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BRIDGE VIBRATION MONITORING SYSTEM BASED ON VIBRATING-WIRE SENSOR AND ZIGBEE TECHNOLOGIES

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ABSTRACT

A bridge vibration monitoring device is used to sense the vibration in a bridge. It is used tomeasure the bridge vibration and to monitor the bridge for a safety functioning. This device is developed using wireless network technology, with hardware and software design integrated on a single chip. The ZigBee and GPRSare mounted on the same chip.The data that has to be monitored is passed through node via wireless communication and finally transmitted to the host computer through GPRS module.The system has more advantages, high reliability and easy networking. It also suits the remote monitoring of health conditions of dams, highway bridges and other large building structures.

Keywords— *vibrating-wire sensor; ZigBee; bridge; vibration monitoring*

I. INTRODUCTION

The bridge structure may vibrate under the action of such dynamic loads as moving vehicles, crowds, wind and earthquake. The vibration of bridge structure is an important content of bridge structure analysis. Under the action of vehicle dynamic load, and on rare occasion, crowd dynamic load, wind and ground motion of the earthquake, the vibration of the bridge structure will increase the internal force calculated according to the static force and may result in fatigue damage of local structure or form the vibration deformation and acceleration that will affect the comfort and safety of vehicle on the bridge structure, and even completely damage the bridge. Structures, including pipelines, aircraft, ships and civil infrastructures, such as bridges, buildings, dams, among others, are major parts of society's economic and industrial success. Bridges are one of the critical cross points of a country's transport network but they are expensive to build and maintain. Bridges suffer overall structural deterioration due to aging, overloading and lack of proper maintenance. For example, more than 26%, or one in four, of the US's bridges is either structurally deficient or functionally obsolete.Therefore, bridges are expected to have a higher level of reliable inspection and condition assessment to protect human lives and economic activities from unsafe bridge structures. As Wireless Sensor Networks (WSNs) are evolving in the past decade and becoming more cost effective; civil engineers with their counterparts in sensing and communications technologies are seizing the opportunity to design, build and implement continuous health monitoring tools for bridge systems. A structural health monitoring system of bridges using bias magnetic field sensor, signal conditioning circuits and impulse radio ultra –wideband transmitter.

II. RELATED WORKS

Bridges are crucial transportation links that carry road and rail traffic across rivers, gorges or other roads. When a bridge collapses or closes for repairs, it can cause massive traffic problems or strand people altogether, if they live on an island. Some of the most massive and expensive engineering projects in history

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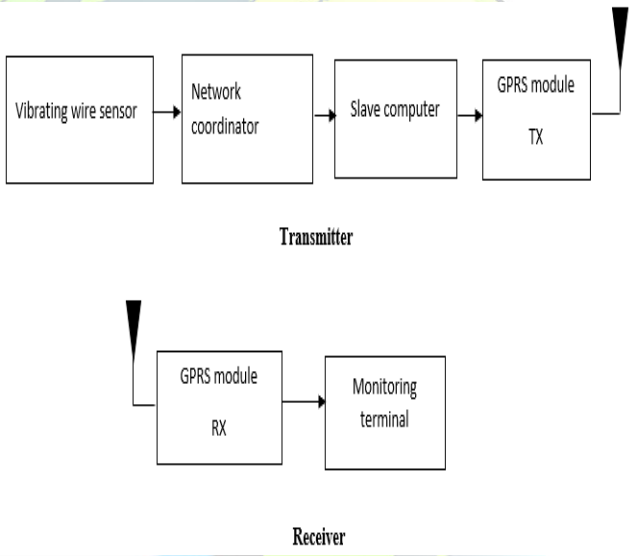
have involved building bridges. Although the general physics of bridge-building have been established for thousands of years, every bridge presents complicated factors that must be taken into consideration, such as the geology of the surrounding area, the amount of traffic, weather and construction materials. Sometimes these factors are miscalculated, or something occurs that the bridge designers didn't expect. The result can be tragic. The old bridge test method is manual method, with which the work condition of bridge structure cannot be acquired in time. So that it is very difficult to make an objective appraisal for the integral safety of the bridge structure. If we want to know the operation state of bridge correctly, the real-time monitoring of each work factors (includes dynamic character, distribution condition of temperature, stress of main truss, deflection of main truss, distribution condition of vehicle load) must be realized first, and the operation performance of bridge should be evaluated by using of bridge evaluation expert system. [1] The basic technique is failed because not providing lack information to avoid bridge collapsing [2]. As sensors are evolving now days they are becoming cost effective and user friendly as recent research are found that wireless sensors are used monitoring the health of the bridge [3]. And also, cable stayed bridge monitoring using smart sensors networks using modern technique as described [4]. Also, other system was developed micro-electro mechanical systems, and fuzzy logic for data analyzing. To avoid this, we have come up with a new system which can overcome above challenges like bridge collapsing.

