Bridge Monitoring System

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Abstract— This work is based off of our Bridge Monitoring System Project. There have been recent incidents of bridge collapses in India due to lack of proper maintenance and inspection, which is what this project is aims to find a solution for. The Project is a Bridge Monitoring System. The Bridge Monitoring System aims to monitor over long durations the vibrations propagated through suspension and possibly other similar bridges under load as well as no load conditions. It also aims to monitor the effects of weather (especially wind) on the bridges. The project makes use of a micro controller-based system to acquire, process, transmits, receive, display, graph and store data. The statistical data will reveal how the bridge responds under various conditions and graph the information in a meaningful way.

Key words: ATmega328P-PU, Gyroscope, Transceiver, LCD (Liquid Crystal Display), IDE (Integrated Development Environment), MEMS (Micro-Electro-Mechanical Systems)

I. INTRODUCTION

There have been several bridge failures in the past due to lack of inspection and audit. Bridge failures result in loss of life and also results in breaking down of the transportation system that people rely on. It also results in financial losses for the governments. The Bridge Monitoring System will basically monitor the vibrations propagating through the bridge in real time. It will do this with the help of a gyroscope-accelerometer MEMS Sensor, which is a device that can sense movement in 3-axis. Temperature fluctuations also play a role in how the response of the bridge changes because of the nature of the material used for building the bridge. Therefore, the system will also monitor temperature in its surroundings. The system will be divided between two devices. One of the devices will be mounted on the bridge and the other will be in the control room from where the data can be wirelessly monitored. A Transceiver module will be used for wireless communication. An LCD Screen will display data from the device mounted on the bridge. The data will also be sent to a computer to plot required graphs and store the data for analysis.

A. Objectives

1) Monitoring vibration propagating through the bridge with no load condition.
2) Monitoring vibration propagating through the bridge under load.
3) Studying the effects of temperature on the vibrations.
4) Wireless monitoring of data.
5) Alert system if vibrations cross a set threshold value.
6) Logging of data.
7) Graphing the data.
8) Analyzing the data to find out the cause behind a given response of the bridge.

II. LITERATURE SURVEY

1) Integrating A Global Positioning System And Accelerometers To Monitor The Deflection Of Bridges

This paper cites how kinematic global positioning system (GPS) allows sub-centimeter accuracy vibration or motion detection at the rate of 20 Hz. It mentions how this can be used for detection of motion and vibration of long bridges. It also mentions how accelerometers have been used to detect vibrations at an even higher rate of up to 1000 Hz. But since there is reliability issue with GPS, the former solution for vibration measurement is not very effective. They therefore suggest the use of kinematic GPS along with accelerometer system for results that are reliable.

2) One Year Monitoring Of The Z24-Bridge: Environmental Influences Versus Damage Events

For this paper one year monitoring of the Z24-Bridge. The main objective was to find out whether a system when monitoring a bridge could differentiate between Environmental and Damage events. The paper refers to environmental changes as "normal changes" and structural damages as "abnormal changes". Wind and temperature are considered to be normal changes and loss of stiffness is considered to be an abnormal change. The authors were able to differentiate between the normal and abnormal changes with ARX models.

III. SYSTEM METHODOLOGY

The device in the control room will have a micro controller at the heart. This micro controller will perform the task of taking input from the user. It will receive data sent to it from the systems on the bridges via a transceiver and process it in accordance with the program. It has a Nokia 5110 LCD connected to it. The LCD will display the received data in an appropriate way. The LCD will also indicate the user of any of the vibrations that make the bridge cross the set motion threshold. This system will be connected to a computer to plot the necessary graphs as well as to log data and analyze it. If a set threshold value of vibration is exceeded then the system will alert the user of the same. This will warrant a inspection as soon as possible.

The device mounted on the bridge has a micro controller will be at the heart of the system. The motion detection is done with the Gyroscope + Accelerometer module attached to the micro Controller over I2C detects motion in 3-axes. The data sensed by this module is sent to the micro controller. The module GY-521 will be used to handle motion detection duties. It has a built in temperature sensor as well which will be used to plot the temperature along with the motion changes. Data collected by the micro controller is sent over to the system on user side via the transceiver module NRF24L01

The images below show the schematics for prototype models of the devices.

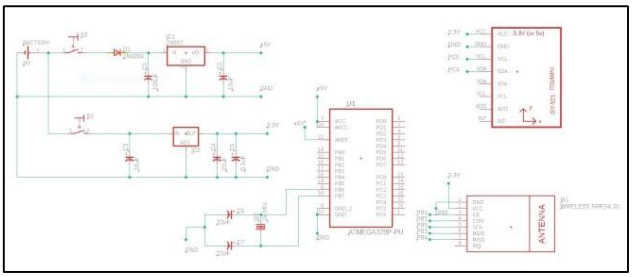

Fig. 1: Bridge Mounted Device Circuit

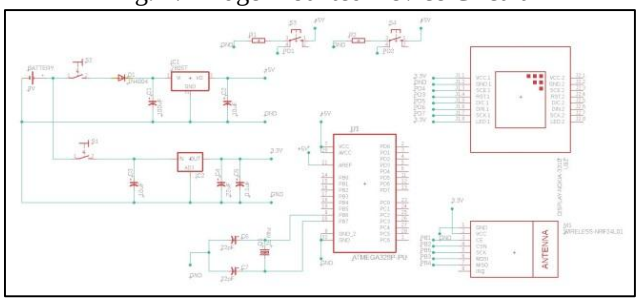

Fig. 2: Receiving Device Circuit

IV. CONCLUSION

We have laid out a plan to make prototype devices that will be able to detect vibrations in a bridge under several conditions. The advantages of this system include being able to monitor continuously as opposed the traditional methods of inspection and testing that are carries out only once in a while. This system has the added advantage of not having to put the bridge out of order for the testing and inspection. Graphing the data will allow us to correlate the vibration data with temperature data as well as the load and no load conditions. As abnormal changes and crossing of threshold values will alert the user, the bridge can be promptly put out of order and inspected for any structural damage.

V. FUTURE SCOPE

1) A wind direction and speed measuring system can be added to device mounted on the bridge. This will allow for the wind speed to be plotted along with the vibration and temperature graphs. This will give us a better set of data to study and analyze.
2) The range of the wireless system can also be increased. Or we can make the system upload the data directly to a dedicated internet server from which all the data can be easily accessed remotely.

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