APPLICATION OF THE WIRELESS SENSOR NETWORK BASED ON ZIGBEE TECHNOLOGY IN MONITORING SYSTEM FOR COAL MINE SAFETY

D. KUMARASWAMY1, SURESH REDDY PURINI2, THUDI VISHNU3
4.T.SRAVAN KUMAR, 5.K.DAMODAR
Elllenki college of engineering and Technology
jntu University, Kphb, HYD
E-mail: Kumaraswamy.btec@gmail.com

Abstract-This article describes the design of a wireless sensor network based on ZigBee technology. It is mainly used for collecting and transfering the various monitoring information about the coal mine underground. Then the data will be analysised and processed in the monitoring system outside, so that we can ensure the safety of the coal production and effectiveness better. Keywords-ZigBee; wireless sensor network; coal mine safety; monitor control system

I. INTRODUCTION

The current informationization level of China coal industry is still low. The underground equipments operate independently. It is inconvenience to communicate with each other, which limits the development of the automation network technology to mine in the region. It is more difficult to achieve the integrated management of data networks, which will restrict the coal mine safety production to some extent. For these reasons, the author designed a coal mine safety monitoring system making use of the wireless sensor network based on ZigBee technology. It can collect the parameters of the environment and the conditions underground, and then the collected parameters will be sent to the computer outside in time. The parameters will be displayed, controlled and processed to alarm when it achieves the limit of the safety, etc.

II. GENERAL DESIGN OF THE SYSTEM

The system is mainly used for monitoring the safety of the mine production system, including the monitoring of hazardous or dangerous ingredients in the mine air, the physical state of the mine air and the running status of the ventilation equipments. In emergency situations it can make some of the electrical power equipments stop running.

The system consists of two parts, the wireless sensor network underground and the security monitoring and management system [I]. The mainly function of the underground part is to collect the data of the temperature, the humidity and the gas volume inside the mine in virtue of various sensors. By means of routing through the nodes, the data will be transmitted to the base station, and then the security monitoring and management system will be in charge of receiving the data transmitted from the base station. In the monitoring and management subsystem, the data will be processed and analyzed, and then to be displayed in the form of curves, graphs, and report forms, etc. It provides a variety of functions such as query, statistics and so on. Figure I shows the overall structure of the system.

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-3, ISSUE-2, 2016
DOI: 10.21276/ijcesr.2016.3.2.5

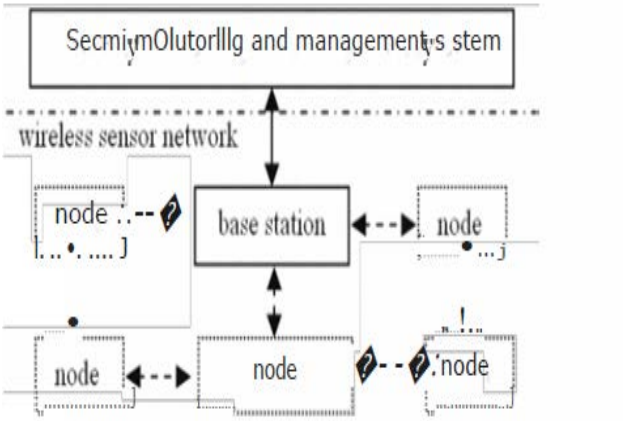

Figure l. Overall structure of the system

III. DESIGN OF THE WIRELESS SENSOR NETWORK

The wireless network of this system is established by using of ZigBee technology based on IEEE802.15.4 standard.

ZigBee is a wireless network technology with the advantages of short-range, low power, low cost, high capacity and high reliability. Its working frequency band varies form 2.405 to 2.480 GHZ, adopting the communication technology of direct-sequence spread spectrum, and the transmission speed is 250 KB/S [2]. The data transmission node module capacity of the wireless network is up to 65,000, and the node modules can communicate with each other. The distance between each network node can be extended from the standard 75m to infinity, which is suitable for the information collection of the coal mine very much. The network nodes constitute a form of self-organized Mesh Topology. Each node can collect data independently, and then transfer it to the clustering node through single-hop mode or multi-hop mode [3].

A. Architecture ofthe Wireless Sensor Network Node Wireless sensor network node is the basic unit of the network, which is in charge of the collection and transmission of the data. Its architecture is composed of four parts: the data collecting module (sensors and AID converter), the data processing module (microprocessor and memory), the wireless communication module (wireless transceiver) and the power module (battery and DC / DC power converter), shown in Figure 2.

