Monitoring and control System based on Airport Boarding Bridge using ZigBee Wireless Network

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***Abstract*— In order to overcome the disadvantages of boarding bridge collapsing and scraping the plane without early warning, a design of wireless fault early warning and monitoring system combining ZigBee wireless communication technology and variable sensors which are used to detect vibration, position, and faults, was proposed. The structure of network, the design of hardware and the software modules of the monitoring system are discussed in detail. Experiments show that the application of wireless ZigBee technique with low cost and low-power dissipation makes the monitoring system of airport boarding bridge more flexible and shortens the troubleshooting time. Besides, it could eliminate the cumbersome problem of overall fault diagnosis on site.**

***Keywords*— ZigBee, Wireless network, Airport boarding bridge, Monitoring system.**

I. INTRODUCTION

Some of the popular wireless Local Area Network (LAN)technologies are Bluetooth standard, 802.11 (Wi-Fi) standard, Infrared Data Association (IRDA) standard, Home Radio Frequency (HomeRF) standard and ZigBee standard. ZigBee technology of low cost, low power consumption and low rate is a kind of wireless and short-distance intercommunication network based on 802.15.4 protocol, suitable for fixed and portable or mobile device. It is mainly applied in automatic control and remote control. What's more, it supports geographica

Positioning capabilities, and can be embedded in a variety of equipment. ZigBee can work for free in the bands of international unlicensed 2.4 GHz, 915 MHz in USA and 868 MHz in Europe. What's more, the wave band of 2.4 GHz has the highest data rates of 250 kbps. Compared with other wireless networks, ZigBee technology is of the lowest power consumption and lowest cost, so it has a promising future in Wireless Sensor Network (WSN) [1] for it is economic, reliable, and efficient. So far, there are many applications based on ZigBee wireless network in different fields, for instance, the design of precision agriculture environment monitoring system[2], the remote street lamp monitoring system [3], grain temperature monitoring system [4] and bridge monitoring system [5], etc.

The ZigBee wireless network not only realizes the fast and reliable remote collection and transmission, but also solves the difficult environment monitoring and control [6-9]. The most important thing is that it provides a new thought for remote control. The monitoring system of airport boarding bridge monitors the running state of boarding bridge according to its environment parameters and hydraulic system parameters.

It is of great significance for fault early warming and . Oiu trouble shooting. sensor network technology, it greatly reduces the workload of field wiring, makes monitoring function realize more quickly, and achieves the timely warming of boarding bridge collapsed, which may even endanger the safety. In the application of airport boarding bridge, the site monitoring, which is done by operators to record the environment parameters or observe the vibration situation, is currently the main monitoring method.

II. EXISTING SYSTEM

In April 2005, the boarding bridge of Guangzhou Baiyun International Airport collapsed, which was caused by the out of control of hydraulic valve. In March 2011, Air China flight CA1854 was scratched by the boarding bridge at Ningbo Lishe International Airport. In April 2013, the boarding bridge of Hong Kong international airport collapsed. Proper remote control and monitoring is not done for airport boarding bridge. wireless communication module and power technology which solves the disadvantages of existing monitoring methods. This paper introduces the network structure of the whole

system and detailed analysis from the perspective of hardware and software, which are showed in the form of the according to the communicating ability, two FFD devices or one FFD device and one RFD device can communicate directly, while two RFD devices couldn't. So the different sensor nodes can't communicate. Only the sensor nodes can collect and transmit data to the central coordinator. And then, the remote control center can complete the function of data analysis and management.

