Design of Air Quality Monitoring System Based on Wireless Sensor

Yamei Zhang

Xi'an Peihua Universty, Xi'an 710125, China

312413420@qq.com

Keywords: Air quality, Monitoring, Sensor network, Zigbee

Abstract: In recent years, China's economy has developed at a high speed, and the resulting air pollution has become more and more serious. The human health problems caused by this are worrying. To this end, the air quality monitoring system of wireless sensors is designed to realize the functions of networking, air pollution data collection and transmission, and user terminal display. The monitoring part adopts the wireless sensor network, and the monitoring center adopts the C# programming language design in the VB environment. The monitoring software is based on the Web network technology, and the corresponding density value collected by the relevant sensor nodes can be queried by opening the corresponding webpage through the browser; The data collected by the node is stored and exported, and the node data is exported and printed according to requirements. It has the advantages of real-time, low power consumption and low cost, and has certain practical value in air pollution monitoring.

1. Introduction

With the acceleration of urbanization, the living standards and consumption levels of urban populations continue to increase, industrial gas, domestic gas and a large number of automobile exhausts are discharged into the air, and urban air pollution becomes more and more serious. At present, many cities in northern China have experienced severe smog, which has seriously affected people's daily life and physical health. Many air quality monitoring systems have emerged based on air pollution, but few systems are commonly used. Therefore, it is important to establish a comprehensive and unified air quality monitoring system.

2. Research Status of Air Quality Monitoring

At present, China's monitoring of the atmospheric environment mainly uses two methods: one is the traditional manual sampling laboratory analysis method; the other is the online monitoring method using imported atmospheric environment monitoring. Although the equipment used in the first method is simple, it does not provide real-time values of the gas being monitored, and the monitoring results are greatly influenced by humans. The second method has the characteristics of accurate, sensitive and high resolution for atmospheric environment monitoring, but the equipment used is complicated in structure, expensive, and high in maintenance and operation costs, so the penetration rate is not high.

Wireless Sensor Networks (WSN) is a distributed sensing network. The sensors in the WSN communicate wirelessly, so the network settings are flexible, the device location can be changed at any time, and the Internet can be connected in a wired or wireless manner. In the WSN, a large number of tiny intelligent nodes with sensors, data processing units and communication modules are densely dispersed in the monitoring area, and the nodes work in a self-organizing manner to cooperate with the specific tasks undertaken by the network, providing a basis for multi-sensor fusion monitoring. Therefore, WSN is very suitable for the monitoring of air pollution.

3. Overall System Design

Because wireless sensor networks have the advantages of large-scale, self-organizing, dynamic

and reliability, based on the wireless sensor network, the measurement is monitored by means of sensor devices such as NO2, SO2, and nitric oxide in the sensor nodes. The parameters NO2, SO2 concentration, total suspended particulate matter, and nitric oxide in the region are sent to the coordinator node through the wireless sensor network. After the coordinator node collects and processes the data, the processed data is fixed according to the fixed data. The format is sent to the host computer by wireless transmission. That is to use the wireless sensor network to achieve networking, air pollution data collection and transmission, computer display and so on.

According to the system function, the hardware design of the system can be divided into two parts: the underlying hardware design and the top hardware design: the hardware design of the sensor node in WSN, the SOPC hardware design. The hardware design of the sensor node is used as the underlying hardware to complete the tasks of collecting, processing and transmitting the air pollutant concentration value; the hardware design of the SOPC is used as the top-level hardware to complete the hardware configuration, design and simulation of the embedded system. Subsequent software development provides hardware support.

4. Wireless Sensor Network Design

4.1 Wireless Sensor Network Networking Design

Because the geographical shape of atmospheric environment monitoring is more complicated, a grid-type wireless sensor monitoring network is adopted, and its network structure is shown in Fig. 1.

