the management centre, which increases the overall cost of installation and maintenance cost of monitoring system. The complicated wiring also makes the installation and repair/replacement process difficult and expensive. The complete parameters of the bridge are taken by a ARM microcontroller and sent to another module which is located in a short distance. Here the communication established

is using IOT that uses wireless Transmitter and Receiver circuitry. The receiver module takes the parameters from the transmitter and sends a message with all the parameters to a database centre. The communication established between the intermediate module and the database centre is using IOT technology. The sensory inputs are process to represent the condition of the bridge and the track against seismic loads and other loads.

The current bridge health monitoring system uses cables for data communication. The installation of data cables is a cumbersome job and it often causes the cost increase in sensor installation, maintenance, and repair. The cable based sensor has many difficulties that might be minimized or eliminated if wireless sensor is used. They are (1) installation cost of communication and power supply cables of the sensors is very high;(2) installation of steel pipelines that protect those cables is also difficult; (3) temperature changes on cables cause sensor data distortions; (4)hard-to-eliminate noises occur at connections between sensors and cables;(5) it is hard to identify the defects of sensors and cables and difficult to replace and/or repair them.

In this paper, the wireless solution that overcomes these problems is presented. The wireless sensors have the following advantages:(1) the installation cost is low because the sensors do not require wiring; (2) no additional supporting structure such as pipeline for cable is required;(3) sensors are easily replaced when malfunctioning; (4) by using Ad-Hoc and Multi-Hop, re-organizing sensor network is relatively easy.

2. System Architecture:

In the proposed system we have the advanced and efficient microcontroller with the IOT for communication media between various sensor nodes. Programming for the ARM7 in this system is done in embedded c language and software used for the programming is KEIL, and the coding part for the webpage is written in html. For the implementation of this system ARM7 development board is used, it uses 32-bit processor with on-chip ADC, timer/counter module, and UART to interface IOT module.

The proposed system consists of wireless sensor network(WSN), which consist of large no. of nodes, each capable of sensing, processing and transmitting information, which is use for structural health monitoring of bridge and railway track on the bridge. WSN can provide continues real time data collection and transmission. It increases monitoring efficiently as compared to manual inspection. It improves data accessibility, transmission and data management.