III. PROPOSED SYSTEM

Data acquisition and transmission subsystem, composed of wireless sensor networks nodes.WSN used to collect, transmit and store all kinds of sensor signals. Here

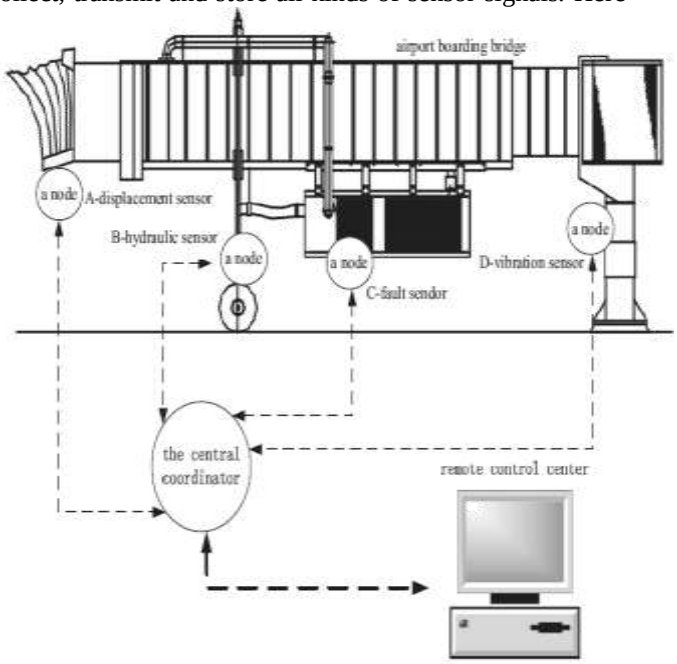

Fig.1 Architecture of Monitoring System

A. Vibration sensor

It is consisted of piezoelectric element, spring oscillator, Sensitivity adjustment knob, and led. We can regulate the knob to adjust the sensitivity. For example when adjusting the knob clockwise, the sensitivity increases, oppositely it reduces and outputs alarm signal, led will light while testing the certain scope shock The location algorithm has a good performance of precision, stability and robustness.

A, B, C, D nodes are the sensor nodes. Besides, they are the Reduced Function Devices (RFD), which send data to the central coordinator. The central coordinator is the Full Function Devices (FFD), which collects data from all sensor nodes. In response to these problems in the site monitoring, this paper designs a wireless monitoring system of airport boarding bridge based on the ZigBee technology, which solves the disadvantages of existing monitoring methods.

Advantages of using ZigBee techniques with low cost and low power consumption. Airport boarding bridge is more flexible and shortens the troubleshooting time. Sensors are used to detect vibration, position and fault finding.

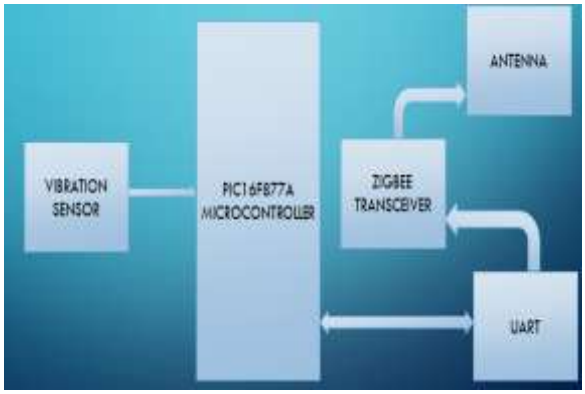

Fig.2 vibration sensor connection

B. Displacement sensor

Meets various needs with high performance at the resolution of 5 µm. Numerous applications are possible when the analog output model ON/OFF output model (NPN open collector) is available. 6 sensor-heads are available newly-developed algorithm and 2 types of optical systems. World's Fast Sampling Speed of 50 kHz Industry Best Accuracy of ±0.02G10/15Class Best Repeatability of 0.0004 Mil (0.01 µm) Multifunctional Controller.

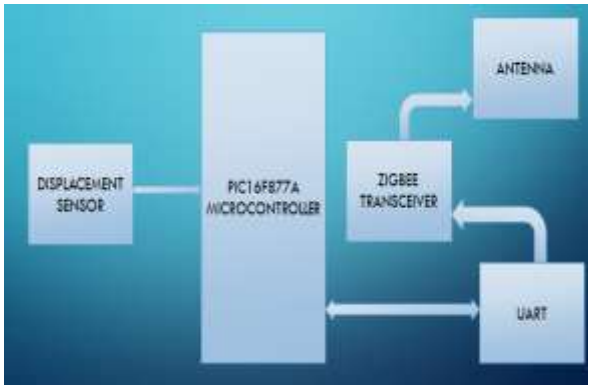

Fig.3 displacement sensor connection

C. Design of the Protocol Layer

ZigBee system is a hierarchical structure based on the Open System Interconnect. Layers from bottom to top are: the physical layer, Media Access Control (MAC) layer, network layer and application layer. Each layer of the adjacent layer provides service point. This service mechanism realizes transparent transmission for the external access request and the upper layer doesn't need to care about how to deal with. The protocol layer [16] includes the physical layer, MAC layer and network layer.

