IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 16-18

Wireless Bridge Monitoring System using MEMS Sensor

Abhijit Kambli[1], Abhiraj Bhongle[2], Sahil Sheikh[3], Shweta Pandare[4]
[1](Department of Electronics, SLRTCE Thane-401107/Mumbai University, India)
[2](Department of Electronics, SLRTCE Thane-401107/Mumbai University, India)
[3](Department of Electronics, SLRTCE Thane-401107/Mumbai University, India)
[4](Department of Electronics, SLRTCE Thane-401107/Mumbai University, India)

Abstract: *The project aims at providing an unobtrusive continuous monitoring system for bridges. Wireless transmission of collected sensor data is carried out. MEMS Sensors are used to monitor the changes in the parameters to be measured. Micro-controller based system that can be run at low power levels. Expandable as needed to suit the application. Facilities to measure gravitational force, rotation and temperature. Alert capabilities built into the system. Can be modified for longer range. Can display, log, and graph sensor data.*
Keywords: *Bridge, MEMS, Micro-controller, Monitoring, Sensor, Wireless.*

I. Introduction

In recent past we have seen incidents of bridge collapses. Bridge collapses happen because of lack of proper maintenance, inspection, or because of the low frequency of monitoring. Technology such as NDT, Visual Inspection, Continuous Deformation Measurement System, GPS bridge monitoring. Most of these are either discontinuous/short term measurement systems or require the bridge to be temporarily put out of use. The Wireless Bridge Monitoring System presented in this paper aims to remedy the shortcomings of the previously used technology.

II. Wireless Communication

The Wireless Bridge Monitoring System essentially hinges around the wireless communication provided by NRF24L01 2.4GHz Transceiver. It provides half duplex capabilities with speeds upto 2 Mbps. Can operate on 125 channels. Can be used to create a wireless sensor network (WSN). It is ultra low cost, low power consumption, provides Automatic acknowledgement for transmitted data.
This transceiver is used to establish communication between one or more of the sensor modules and the Main Receiving Station that will collect and perform calculations on the transmitted data.

III. MEMS Gyroscope And Accelerometer

MEMS or micro-electro-mechanical systems is a technology of devices that are microscopic in size. They are fabricated using widely available IC fabrication technology. These differ from the usual ICs in the sense that they have microscopic moving parts along with microscopic electronic components. These devices open up immense possibilities for technological development due to the small size that allow them to be integrated into various systems without demanding too much of the available space.

The MEMS Gyroscope and Accelerometer is basically an Inertial Measurement Unit or IMU. This unit provides the transduction of vibrational movement to sensor data that is the basis of the Wireless Bridge Monitoring System.

The data provided by this unit is made available to the micro-controller via I2C interface. Further calculations of the raw sensor values are done on the micro-controller.The unit comes in a small package, provides various sensitivities and ranges. It does all this at low power cost.

IV. Features of the system and Current progress

4.1 Vibration Detection

Vibration detection using MEMS accelerometer. The accelerometer will measure gravitational force generated by the vibrations on the bridge. The vibrations are transduced using MEMS technology and are output digitally to the micro-controller over the I2C bus.

4.2 Rotation Measurement

The rotation of the plane of the bridge that the sensor node is connected to will be measured using MEMS Gyroscope and forwarded to the micro-controller. Rotation is measured in degrees of rotation per second.

4.3 Live Value Display

The live values of vibration and rotation will be displayed on the Main Receiving Station LCD. The LCD will also display the set threshold value. If the threshold value is crossed then the display will mention the same. Oher values such as current temperature can also be displayed.

4.4 Visual and Auditory Alerts

Visual and auditory alerts can be triggered when the set threshold limit for vibrations is crossed.

4.5 Logging of sensor data

Sensor data can be logged on to the computer to which the Main Receiving Station is connected. This data can be used for further analysis of the change in the condition of the bridge.

4.6 Graphing of the sensor data

Sensor data that is continuously being logged onto the computer can be used to make graphs that visually represent the changes in the vibrational response of the bridge.

4.7 Current Progress

Fig. 1 Serial Monitor of Transmitting Module on Bridge 1 showing values being transmitted

Fig. 2 Serial Monitor of Transmitting Module on Bridge 2 showing values being transmitted

Fig. 3 Serial Monitor of Main Receiving Station showing values received from two bridges

V. Conclusion

Sensor values from the MEMS Gyroscope and Accelerometer have been successfully extracted. Sensitivity in the range of -2 to +2 is producing expected results. 2 way communication between Transceivers has been established. Upcoming focus of work will be on being able to transmit the MEMS IMU sensor values to the Main receiving station for display, alert, logging and graphing purpose.

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