International Journal of Research in Engineering, Science and Management
Volume-3, Issue-6, June-2020
www.ijresm.com | ISSN (Online): 2581-5792

Vision Based Boat Height Prediction Crash Avoidance with Bridge Height and Condition Monitoring System

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***Abstract*: Highway bridge systems are critical in many regions and can consist of several tens of thousands of bridges, being used over several decades. It is critical to have a system to monitor the health of these bridges and report when and where maintenance operations are needed. Advancements in sensor technology have brought the automated real-time bridge health monitoring system. Mainly deals with Height of prediction of boat, water level monitoring, pressure monitoring below the bridges. It deals with comparison between bridge height and the boat height and predicts weather boat can pass under the bridge or not in order to avoid collisions.**

***Keywords*: Crash avoidance, Condition monitoring system.**

1. Introduction

In today's world road and transport has become an integral part of every human being. Everybody is a road user in one shape or the other. The present transport system has minimized the distances but it has on the other hand increased the life risk. Every year road crashes result in loss of many lives and serious injuries too. Highway bridge systems are critical in many regions, and can consist of several tens of thousands of bridges, being used over several decades. It is critical to have a system to monitor the health of these bridges and report when and where maintenance operations are needed. Advancements in sensor technology have brought the automated real-time bridge health monitoring system. Many long span bridges in Korea and in Japan have adopted this real-time health 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 health monitoring system. The complicated wiring also makes the installation and repair/replacement process difficult and expensive.

In this project an idea of bridge health monitoring system using wireless system is proposed. For short distance (among sensors in the bridge) RF module is used as wireless network, and GSM is used for long distance (between the bridge and the management center) data communication. This technology can be called MBM (Monitoring Based Maintenance) that enables the bridge maintenance engineers monitor the condition of the bridge in real time. The sensors installed on various parts of the bridge monitors the bend, beam sustainability, weight of the vehicles 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. The complete parameters of the bridge are taken by an ARM processor and sent to another module which is located in a short distance. Here the communication established is using RF module 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 GSM technology. The sensory inputs are process to represent the condition of the bridge against seismic loads, loads etc.

2. Existing System

Presently there is no such monitoring and controlling system available for bridges and Fly overs. Even if some monitoring system is there then very traditional way is followed where the processed data at the bridges will be sent using wired data transfer which is having drawbacks with respect to reliability and range. Also, manually one has to examine the bridges by watching them carefully. It may lead for any human errors. All the heavily weighted vehicles are allowed to move on the bridge that is leading for the damage of bridges.

3. Proposed System

Proposed System mainly deals with prediction of bridges height, water level monitoring, pressure below the bridges. It deals with comparison between bridge height and the boat height and checks weather the boat can cross the bridge or not. It also deals with measurement of flow sensors i.e. to predict pressure below bridges and intimates the boat owners whether it is safe to cross the bridge or not. It even measures overflow condition and also the earthquake parameters and closes the bridge if it is not a safe condition.

4. Methodology

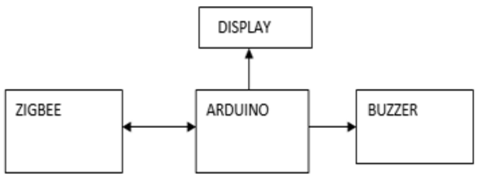

Fig. 1. Block diagram of boat module

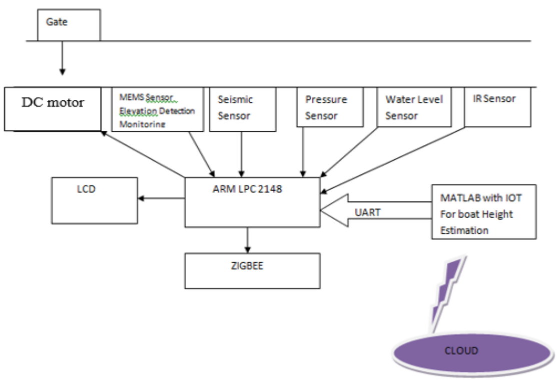

Fig. 2. Block diagram of bridge module

- Measuring the height between bridge and river water.
- Measuring the level of the water flowing under the bridge.
- Measuring the height of the boat using Image processing (MATLAB).
- Intimation to the boat owner if there is a chance of crash.
- Counting the no of vehicles from either side, and measuring load on the bridge and closing the gates when threshold is reached.
- Bridge overflow detection using water level sensors
- All the data can be stored on cloud.
- Communication between dam and bridges can achieved using IOT so whenever there is excess release of water boat/shipper man can be intimated and bridges can be closed.

Steps involved in detecting the height of the bridge are

1. Capture the image of boat with red strip on it which indicates height of the boat.
2. Extract the red layer details using image processing function in MATLAB.
3. Using region properties tool present in MATLAB find the major axis length of the red strip that is detected which helps in determining the boat height.

Fig. 3. Detecting the height of the boat

5. System Implementation

A. ARM 2148 Microcontroller

It is a 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package. Power saving modes include Idle and Power-down.

CPU operating voltage range of 3.0 V to 3.6 V with 5 V tolerant I/O pads. The 2148 microcontroller is used, where all the other components (like sensors, battery, dc motor) are interfaced to it.

