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"WIRELESS BRIDGE HEALTH MONITORING SYSTEM"

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Abstract-: *Structural Health Monitoring (SHM)[2] mainly focus on how the monitoring and the functionality of the different sensors may lead to the increase of the Life Span validity of the building, bridges or any public buildings. Hence the implementation of the building such smart structural using the wireless sensors will lead to the bypassing of the hazardous conditions which may occur during the natural calamities situations like Earthquake, hurricanes, storms etc. It involves the integration of sensors, data transmission, collection of data, and processing ability inside the structures. We will be implementing this project, as we had seen that due to heavy loads, vibration produced in the bridge may extend beyond the limit which may leads to damage of the bridge and due to that accidents may take place. So by using this technology we can avoid these accidents.*

Keywords: *Structural Health Monitoring [2], Wireless module [4], Accelerometer, Vibration sensor Xbee Module[1], Networking, ARM7 Controller.*

"I. INTRODUCTION"

In today's scenario the monitoring of the bridge is done manually, the tilt formed in the column of the bridge is measured with the human efforts. 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. In this paper, the wireless solution that overcomes these problems is presented. The installation cost is low because the sensors do not require wiring; no additional supporting structure such as pipeline for cable is required. Sensors are easily replaced when malfunctioning; Data collected from the sensors can provide bridge owners with diverse information on bridge structural health such as overstrain changes in load conditions, deformation, excessive vibration, crack development and growth, and conditions that are conducive to corrosion. The type of probe used on the sensor corresponds with the conditions being monitored in the concrete In this Report, a new idea of bridge health monitoring system is suggested. For short distance (among sensors in the bridge) Zig- Bee wireless network is tested, An A/D converter for each type of sensor is developed in this research work. Thus, the A/D converter reads analog data from the sensor and delivers the data to the Zig- Bee Module. A multi-functional wireless bridge monitoring system has been developed for concurrent deployment of accelerometers, strain transducers.

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. 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 Zig Bee module combined becomes u-node (ubiquitous node). Zig Bee is proved to be excellent solution in short distance wireless data communication. Sensors and network modules are combined into one unit, which often called ubiquitous sensor, and communication network delivers sensor data wirelessly. Accelerometer sensor can measure level of acceleration where it is mounted.

"II. BLOCK DIAGRAM"

2.1 ARM Microcontroller:-

Advanced RISC Machine, is a family of reduced instruction set computing (RISC) architectures for computer processors, configured for various environments. Basically we have used LPC2138 as the main Microcontroller which is mainly used for the high throughput operations and the 10 bit channel ADCs are used which is mainly used for the analog data conversions to the digital data conversions to which the given module works and with the interfacing with the crack sensors, Vibration sensors and Accelerometer Sensor. All of them support a 32-bit address space pre-ARMv3 chips, made before ARM Holdings was formed, as in original Acorn Archimedes, had smaller and 32-bit arithmetic;

2.2 Accelerometer:-

An accelerometer is an electromechanical device used to measure acceleration forces. Such forces may be static, like the continuous force of gravity or, as is the case with many mobile devices, dynamic to sense movement or vibrations. The tilt sensor is a component that can detect the tilting of an object. However it is only the equivalent to a pushbutton activated through a different physical mechanism. This type of sensor is the environmental-friendly version of a mercury-switch.

The ADXL335 is a triple axis MEMS accelerometer with extremely low noise and power consumption - only 320uA! The sensor has a full sensing range of +/-3g. There is no on-board regulation, provided power should be between 1.8 and 3.6VDC. MEMS (Micro-Electro Mechanical System)-based accelerometers are devices that measure the proper acceleration. In relativity theory, proper acceleration is the physical acceleration experienced by an object. The psychical acceleration is measurable by sensors.