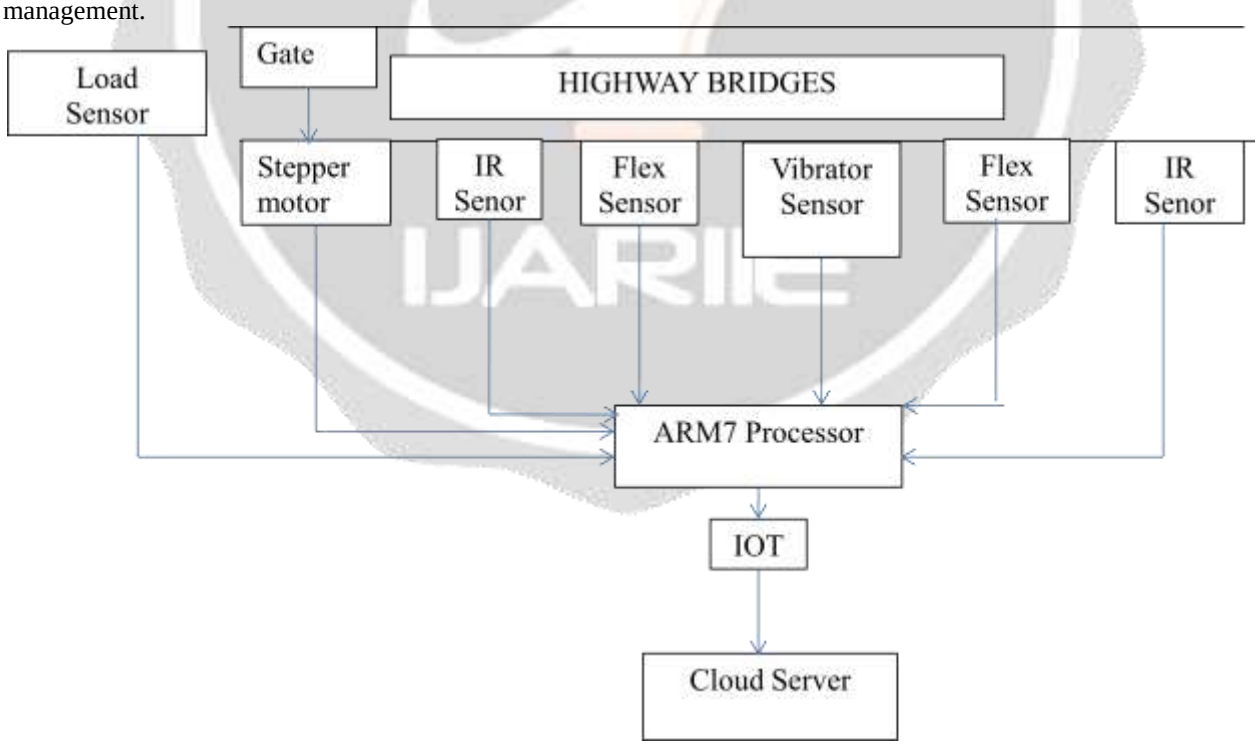

Fig -1: Block Diagram of Bridge Condition Monitoring System.

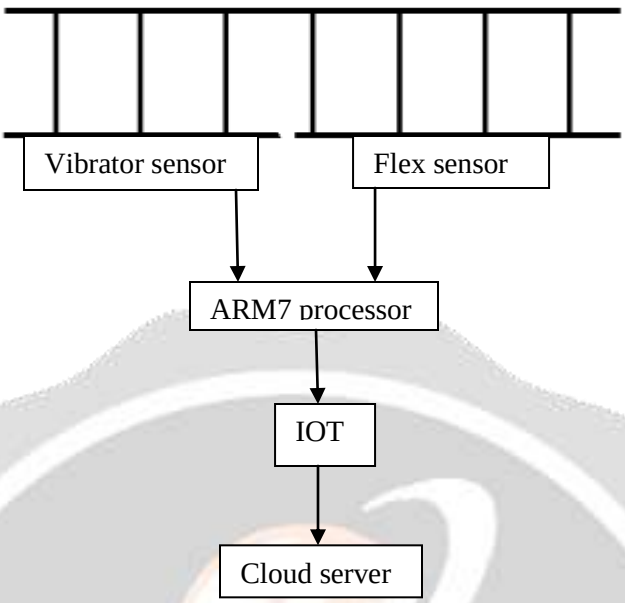

Fig -2 Block Diagram of Railway track Condition Monitoring System.

This paper proposed a monitoring of the bridge structures and tracks on the bridges using wireless sensor network h helpful to avoid any accident. Fig-1.When the vehicles enter the bridge load sensor will detect the load, if the load exceeds threshold the gate closes automatically. The IR sensor detects the number of vehicle that enters the bridge, if it exceeds the threshold the gate closes. The vibration sensor detects the cracks caused by seismic vibration and sends the information to the ARM processor. Fig-2.Flux sensor are mounted on the surface of joints on the railway tracks to detect the cracks and the information is sent to ARM processor. All the sensors are interfaced with ARM processor ant detail of the ARM processor is sent to Wi-Fi wireless channel to transmit to IOT. The Internet of Things , also sometimes referred to as the Internet of Everything (IoE), consists of all the web-enabled devices that collect, send and act on data they acquire from their surrounding environments using embedded sensors, processors and communication hardware. All the details from the various sensors are given to the local controller which is the ARM7 processor. Gateway helps to bridge the internal network with the external internet. They do this by collecting the data from the ARM processor and transmitting it to the internet infrastructure. The data transmitted through the gateway is stored and processed securely within the cloud in fracture using Big Data analytics engine. This processed data is then used to perform intelligent action that make all our devices a smart device. The PC (personal computer) will help end users to control and monitor their devices from remote location.