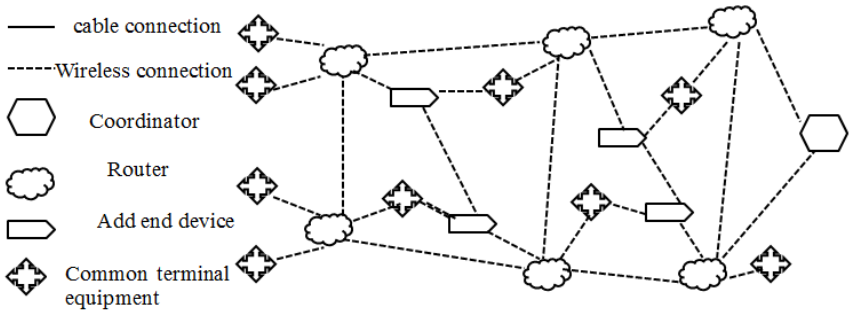

Fig. 1 Wireless sensor network architecture

The grid type wireless sensor network is connected to a network-like structure, and has the advantages of wide coverage, large amount of data collected, high transmission rate, and low cost. The data transmission path collected by the network is non-unique, which can better reduce the impact of node position change or individual link and sensor node failure on the successful transmission of data, and will not cause the network to be separated. This improves the reliability of network information transmission to a certain extent; SOPC technology and wireless sensor network technology have greatly improved the data processing capability of the air quality monitoring system, and have high practical value.

The wireless sensor-based air quality monitoring system is a wireless sensor network node is the basic unit of the entire network, which is responsible for data collection, reception and transmission. The information monitoring management system includes a database, an information platform and an information publishing platform.

The grid topology can not only cover a large area of the network, but also ensure the transmission of environmentally important parameters such as O2, NO2 concentration, total suspended particulate matter, and nitric Oxide. The coordinator is responsible for network establishment and maintenance, control command transmission and monitoring parameter reception, and acts as a gateway role to connect with the wired transmission link; the enhanced end device and the common end device are connected with various sensors, which are responsible for various The collection and transmission of parameters; the router associates other nodes to the network, and is responsible for routing and message forwarding of the data collected by the peer device and transmitting the data of the end device to the coordinator.

4.2 Wireless Sensor Network Protocol

The Zigbee standard is adopted as the wireless communication standard for sensor networks. There are 16 channels in the 2.4GHz working frequency band and the data rate is 250Kbps, which can meet the transmission requirements of monitoring data. In each wireless network composed of Zigbee, the connection address code is divided into 16-bit short address or 64-bit long address, and the maximum number of devices that can be accommodated is 216 and 264, respectively, which has a large network capacity. Zigbee is a low-power, low-cost two-way wireless communication technology with positioning capabilities and energy detection and link quality indication capabilities.

The sensor network establishes the general process: first start the coordinator to establish the network, and then start the router and the end device to join the network. Each node is identified by a combination of a fixed number and a spatial network address. After the router and the end device join the network, the node sends the node fixed number and the network address and the device logical address to the coordinator, so that the coordinator sends the parent-child relationship according to the node. Determine the entire network tree structure. After the data transmission, the appropriate route is selected according to the node location and the tree shape.

5. Software Design of Air Pollution Monitoring System

The software design of the system is divided into data acquisition module, data transmission module and monitoring module according to functions.

5.1 Software Design of Data Acquisition Module

The system monitors four pollution gases, NO, NO_2 O_3, and SO_2 in the environment. The basic data acquisition process is exactly the same. The flow chart of the data acquisition program is shown in Fig. 2.