B. Arduino

Arduino can be used to develop standalone interactive objects or can be connected to software on your computer. Arduino is an open source physical computing platform based on a simple input/output (I/O) board and a development environment that implements the processing language. Here, the Arduino is interfaced with LCD, Buzzer and Zigbee.

C. Liquid Crystal Display (LCD)

LCD module has 8-bit data interface and control pins. To display any character on LCD micro controller has to send its ASCII value to the data bus of LCD. The LCD is used in both boat and the bridge. Where it displays the message or caution. LCD on bridge displays the number of vehicles, weight of the bridge, flow rate due to water pressure etc. The LCD on the boat displays the message or alert that is sent from the bridge.

D. DC Motor

A D.C. motor is a machine that converts electrical energy into mechanical energy. Here, the DC motor acts as a gate to open and close.

The DC motor automatically closes when the weight on the bridge is overloaded and the gate will open only when all the vehicles are exited from the bridge

E. Zigbee

The ZigBee is a very low-cost, very low-power, two-way, wireless communications module. Zigbee operates in the range of 30m. It operates at a frequency of 2.45 MHZ. The communication between the bridge and the boat is achieved using Zigbee.

F. Sensor

IR sensor: The IR Sensor-Single is a general-purpose proximity sensor and consists of IR emitter and IR receiver pair. The main purpose of using this sensor is to count the number of vehicles entering and exiting the bridge.

Vibration Sensor: The vibration sensor is used to detect the vibration under the bridge caused by earthquake, high water pressure etc.,

Water-level Sensor: Level measurements can be done inside containers or it can be the level of a river or lake. It is used to measure the level of the water under 3 stages. In first stage, the boat can pass easily, in second stage, boat can pass with a little gap and in third stage, the boat cannot pass under the bridge.

Pressure Sensor: A pressure sensor usually acts as a transducer. In this, pressure sensor is used to measure the pressure of the water under the bridge.

6. Outcomes

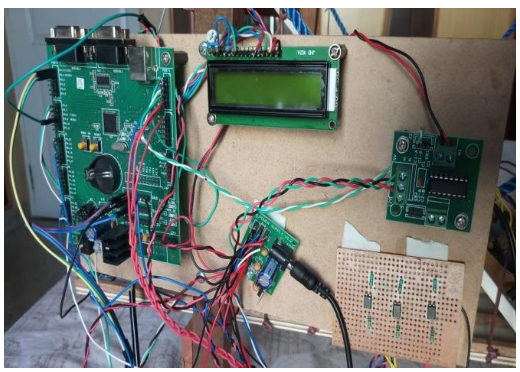

Fig. 4. Bridge module

- In Bridge Module IR sensor is used to detect 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.
- Vibrator sensor detects extreme vibration on the bridge.
- DC motor acts as the gate in our bridge monitoring system
- Water Level Sensor is used to detect the water level at the bridge.
- Pressure Sensor is used to measure the velocity of water flowing downstream to avoid boat imbalances due to high velocity of water flow.
- ZigBee is used for communication purpose, to send message from bridge module to boat module.
- LCD is used to display the parameters of all the sensors.
- In Boat Module, it consists of Arduino to interface LCD and ZigBee.
- ZigBee is used to receive the message sent from the Bridge module.
- LCD is used to display the message received by the ZigBee.

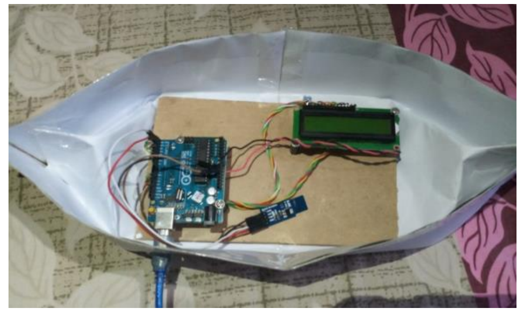

Fig. 5. Boat module

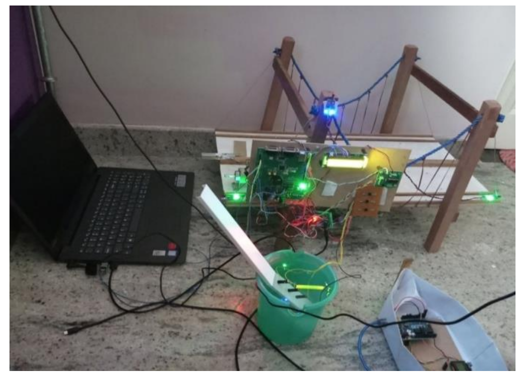

Fig. 6. Complete prototype

7. Conclusion

This paper presents a prototype of a novel self-powered wireless system for applications of structural health monitoring of bridges. Conducted theoretical analysis facilitates selection of a natural frequency with the highest energy content and quick estimation of parameters for an electromagnetic harvester. Field tests sensor show the feasibility of the proposed approach for applications of structural health monitoring.

8. Future scope

Application of structural health monitoring technologies to bridges has seen great increase in the past decade. Initial results from these applications have shown the capability of available SHM technologies in monitoring, analyzing and understanding the health of the monitored bridges. Since most of case studies and applications are just in past recent years, it is necessary to examine their performance and results over a long time by continuous monitoring to determine the durability and reliability of these systems.

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