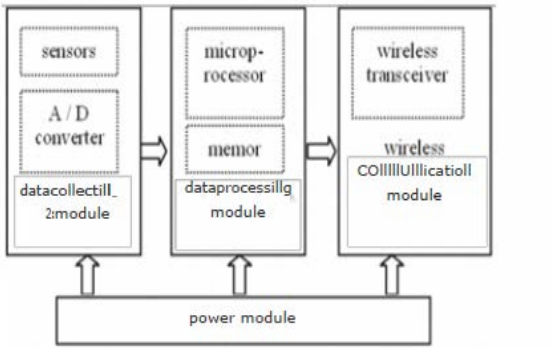

Figure 2. Architecture of the wireless sensor network node

B. Design o/the Wireless Sensor Network Node

In the data collecting module, the temperature and humidity sensor is a SHTII chip, and the gas sensor is the type of KGS-20. SHTII is a digital temperature and humidity sensor chip. It is introduced by Sensirion Company with the qualities of high integration and low power and high precision and strong jam-proof capability. With the sensor chip, the humidity and temperature are converted into electrical signals through two sensing elements respectively. The electrical signals will be amplified by a faint signal amplifier firstly, and then the amplified signals will be transmitted into a 14-bit AID converter with which it will be converted into digital signals and be outputted finally through the wire serial digital interface. KGS-20 is a type of combustible gas sensor which adopts the tin oxide as the basic sensitive material, and it is dedicated to the measurement of the gas concentration as a semiconductor gas sensor. Its essential features include the characters of the extreme high sensitivity, the extreme fast response speed and the low power consumption, so it is very suitable for detecting the volume fraction of the gas within the mine.

In the data processing module, the microprocessor is the core component of the sensor node, which is in charge of processing the data and coordinating the whole system. In order to make the system possess the characteristics of high performance, low power dissipation and multi-model interfaces, the system chose ATMEL Companys 8-bit ATmega128L as the microprocessor unit. The advanced RISC structure of ATmega128L makes it possess high calculative performance [4]. It holds the common interfaces such as UART, SPI, and HC, etc. It also holds a multi-channel ADC. At the same time, the available

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-3, ISSUE-2, 2016
DOI: 10.21276/ijcesr.2016.3.2.5

open source developing tools have reached full development, and TinyOS, the operating system for the sensor node, supports it better.

Although the ATmega128L microprocessor comes with the EEPROM data storage space of 4KB, but it is necessary to possess a relative greater and more permanent data storage space for sensor nodes. It will meet the need of a greater storage space, which is useful for updating the code of the remote node automatically and preserving the configuration information of the node. So an additional non-volatile flash memory of 512K, AT45D8041, was used as the external data memory when the sensor node is designed.

In the wireless communication module, taking into account of the aspects of the wireless transmitter such as the transmission rate of the data, the power of receiving andtransmitting, the consumption of the sleeping power, the stable time of booting, and the signal modulation method, the smart RF chip CC2420 of Chipcon Company was finally adopted. CC2420 adopts the technology of SmartRF. It is made in 0.18urn CMOS process, and only very few external components are needed. Its performance is stable and the consumption power is very low. For TinyOS has included the driver of CC2420, it will be more convenient to connect with the microprocessor.

In this system, in order to achieve the communication between the base station and the host, a serial communication module was designed. The data from each node were collected by the base station, and then were transferred to the host through a RS232 serial interface. Finally the data will be processed by the host.

IV. DESIGN OF THE SECURITY MONITORING AND MANAGEMENT SYSTEM

The security monitoring and management software was written with Borlands Delphi7.0, and the database is Microsoft Access 2003. It can display the parameters in a variety of forms, such as table, curve, alarm display and alarm statistics, as well as generate and print the reports of the parameters. The functions of the whole system include the following aspects.

• Collection of various sensor parameters. It includes the environmental parameters (such as the concentration of methane and carbon monoxide, the temperature and the negative pressure, etc.) and mining parameters.

• Display of various sensor parameters. The parameters collected in the collector will be displayed in the LCD screen and the computer.

• Overrun alarm. When it is found that the parameters detected by the sensor have exceeded the limit, the collector will control the alarm buzzer to ring in time, and the computer also gives the alarm ring and the alarm pictures.

• Power control of the equipment. When it is necessary to achieve the power-off control of the equipment, the collector will operate the breaker of the equipment.

• Transmission of the remote data. All the parameters collected by each mine collector should be transferred timely to the central monitoring station on the ground.

• Recording and replaying of the various sensors parameters. The computer stores the parameters transferred from the base station in the hard disk, and staff can choose any of the parameters for recording and replaying.

V. CONCLUSIONS

The system combined the Zig8ee wireless sensor network technology with the traditional coal mine security monitoring system. It made up the limitation of the previous system relying on the wire transmission, and it was useful for covering the largest possible areas of potential accidents effectively. It provided the technical support for the synchronization of the mobile equipment and the networks.

By using this technology, the connection of the wired networks and wireless networks were easily realized, and it provided an important reference for the realization of the hybrid networks.

REFERENCES

[1] Yuemin Zhong and Wancheng Xie, Wireless Sensor Networks for Environmental Monitoring of Mine Journal, Coal Technology, 2009, 28(9), pp. \02-\03.

[2] Chengyu Wu and Yunqiang Sun, Short-range Wireless Data Transmission System Based on Technology Journal,
Instrument Technique and Sensor, Shenyang, 2008(5), pp. 38-39.

[3] Jilin Li, Status and Development Trend of Coal Mine Safety Monitoring System Journal, Coal Technology, Harbin, 2008(11), pp. 4-5.

[4] Baohua Zhang, Shining Li, Wenxing Teng, and Yaowei Zhang, Design of the Greenhouse

Measurement and Control System Based on Wireless Sensor Network Journal, Microelectronics & Computer, Xi;an, 2008, 25(5), pp. I 54-157.

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-3, ISSUE-2, 2016
DOI: 10.21276/ijcesr.2016.3.2.5