2.1 System details:

The monitoring of condition of railway infrastructure is uppermost priority of this system. The proposed system continuously monitor the condition of the bridge structures and tracks on the bridges, collect the information and efficiently transfer to the monitor center through base station. In this paper, the arrangement of the system is divided into two parts : the sensor node mount around railway track line and the sensor node mount on the bridge.

A. ARM7 processor

ARM7TDMI-S is a general purpose 32-bit microprocessor**.** It offers high performance and very low power consumption.It is based on Reduced Instruction Set Computer (RISC) principles**.** High instruction throughput impressive real-time response from a small and cost-effective processor core. ARM is a low power consumption device. The CPU operating voltage is 3.0V to 3.6V with 5V tolerant I/pads.16/32 bitARM7TDMI-S microcontroller in a tiny LQFP64 package.8kB to 40kB of on-chip static RAM and 32kB to 512kB of on-chip flash memory.128-bit wide interface enables high speed 60MHz operation .It has 2 ports (P0, P1) each port has 32 pins. Only 42 pins are user available pins.P0 port has 29 user available pinsout of 32 pins (24, 26, 27 pins are not available). In P1 port 0-15 pins are not available for user interface and 16-31 pins are available for user interface. Operating frequency is 20MHz to 60MHz.

B.Sensor network:

a. The sensor node mounted around railway track line

Track monitoring system is very important for collection of data for maintaining the safety. In this mode sensors are mounted on different places. Like to detect vibration on track a vibration sensor are mounted on track, for detection of crack flex sensors can be deployed on track .for Analyzing the vibration data produced by vibration sensors on the track, data from flex sensors the condition of track can be monitor. This collected data is then immediately delivered to the nearest monitor centre so that the monitor center can process the real-time data of the tacks and bridge structures.

b. The sensor node mounted on the bridge

The important task of the sensor nodes mount on the bridge is to monitor any defects on structures. In Bridges any defects occur due to passing of heavy load vehicles and constant strain. The sensor nodes placed at different position enable monitoring of the structure including the internal structure of the bridge.

The various MEM'S sensors for monitoring structural changes in concrete like- for crack and fatigue detection we used IR sensors, flex sensors, vibrator sensors, to analyze the static loads we use load sensors.

c. Transmission of data

In this mode various data from different sensor nodes which are placed at different section of tracks and bridge are collected and transfer to base station. The base station controls the sensor nodes and act as a gateway for data transmission to monitor center. The collected data is transfer to the base station with the help of communication such as IOT.

The collected data from base station is transmitting to monitoring center through GPRS network.
If sensors detect any defects on the track or bridge, the base station will immediately inform to the monitor center.

C.IOT network:

The Internet of Things , also sometimes referred to as the Internet of Everything (IoE), consists of all the web-enabled devices that collect, send and act on data they acquire from their surrounding environments using embedded sensors, processors and communication hardware. All the details from the various sensors are given to the local controller which is the ARM7 processor. Gateway helps to bridge the internal network with the external internet. They do this by collecting the data from the ARM processor and transmitting it to the internet infrastructure.
The data transmitted through the gateway is stored and processed securely within the cloud in fracture using Big Data analytics engine. This processed data is then used to perform intelligent action that make all our devices a smart device. The PC (personal computer) will help end users to control and monitor their devices from remote location.

3. EXPERIMENTAL OUTPUT

This system is designed for condition monitoring of diff parameters like temp, weight, vibrations , bending angle of rail track and also monitor current status from remote location using IOT technology. The accelerometers senses real time vibrations and these vibrations are in form of analog signal. Latter on these vibrations i.e. analog signals are converted into digital signals by using inbuilt ADC of ARM 7 processor. In the proposed system, there are two transmitter node and a base station. Here base station acts as receiver and ARM7 is the communication media between various transmitter node. Base station contents an advanced efficient microcontroller lpc 2148.