III. PROPOSED SYSTEM



IV. METHODOLOGY

The parameters to be analyzed like temperature sensor,flex, altimeter and vibrating wire sensor. Temperature sensor is the most crucial parameter that determines temperature of the bridge. Flex sensor at measures the amount of deflection or bendingand resistance of sensor element is varied by bending the surface. An altimeter or an altitude meter is an instrument used to measure the altitude of an object above a fixed level. The measurement of altitude is called altimetry.

And vibrating wire sensor monitor the condition of the bridge and provides bridge vibration acceleration and amplitude and transmit the data through the ZigBee module and receiver collects the data analyze the algorithms and sends a warning signal to monitoring center.

V. SENSOR

Vibrating wire sensor

The sensitive component of the vibrating-wire sensor is a metal wire (generally called vibrating wire) fixed at both ends, which is commonly made of elastic spring steel, martensitic stainless steel or tungsten steel. Under the action of external force F, there will be a certain tension within the vibrating wire, and different natural vibration frequencies will be generated in accordance with different tensions and vibrating wire lengths.

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Thus, the change of internal tension can be determined by measuring the change of natural vibration frequencies of the vibrating wire, so that the strain value of the vibrating wire can be obtained.

VI. DESIGN OF MONITORING SYSTEM

The bridge monitoring system was mainly designed for monitoring the station and remote monitoring station. The monitoring station consists of ZigBee wireless sensor network, slave computer and GPRS wireless communication module; the remote monitoring center consists of GPRS module and host computer. The sensor nodes transmit the data stored in each vibrating wire sensors monitoring device to the co Ordinator nodes wirelessly and store in slave computer which is connected to GPRS module which will communicate with remote monitoring center through GPRS network. The development of whole communication system using ZigBee module and sensors nodes manly involve in networking, data communication with GPRS module, and sending data and receiving data through GPRS module. When the system is started up the control center sends data request to network nodes to communicate with hardware and send the information and issues of monitoring the bridge through the of ZigBee module. The network co Ordinator receives collection of data and analyze the data of the vibrating-wire sensor monitoring device accessed and gather the monitoring data to the network coordinator. the network co Ordinator send the data to slave computer and with the built algorithm and obtain vibration acceleration and amplitude of bridge and transmit data to remote monitoring center through GPRS network. The central server will analyze and store the data and draw vibration time travel curve in real time and send the warning signal at the vibration acceleration or amplitude.

