Review on Advanced Weight-In-Motion System For Bridge Protection & Bridge Traffic Data

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Abstract—Advancements in sensor technology have brought the automated real-time bridge health monitoring system. However, current system uses complicated and high cost network amongst sensors in the bridge and high cost optical cable between the bridge and the management center, 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. Monitoring of the strategic structures is getting more and more important. New sensors platforms and promise early damage detection and damage estimation. This paper designs a sensor network for Structural Health Monitoring using available sensors to measure and extract characteristics of bridges.

The increasing in traffic volume and frequentation in overweight vehicles, which make more and more serious diseases for bridges so that reinforcement measures must be taken. We are going to validate the proposed framework on indirect bridge structural health monitoring system and show that it performs significantly better than previous approaches.

In this paper, a new idea of bridge health monitoring systems suggested GSM for long distance (between the bridge and the management center) data communication is used.

This paper provides an overview of research on Weigh-In-Motion system. It first talks about the problem the overweight causes in the reservation of the roads, the transportation, the traffic and mainly bridge safety. Then the paper analyzes the cause of this problem and gives a brief introduction on the current relevant research carried out abroad.

Keywords—MBM(Monitoring based maintenance), WIM (Weight in Motion), Wireless Data Comunication

1. INTRODUCTION

With the rapid development of the economy in our country, the transportation has made great progress, and the highway mileage has been increasing fast. However, the increasing vehicles which exceed the weight limits have done great damage to the pavements and bridges. According to the experience in highway construction in other countries, if this situation can’t be controlled effectively as soon as possible, the lifespan of these roads and bridges will be greatly shortened, which will cause a huge waste in investment.

The overweight transportation, so-called “Killer of the Highways” can cause destructive damage to the roads and bridges, furthermore the great loss in the state’s regulation fees and tax income. It brings about a sharp increase in the traffic accidents and the disorder in the road transportation. In order to improve the Bridge maintenance, it has become a very important task to develop an accurate, complete and practical weigh-in-motion as well as crack detection system to meet the needs of the bridge safety &traffic controllers.

It has a technology called MBM (Monitoring Based Maintenance) that enables the bridge Maintenance engineers to monitor the condition of the bridge in Real time. The sensors installed on main cables, hangers, Decks, towers, etc. Detect the strain and crack of the bridge. The sensory inputs are process to represent the condition of the bridge against seismic loads.

Sensor technologies have made the monitoring process more Accurate and fast. GSM technology is suggested to send the data to the remote location in which the maintenance office is located. However, regardless the advancements of the sensor and sensor data processing technologies, there is one thing that has not been changed: data communication is through wires and optical cables. The advancement in wireless technology has provided motives to the
authors to develop the wireless network based bridge health monitoring system.

2. BACKGROUND

Many existing bridges are quite old and may be either near or exceed their 75 to 100 year design life. Motivated by the fact that older existing bridge structures have numerous deficiencies, it is essential to have an accurate, complete and practical Weigh-In-Motion (WIM) system to meet the needs of the traffic controllers.

As per with the help of the wireless technology many problems due to data cables and expensive optical cable are now minimized and eliminated. Sensor and GSM module combined becomes u-node (ubiquitous node). GSM is proved to be excellent solution in short as well as long distance wireless data communication.

A multi-functional wireless bridge monitoring system has been developed for concurrent deployment of strain gauge, bridge collapse indicator and water level sensor. The hybrid sensing capabilities of these nodes satisfies the immediate requirements for economic, low maintenance load ratings and short-term dynamic measurements in addition to providing the hardware functionality for development of a long-term continuous bridge monitoring system.

3. DAMAGED CAUSED BY OVERWEIGHT

The overweight transportation can cause a sharp increase in the traffic accidents and the disorder in the road transportation. Designed according to the technical criterions, roads and bridges can bear certain load caused by the passing vehicles. The over weight of these vehicles poses repeated threats to the road to make it tired. When this weight increases, there will be a sharp weakening in the road’s ability to endure the elastic transfiguration within the period of validity. And it might cause disastrous damage to the roads and bridges, resulting in structural damage and the permanent transfiguration. Such damage will bring forward the Large and Medium Scale Maintenance Period of the roads and the small scale maintenance workload will increase, which will cost much more and cause great loss to the state properties.

4. TECHNOLOGY

The system contains the GSM module for wireless data communication. This system uses three main sensors: Strain gauge, Bridge collapse detection system, water level sensor and interface LCD to display all the notifications and results from sensors.

The system which uses sensor module and GSM module with A/D converter is called u-node. The output data from sensors are in the form of voltage, or resistance, or pulse depending on the type pf sensors. The sensors output are analog in nature, which need to be converted to digital form. A/D converter is inbuilt in the processor. A/D converter receives the data from sensors and convert it into the digital form which is further processed by the processor and gives the result. This system uses a combination of wireless communication technology and sensor technology. To measure the strain here load cell is used. After detecting any issue, red and green signal, barrier gate, buzzer, LCD display is used for the protection as well as GSM system is used to send the message to control room.