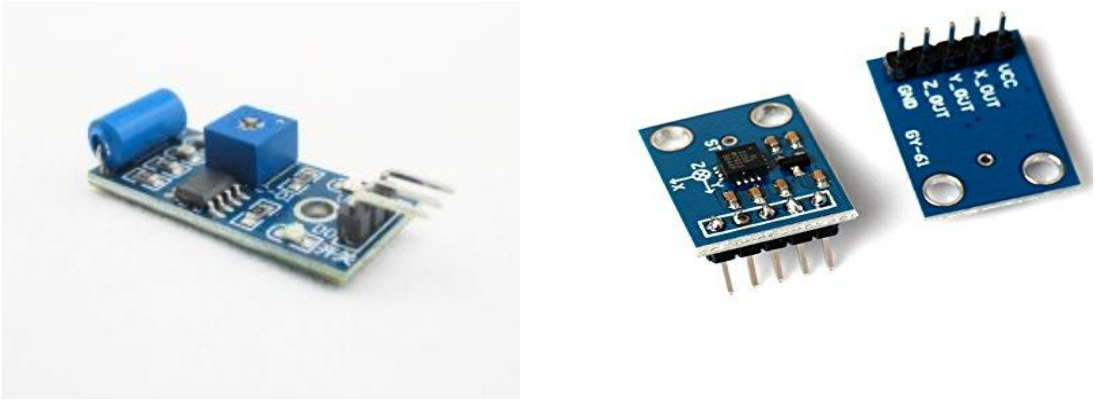


Figure 1. Accelerometer, Tilt and Vibration Sensors

2.3 Tilt Sensors:-

The tilt of the ski slopes and the steepness of the lands is measured with the help of tilt sensors. (<10° for beginners; 10–20° "green"; 15–25° "blue"; 25–35° "black"; and 35–45° "double black"),used as a warning system on the external surface of transport cryogenic liquids to indicate tilt being too much. Measuring and alignment of 2-dimensional plane tilt angles with dual-axis tilt sensors: 2-axis tilt sensors/ inclinometers utilizing MEMS tilt sensors are capable of simultaneous 2-axis high accuracy (typically 0.001°) and wide angle measuring range (e.g., ±30.000°).

The 2-axis tilt sensor technology enables simultaneous 2D (X-Y plane) tilt angles measurement which traditional single-axis tilt sensors are unable to offer. Often, precision industry applications in particular, leveling, angle measurement/ alignment and surface flatness profiling tasks essentially involve 2-dimensional planes rather than single-axis.

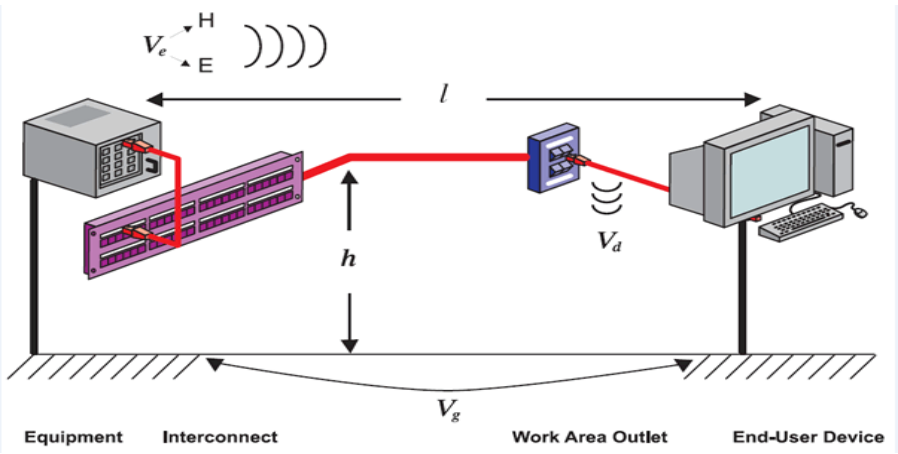


Figure 2. Crack Detection Sensor

2.3 ZigBee Module:-

ZigBee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low-bandwidth needs. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi.