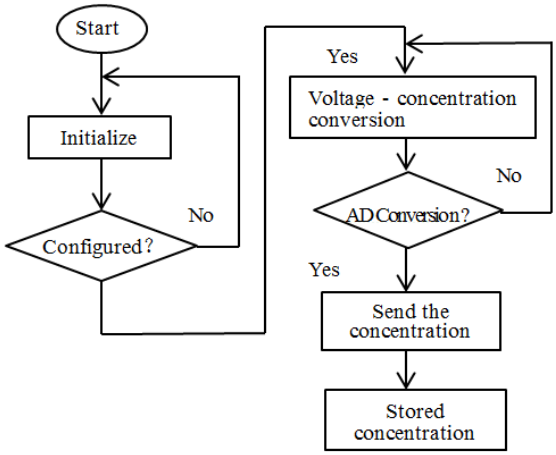

Fig. 2 Data acquisition program flow chart

System initialization begins, numbering the sensors, and it is convenient to manage the collected data. Use the sensor's signal amplification knob to configure the sensor for optimal performance. According to the data sheet of the sensor probe, according to the derived voltage-concentration segmentation formula, the voltage signal output by the sensor is converted into a corresponding gas concentration value. Since the data is an analog signal, the conversion of the analog signal to the digital signal by the ad chip, the resolution of the ad chip used in the system is 8 bits. Finally, the digital signal is stored in the sdram according to the number at the beginning.

5.2 Data Transmission Module

The data transmission module is composed of a Zigbee network and a GPRS network, and is mainly responsible for completing data exchange between the monitoring terminal and the monitoring center.

The Zigbee network part consists of three nodes: network terminal, router and coordinator. The

Zigbee network control core uses the ATmega328P microcontroller to collect and process the sensor data of the terminal node. Various types of gas sensors use the RS485 interface to communicate with the microprocessor through the hub device, and a communication network with simple link and high transmission efficiency is constructed. In the Zigbee network terminal node, the sensor forms a communication network with the microprocessor through a serial communication interface, and the communication network has the characteristics of simple link and high transmission efficiency. The wireless RF module integrates single-chip control and wireless coding, and is connected to the ATmega328 microcontroller through an asynchronous serial port to complete data reception and transmission. The serial clock chip is embedded in the microcontroller and has a real-time clock, calendar and RAM to perform different functions according to the control commands.

The GPRS network part mainly consists of sim900a microcontroller, eeprom chip and power module. The GPRS module uses a dual-band sim900a module, which is a compact, high-reliability wireless module that uses a dual-band GSM/GPRS module solution in SMT package and a powerful processor core to meet low cost. The development requirements of compact size can be more complicated by built-in applications. The eeprom chip is plug and play and is used to store hardware setup data.

5.3 Monitoring Module Implementation

The system is designed in C# language in VS environment. The monitoring software is based on Web network technology. The corresponding webpage can be queried by browser to open the corresponding webpage. The data collected by all nodes is stored according to database technology. Export and print node data as needed. For web applications, ASP.NET is used as a development tool that is compatible with any language supported by the .NET common language runtime, including C#. For the database technology used by the system, the development of ADO.NET, a follow-up technology of Active Data Objects (ADO), enables quick and easy access to data in the database.

6. Conclusions

In this paper, the research and design of air quality monitoring system based on wireless sensor network is carried out for the problems of high network cabling cost and poor real-time data acquisition in traditional air quality monitoring. The system obtains information such as atmospheric pollutants of sensor nodes distributed in different regions through wireless transmission. After analysis, the air pollution status is obtained, which provides an important basis for the air quality monitoring department, and has the characteristics of long working hours and low cost. After field testing, the system indicators are running normally, basically meeting the needs of control quality monitoring within the predetermined range.

Acknowledgements

The project originates from Xi 'an PeiHua University “Research on Air Quality Grid Monitoring Platform Based on Internet of Things”. (No.PHKT18053)

References

[1] Wei yabo, wang xueqing. Design of portable air quality monitoring system based on GSM [J]. Journal of Heze University. 2018, 40(05):27-29.

[2] M. P. Brown and K. Austin, Appl. Phys. Letters 85, 2503–2504 (2004).

[3] Song yongsheng. Design and implementation of air quality monitoring system for chemical industrial parks based on Internet of things [J]. Computer knowledge and technology, 2008, 14(30):255-257.

[4] Lin meiyan. Research and design of indoor air quality remote monitoring system [J]. Journal of mianyang normal university, 2008, 37(08):56-63.

[5] Zhang di, Chen xiangdong. Design of indoor air quality wireless monitoring system [J]. Electronic design engineering, 2008, 26(09):95-100.

[6] PENG C, QIAN K, WANG C. Design and application of a VOC-monitoring system based on a Zigbee wireless sensor network[J].Institute of Electrical and Electronics Engineers Sensors Journal, 2015(4): 2255-2268.