Bridge Structural Health Monitoring using Wireless Sensor Networks

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Abstract: *A wireless sensor node is placed on the bridge to monitor the structure of the bridges automatically. Monitoring and analyzing the structure of the bridges helps to avoid the accidents on the bridges, save lot of wealth and many precious lives. These wireless sensor nodes has to be places on the bridges with some distance, so that each node monitors a particular area of the bridges. Each wireless sensor node contains accelerometer sensor, pizeo sensor, ARM processor and Zigbee transmitter. These sensors are used to monitor vibrations, tilts and pressure applied on the structure of the bridge. These nodes will continuously send the data to the Zigbee receiver. The data received is displayed on the monitor. The processing and Zigbee module consumes less power, so power consumptions will be very less.*

Key words: *wireless Sensors, ARM processor, bridge health monitoring, Zigbee, accelerometer.*

I. Introduction

For the effective bridge management the structural health monitoring (SHM) is used for the bridges. This monitors the structure of the bridges and identifies the damages on the bridges. This SHM consists of nodes. Each node has sensors, processing unit and data gathering units. This SHM has monitoring based technology. The procedure of identifying the damage and characterized method for building bridge structure is referred as structural health monitoring of bridges.

The structural monitoring includes the awareness of the outline of the structure like the limitations of the structure can go through. By this method we can identify the issues on the structure of the bridge. As the issue has been identified it can be rectified before it causes any major harm to the structure. The SHM includes different steps which are monitoring the structure, processing the data and sending the data to the control room. If any natural disasters occur like earth quakes this monitoring process will be useful for fast screening and give the instant data about the damage of the structure. This will help to rectify the damages on the structure.

The Structural Health monitoring (SHM) concept is widely applied to various types of infrastructures, especially as countries all over the world enter into an even greater period of construction of various infrastructures ranging from bridges to skyscrapers. Especially so when damages to structures are concerned, it is important to note that there are stages of increasing difficulty that require the knowledge of previous stages, namely:

1) Detecting the existence of the damage on the infrastructure
2) Locating the damage
3) Identifying the types of damage
4) Quantifying the severity of the damage

II. Design and Implementation

There are many advantages of wireless sensor network than a wire-based system. Yet, there is no wireless sensor network system that permanently replaces the existing wire-based system.

In this paper we have been used the wireless sensor networks. The two sensors used are accelerometer sensor and the pizeo sensor.

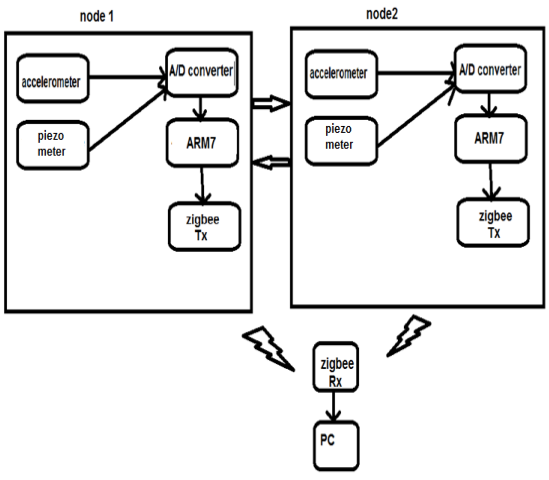

Fig 1: Block diagram

ARM7 is used for the processing unit. The above shown figure is the main block diagram of the paper. In the block diagram two nodes has been shown. Each node consists of an accelerometer sensor, pizeo 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. 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. Pizeo sensor is used to find the pressure applied on the bridges.

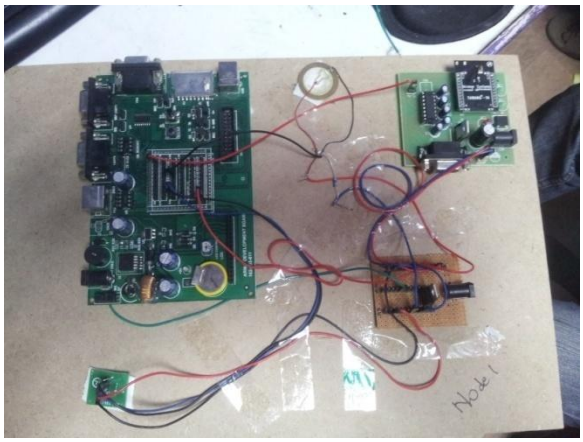

Fig 2: Node1

The output from the sensors is analogue values. These analogue values are given to the ARM7 processor. This Arm7 processor covert the analogue values to the digital format and do the processing and give those values to the Zigbee transmitter.

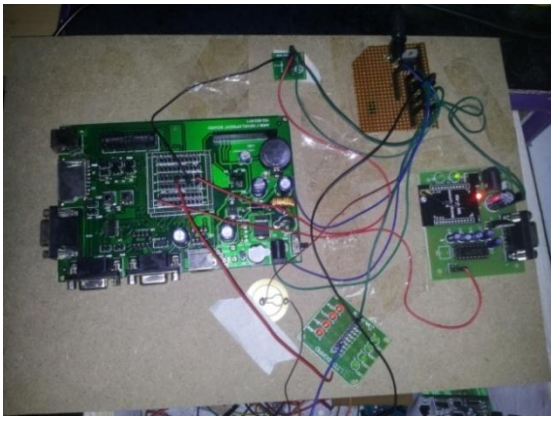

Fig 3: Node 2

Node 2 as shown in the above figure 3 performs the same operation as the node1. This node 2 monitors the particular part of bridge and the values are given to the Zigbee transmitter.