Wireless adaptors have the following characteristics:

2.3.1. Wireless adaptor provides the radio/wireless access between AP and other Wireless Network.

2.3.2. Wireless adaptors can be integrated into Sensors.

2.3.3. Wireless adaptors can be external to the Sensors.

Figure 3. Mounting of Tilt Sensor

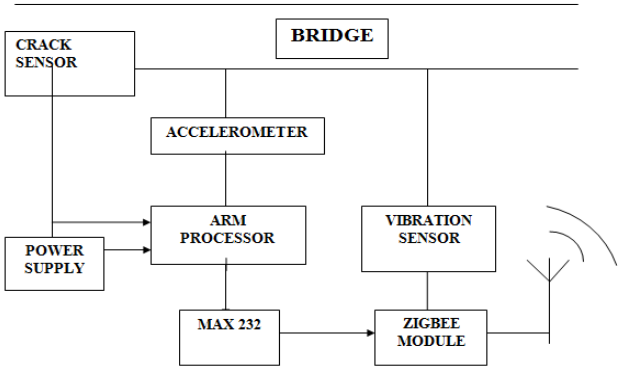


FIGURE: TRANSMITTER

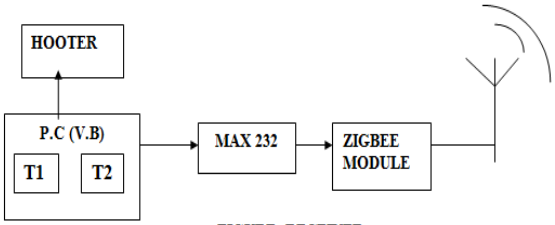


FIGURE: RECEIVER

The block diagram consists of the Transmitter and receiver part. In which the transmitter consist of accelerometer for measuring tilt, vibration sensor for measuring the vibration of the bridges, crack sensor(strain gauge) for detecting cracks on the bridges. These all sensors are interfaced with ARM Processor (LPC2138).MAX232 is used for serial communication with zigbee module for transmitting the data to receiver.

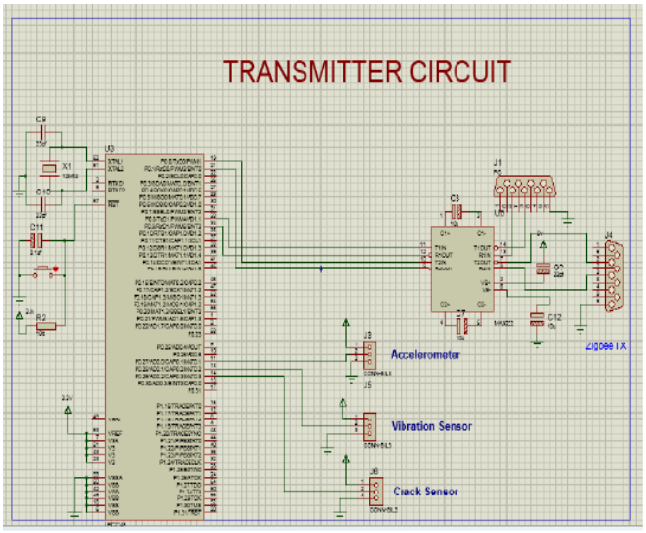
The Receiver block consists of a zigbee module for receiving the signal and through MAX232 serial communication to display the analyzed data on the screen. The Hooter is used to inform when there is any damage on the bridge, so that the appropriate action would be taken to resolve the problem.

"III. WORKING"

ARM7 is used for the processing unit. The above shown figure is the main block diagram of the paper. In the block diagram node has been shown. The node consists of an accelerometer sensor, vibrator sensor, ARM7 processor and a Zigbee transmitter. Each node is placed on the bridges with some particular distance on the bridge, so that each node can monitor particular place of the bridge. The Main Focus is on the Structural Monitoring [2] of the bridge which will ensure that the given structure is All Climate Ready and such that it will withstand and Tilt warnings and the vibration warnings will be easily notify in the nearby Control centres.

All the nodes send the data to the zigbee receiver at the control room. The accelerometer sensor will be identifying the tilts and vibrations occurred on the bridges. The Sensor is mainly capable of notify the readings according to the tilts in the different directions as it is having 3 axis sensors which are piezoresistive so the rolling axis and the pitch of the directions in which it is tilted. The directions of the tilt sensors have been classified as x, y and z-axis. Also the various configurations of the bridge we have defined as per the angle of the action of Tilt which are basically given as: Left Front up, Right Front up, Normally Right and Normally Left.