5. BLOCK DIAGRAM

Block diagram of the advanced weight in motion over weight protection system is shown in Figure 1 In which we see ‘BRIDGE PROTECTION’ is automatic maintenance system. In this system there are several blocks namely Driver, Controller, Sensors, LCD.

When car enters on a bridge the weight of car or vehicle is measured by load cells, after that the load cell will continuously measure & adds the weights of each vehicle, as we are setting a threshold for maximum capacity of bridge. If the threshold of maximum capacity is crossed then controller will take action as actuating the barrier gates for controlling the traffic over the bridge.

Figure 1: Block Diagram of Advanced WIM Bridge Protection Monitoring System

Collapse detector is used for detection of bridge collapse, Also RED signal is used for indication. As well as GSM technique is used to alert the control room.

Below is the detail information about the system:
5.1 Load Cell:
A strain gauge is a device used to measure strain on an object. The most common type of strain gauge consists of an insulating flexible backing which supports a metallic foil pattern. The gauge is attached to the object by a suitable adhesive, such as cyanoacrylate. As the object is deformed, the foil is deformed, causing its electrical resistance to change. This resistance change, usually measured using a Wheatstone bridge, is related to the strain by the quantity known as the gauge factor. A load cell is a transducer that is used to convert a force into electrical signal.

5.2 GSM Module:
GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine- SIM900A, works on frequencies 900/1800 MHz’s. The Modem is coming with RS232 interface, which allows you connect PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The on-board Regulated Power supply allows you to connect wide range unregulated power supply. Using this modem, you can make audio calls, SMS, Read SMS; attend the incoming calls and internet etc. through simple AT commands.

5.3 MAX 232:
The MAX232 is a simple logic TTL/CMOS input levels into EIA-232 levels. It is a dual driver/receiver that includes a capacitive voltage generator. This generators supply EIA-232 voltage levels from a single 5-V supply. It have typical threshold value of 1.3 V and a typical hysteresis voltage value of 0.5 V, and can handle up to ±30-V inputs.

5.4 LCD Display:
This display contains two internal byte wise resisters. One for the commands (RS=0) and second for character to be displayed (RS=1). It also contains a user programmed RAM area (the character RAM) that can be programmed to generate any desired character that can form using a dot matrix. To distinguish between these two data areas, the hex command byte 80H will be used to signify that display RAM address 00H is chosen. Port 1 is used to furnish the command or data byte, and ports 3.2 to 3.4 furnish register select and read/write levels. The display takes varying amounts of time to accomplish the functions. LCD bit 7 is monitored for logic high (Busy) to ensure the display is not overwritten.

5.5 Motor Driver:
The L293 & L293D are drivers that are capable for providing more output currents up to 1A per channel respectively. Every channel is handled by a TTL-compatible logical input & every pair of drivers (a full bridge) is equipped with an inhibit input which turns off all 4 transistors. A separate supply input is provided for the logic so that it may be run off a lower voltage to reduce dissipation. Additionally the L293D includes the output clamping diodes within the IC for complete interfacing with inductive loads. Both devices are available in 16-pin Batwing DIP packages.

5.6 Water Level Detector:
Water level sensor is used to detect the water flow level. When water level exceed the threshold level, it proceeds to alert using system.

5.7 Bridge Collapse Detection:
Bridge Collapse detection system is used for detection of collapse. Non corrosive metal wire is used for the bridge collapse detection.

6. WORKING
The Strain gauge for live load monitoring, non-corrosive metal wire for bridge collapse detection and water level sensor for flood detection are the sensors which sense the any accidental condition on the bridge. These are interface with the micro controller At-Mega328. After sensing any emergency, it actuates the barrier gate, red signal as well as alarm. Also it shows the notification LCD display and send message to control room using GSM network.

7. APPLICATIONS
1. Protect infrastructure by using overweight on bridge.
2. Bridge collapse detection and notification to the control room using GSM module.
3. Avoids the accidental condition during flood or water over flow.
4. To control the bridge traffic using the barrier gate and traffic signals.
5. Live load monitoring.

8. CONCLUSION
The overweight problem causes great damage to the road, to the traffic security and the transportation. To overcome these problems and to utilize the current technology and manpower
resources, we must take efforts in developing advanced WIM system. It has been an important task for us to integrate the advanced technologies abroad into the research and development of the domestic WIM systems. A multi-functional WIM bridge monitoring system has been developed for concurrent deployment of strain transducers, Bridge Collapse detection and water overflow indicator. The sensing capabilities are satisfies the immediate requirements for economic, low-maintenance load ratings in addition to a bridge monitoring based maintenance system.

9. REFERENCES