All the nodes send the data from their transmitters to the Zigbee receiver at the controlling room. The Zigbee receiver module is connected to the system in the controlling room. The values received by the Zigbee receiver are displayed on the monitor. The outputs of the Zigbee receiver are displayed using the proteus software.

Fig 4: Zigbee receiver

III. Results

Software tools used in this paper are

1. Keil software
2. Flash magic
3. Proteus software

Keil software is designed for the software developers as they can use them to get the most out of the embedded microcontroller architectures that are supported. The program has been written using keil software and the output has been checked.

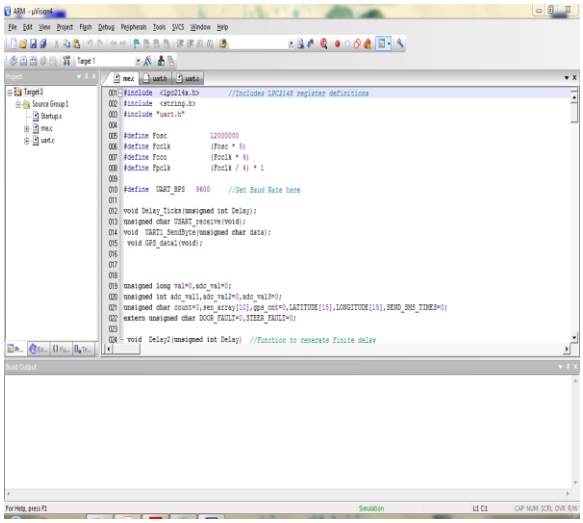

Fig 5: keil window

Flash magic software is used dump the program in to the hardware kit.

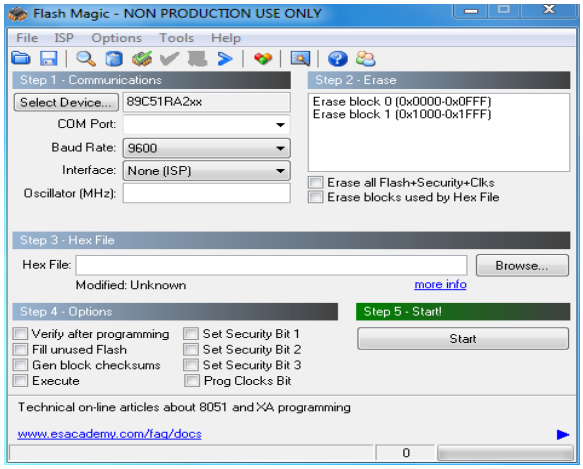

Fig 6: Flash magic window

Proteus software is used to display the output on the screen. The Zigbee receiver is connected to the system through the UART port. In proteus we can design the model and can check the output. Here we are selecting the compin and the values are displayed using the virtual terminals as shown in the below figure.

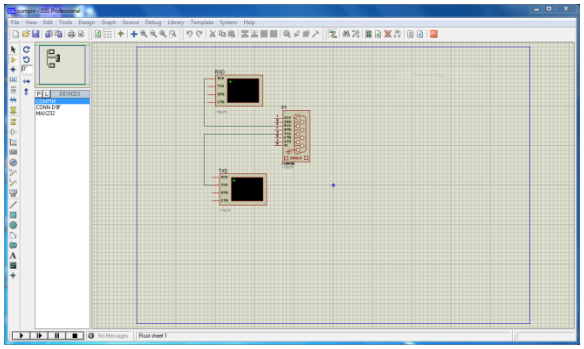

Fig 7: Proteus window

The nodes send the data and the Zigbee receiver display the result using virtual terminal as shown in the below figure.

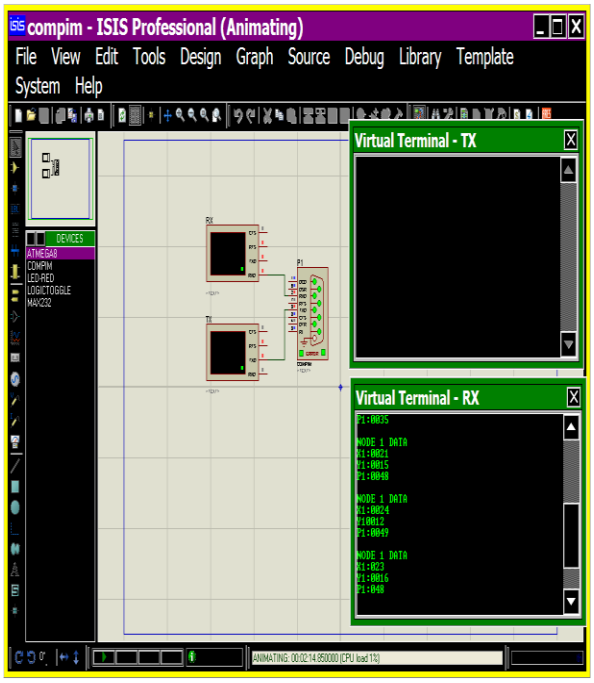

Fig 8: Result window

IV. Conclusion

In this project a model of the wireless-sensor-based bridge health monitoring system is developed. Sensors and wireless communication protocols have been used to create a Node and data transmissions. ARM7 does the Analog-digital conversion between sensors and ZigBee modules, which are in the form of a single unit called a "Node" that combines all these sensors, an ARM processor, and a ZigBee module. The maximum number of sensors was selected to allow wireless communication stability to

be tested. In this study, wireless network was achieved, with low consumption of power.

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