Vibrator sensor is used to find the pressure applied on the bridges. This pressure is made by the movements of the vehicles in the top layer of the structure.



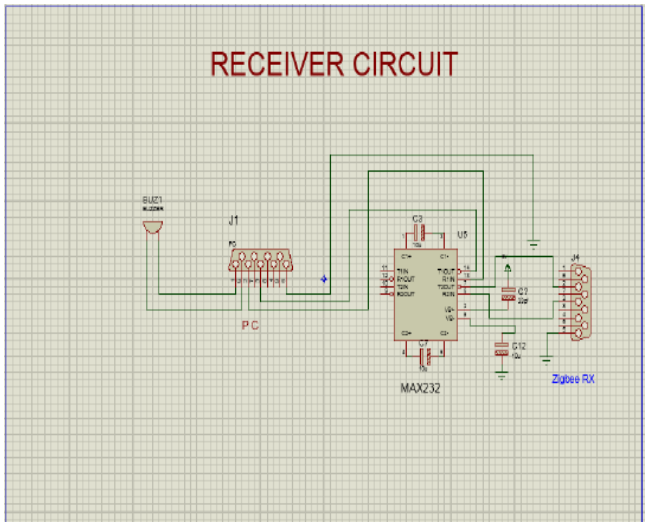


Table 1. Accelerometer Tilt Sensors Readings

Axis of Tilt	X co-ordinate	Y co-ordinate	Z co-ordinate
Initial condition	517	502	678
Normally Left	515	519	670
Normally Right	521	485	679
Left Front Up	571	506	678
Right Front Up	530	506	679
Extreme	525	520	680

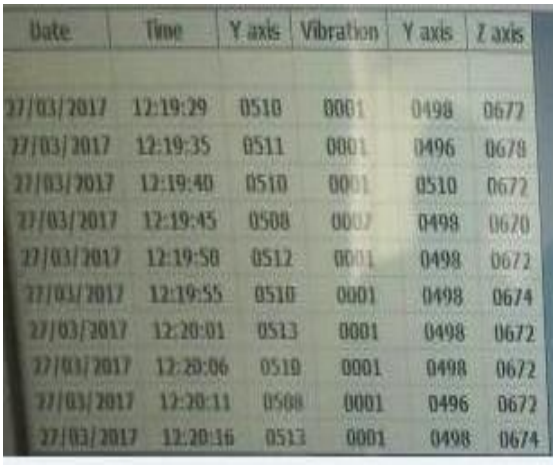


Figure 4. Vibration Sensors Reading and Graph

"IV. OBJECTIVES"

- It is used to find out the mechanical strain on the bridge.
- It is used to measure the bridge tilt.
- It is used to read ambient temperature.
- It can be used for structural health, bridge safety, damage detection.
- The wireless sensor system enables remote damage detection and structural health monitoring [2] for bridges and other structures.
- It detects steel corrosion and concrete deterioration.
- It can avoid accidents caused by the extreme weather conditions.
- It is useful for monitoring the faults of bridge occurred.
- It has a technology called MBM (Monitoring Based Maintenance)[2] that enables the bridge maintenance engineers monitor the condition of the bridge in real time.

"V. RESULT"

In the proposed system we will continuously get the information at the control room about the angle of tilt of the columns of the bridge, and also the vibrations into the columns along with the graph using the Crack Sensor, Accelerometer and vibration sensors respectively in the situations like natural disasters etc. If the tilt of the column goes above the standard level then we will get to know about the damage in the columns from the Buzzer placed at control room. So the accidents can be avoided and more lives can be saved using this technology.

Figure 5. Proposed Model of the Wireless Bridge Health Monitoring System

"VI. FUTURESCOPE"

The current system can be upgraded by using laser detection method e for scanning and detecting the tilts, cracks by using laser technology. This system can be also used in Towers, Bridges and also in ships for detecting the crack, tilts and vibration and will also provide the data on regular basis easily.

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