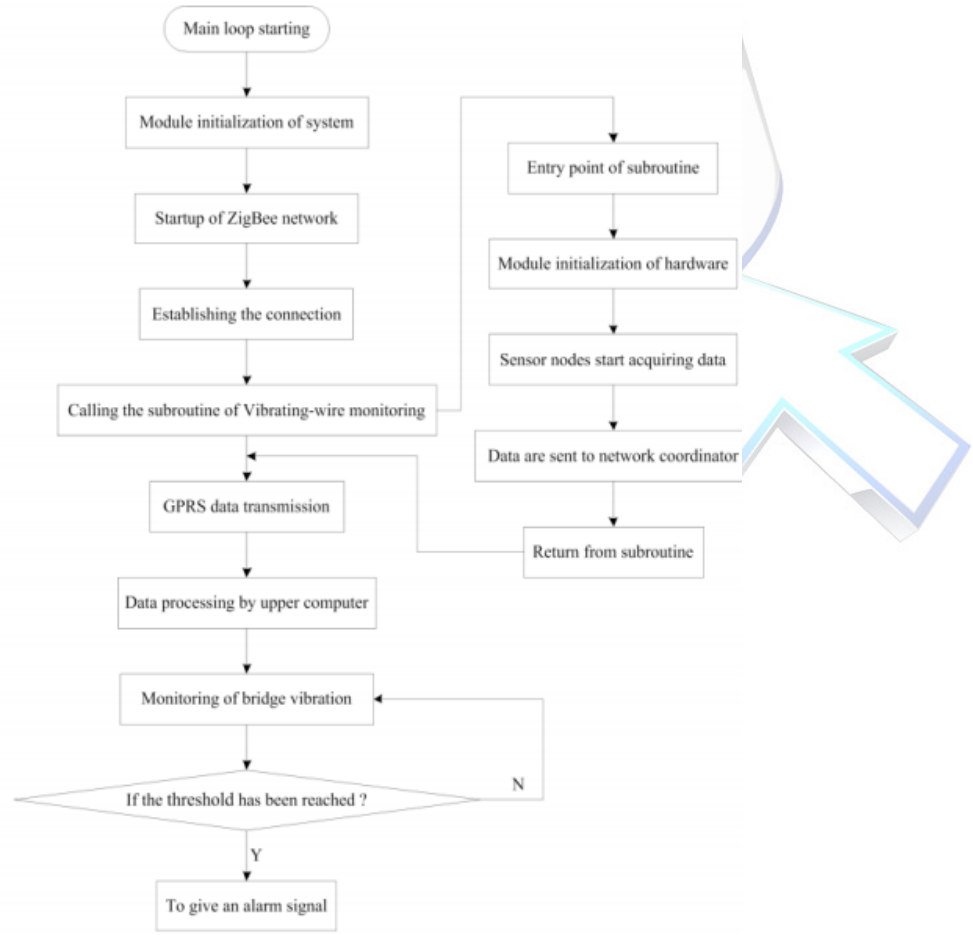

Figure1: - Process flow of software of monitoring system.

VII. SYSTEM HARDWARE DESIGN

The hardware for ZigBee network node is mainly achieved through RF transceiver CC2431 and SCM

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MSP430F1612. CC2431 is a kind of 2.4GHz RF system with the hardware location engine, which was launched by Chipcon, conforms to ZigBee technology and is suitable for various wireless network nodes related to ZigBee, including tuner, router and terminal device. CC2431 sets the working mode of chip via 4 SPI buses for data caching and reading/writing of state register. The pins FIFO, FIFOP, CCA and SFD are used for setting the transmitting/receiving buffer, controlling clear channel estimation, and inputting clock/timing information.

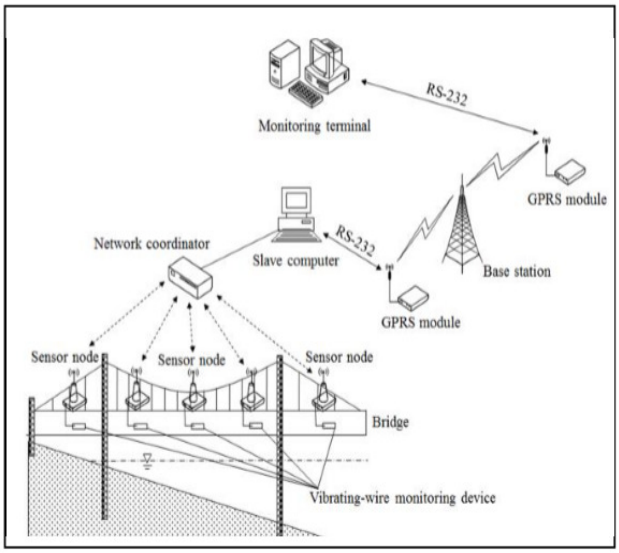

Figure 2: - Composition diagram of monitoring system.

VIII. RESULTS

Bridge Vibration Monitoring System Based on Vibrating-Wire Sensor and ZigBee Technologies is designed to ensure the quality of the bridge used by the customers for transportation from one place to another place and improve the bridge condition.

The sensor is able to detect vibration in the bridge and monitoring the bridge through vibrating wire sensors. The system provides the accurate vibration values it helps in monitoring the bridge using sensors. This design is simple, effective& feasible and cost effective.

VIII. CONCLUSION

The system is implemented using reliable vibrating wire sensor measuring method with the combination of wireless transmission network to design bridge monitoring system, with high measuring precision anti-electromagnetic interference, anti-corrosion, and others. This system is proves that it is design with high reliability and unattended operation and also can operate continuously, which will reduce the cost of monitoring and increase the efficiency and satisfies the low frequency test demands of various engineering structures and mechanical systems.

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