D. Design of the Application Layer

The design of software in application layer is mainly application software of the network coordinator. The coordinator is the core of the whole wireless network. The function of the application layer is to send out the data request signal coming from the host monitoring program of network coordinator.

At the same time, it should receive data from the data collection terminals and upload it to the hos The specific implementation process is as follows. Figure 5 shows the flow chart of program. At first, the coordinator system of the network enables interruption after system initialization and goes into sleep mode. After the coordinator establishes the wireless network, whose communication is normal, the control center opens monitoring function. When the host terminal sends out data request command, it triggers the serial port Secondly, the interrupt service program sets the system to the state of sending command. The system parses the command signal next, packages command signal and send it out. After the success of data sending, the system will be into the waiting mode for receiving data. At last, if the data come again, it will reach the host via a serial port directly. In this way, the data transmission of the systemic complete.In order to meet the demands of periodic testing for the system, all data collection terminals are actually in low-power status for a long time, so the batteries can meet the requirements. By analyzing the demand of the whole system the Overall Structure of Embedded Intelligent Workshop Remote Measurement and Control System.

Embedded intelligent workshop remote measurement and control system mainly consists of three parts the embedded measurement and control unit, local server, remote management mainframe computer. The basic architecture of the remote measurement and control system is shown in Figure 1.

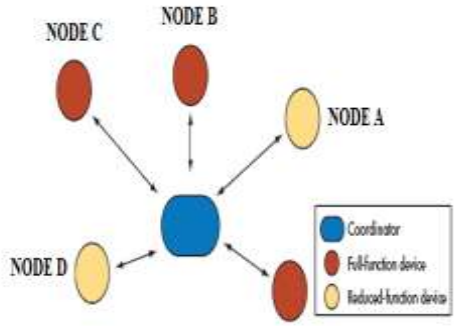

Fig.4 Sensor node connection

IV. TESTING RESULTS

After the system design was completed, it was used to operate an on-site monitoring of a boarding bridge at the airport. First of all, the center coordinator is connected to the PC of control center via RS-485 serial port. Then the power supply of center coordinator node and terminal sensor nodes are turned on. After power-on initialization, the center network coordinator begins to establish a ZigBee wireless network and all terminal sensor nodes join it. The network communication is displayed by the monitoring software of control center.

When the network communication is normal, terminal sensor nodes start to collect and parse signals. At last, the control center receives monitoring information from each terminal sensor nodes through the ZigBee wireless network. Figure 6 just shows the monitoring results of boarding gate.Monitoring data show that the environment temperature of airport boarding bridge is 25 degrees Celsius and the humidity is 84% RH. The boarding gate turns left 34 degrees and the out tunnel extends 33 centimeters. There is no column vibration of the boarding bridge, and this operation is normal.

V. CONCLUSIONS

With the advantages of low cost, low power consumption and low rate, ZigBee technology makes up for the gap of wireless communication market. It is a necessary part of wireless personal network, and the key to success lies in rich and convenient applications, rather than the technology itself. The formal version of ZigBee protocol is to be announced. More researches and developments of the industry are transferred to the application design, implementation, connectivity testing and market promotion, etc. Once the wireless ZigBee technology is applied to the airport boarding bridge monitoring system, it can not only realize the real-time online data collection such as vibration, temperature and humidity, location, and the fault information of hydraulic

system, but also contribute to the early warning of collapse crisis, which may endanger personal safety. Besides, it reduces the on-the-spot troubleshooting time. Most of all, Bridges monitoring system based on ZigBee technology is bound to shorten time for fault recovery.

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