This section will also highlight the quantitative parameters experimentally determined from the strain measurements and how such parameters could serve as indicators in a long-term bridge management program. To develop these estimates, trucks of known weight are parked at locations in designated lanes and the strains recorded in each girder are used to express the live load moment experienced by each girder as a fraction of the total moment. As load is applied to a structure with redundancy, it is distributed to the nearest primary members and then shed via the slab and diaphragm connections to the remaining structural elements. Section loss, either through corrosion or cracking, is directly reflected in the distribution factors, as the strain distribution of the member affected is amplified by the loss of stiffness. Furthermore, bearing and diaphragm connection degradation will result in a change in the load transfer mechanism of a bridge, thereby affecting the noise terms.

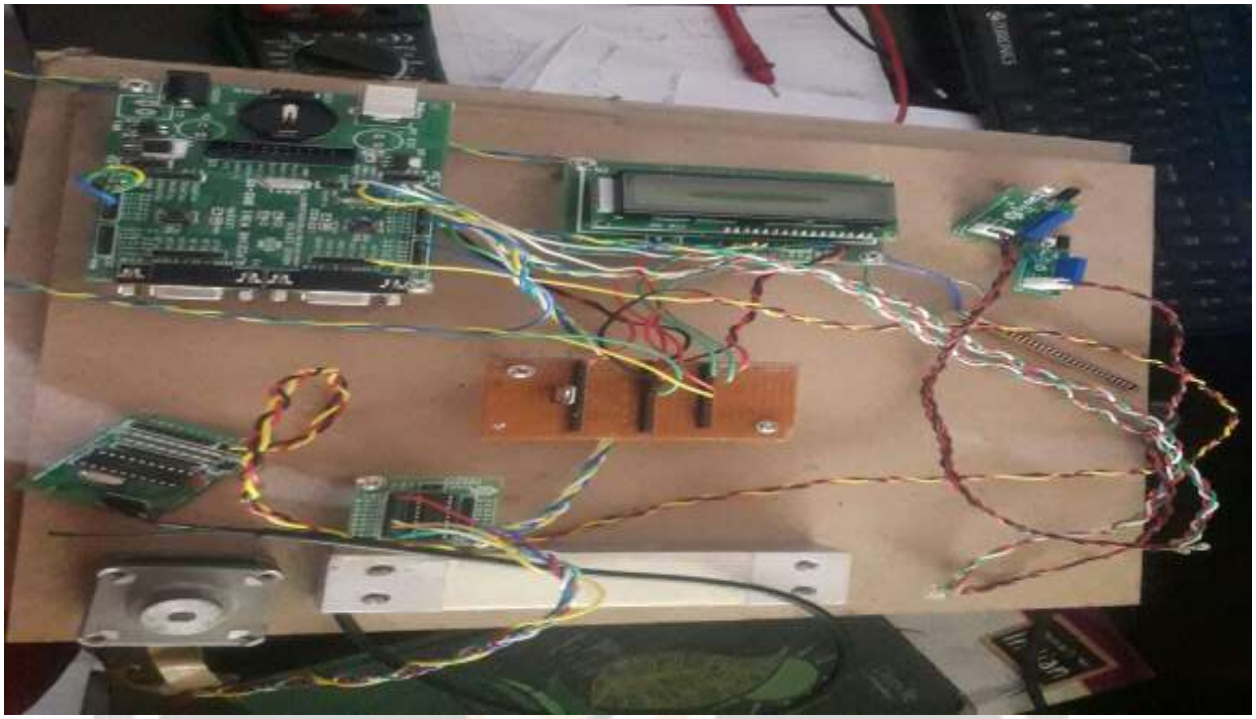

Fig-3 : Experimental setup

4. CONCULSION

This paper mainly focuses on condition monitoring of bridge structure and tracks on the bridge for avoiding any accidents provide safety and also reduce maintenance cost of overall railway/bridge. The proposed system automatically detects the faulty rail tracks and defects in the bridge structure which immediately transfer to the cloud through IOT. Wireless network technology has enabled the widespread adoption of structural health monitoring techniques for integration into bridge management systems. The Wireless Sensor Solution provides an adaptive, field demonstrated approach to in-service monitoring of highway infrastructure through offering a concurrent platform for strain-based as well as vibration-based real-time wireless monitoring.

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