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Design of Environmental Monitoring System for Sports Stadiums and Gymnasiums of Jiangxi Teachers College in China

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Abstract. With the application of basketball hall, swimming pool, comprehensive gymnasium and field hall in the new campus of Jiangxi teachers college, the monitoring and construction of the safe environment of sports teaching venues have aroused the common concern of schools, sports bureaus and other relevant departments. Taking the gymnasium of Jiangxi teachers college as an example, this paper proposes a gymnasium environment monitoring system based on ZigBee protocol. The system achieves data transmission and processing, information sending and reminding services through temperature, humidity, smoke, CO_2 sensors and hardware devices such as ZigBee gateway. The application of this system in school gymnasiums and other fitness venues can not only ensure the physical and mental health of students to a greater extent, but also make the management of the gymnasium more efficient, safe and convenient, and solve the shortcomings of traditional management methods, so as to provide scientific decision-making basis for the management of university gymnasiums in China.

1. Introduction

With the rapid development of China's society and economy, the scale of school sports venues is expanding. In order to promote the construction of healthy China and improve the people's health level, the strategic deployment of the fifth plenary session of the eighteenth central committee of the communist party of China formulated the outline of the"Healthy China 2030 Plan". This strategic deployment puts forward new requirements for the environmental safety of school sports venues. In 2016, the new campus of Jiangxi teachers college was relocated. The school sports venues cover more than 30,000 square meters. There are four venues: basketball venue, swimming venue, track venues and comprehensive venue. Yingtan municipal government of Jiangxi province also attaches great importance to the construction and management of sports venues in Jiangxi teachers college, and actively advocates the environmental safety of sports venues in colleges and universities. With the vigorous development of school sports, the environmental safety and monitoring of university sports venues have become an important research topic.

2. The theoretical basis and environmental monitoring system

2.1 The theoretical basis of environmental safety for college stadiums and gymnasiums

The environmental safety of college sports venues refers to the influence of the content of microorganisms (pathogenic species) on the surface of sports games, sports venues used for physical fitness, indoor air environment (harmful air), equipment and maintenance equipment on the health and safety of users. We know that there are many factors affecting sports environment, including atmospheric environment, harmful air, microbial species and content, etc. Because of the limited conditions, this paper focuses on indoor environment inspection and detection. Indoor air quality detection methods are mainly divided into three kinds: gas oxygen consumption method, chemical analysis method and sensor detection method. In this paper, the sensor method is used to collect the temperature, humidity, carbon dioxide concentration and other information of the venue.

2.2 Design of environmental monitoring system
This paper designs and develops an air quality monitoring system which can monitor oxygen, carbon dioxide, temperature and humidity in real time. It also uses a testing instrument that meets the standards of the state administration of quality supervision and inspection in China to test and record data at the same location, and makes a comparative analysis with sensor data. It also develops data processing software to process the data from sensors, so as to make it more accurate and effective. This monitoring system reminds the alarm data on the screen and sends it to the manager's preset mobile phone. It can remind the venue manager to pay attention to the change of indoor air quality at any time, so as to take ventilation, open air conditioning and other operations to ensure air quality.

3. Overall framework of environmental monitoring system for college stadiums and gymnasiums

3.1 Overall design
The design of environmental monitoring system for university stadiums and gymnasiums requires collecting temperature, humidity and carbon dioxide data at all locations every 10 minutes. In order to facilitate data analysis in the future, the data should be kept for at least two years. It is also acceptable to accidentally lose some sampling data. The system will replace the original manual sampling monitoring method, because the stadiums are relatively large, high height, the traditional cable network scheme is not applicable. The data collected by the system is transmitted and stored to PC machine through wired or wireless network. Considering the errors of various sensors, we need to deal with the data twice to ensure the correctness of the data. In addition, considering the convenience of installation and the long-term use of the collection point, the terminal recommends using battery power supply. The working time of the battery is at least one year. According to the air data of the venue, the alarm function is designed.

3.2 System structure
The overall structure of the system is shown in the following figure. The system consists of acquisition module, receiving and processing module and analysis module. The acquisition module mainly completes the detection of oxygen and carbon dioxide concentration, temperature and humidity, and transmits the detection data to the receiving module through wireless transmission. The system collects real-time temperature, humidity, carbon dioxide concentration and other information distributed throughout the gymnasium through sensors, and sends the collected information to PC network through ZigBee gateway with the help of ZigBee network. Receiving and processing module is the main module of the system, which is mainly used to receive the data sent by the acquisition module, and carry out temporary storage, alarm and other operations, and then send the data to the analysis module. When the alarm information is sent out, the ventilation or air conditioning equipment is manually opened. The analysis module mainly completes the task of data storage and analysis, and controls the display screen to display the current air quality data.
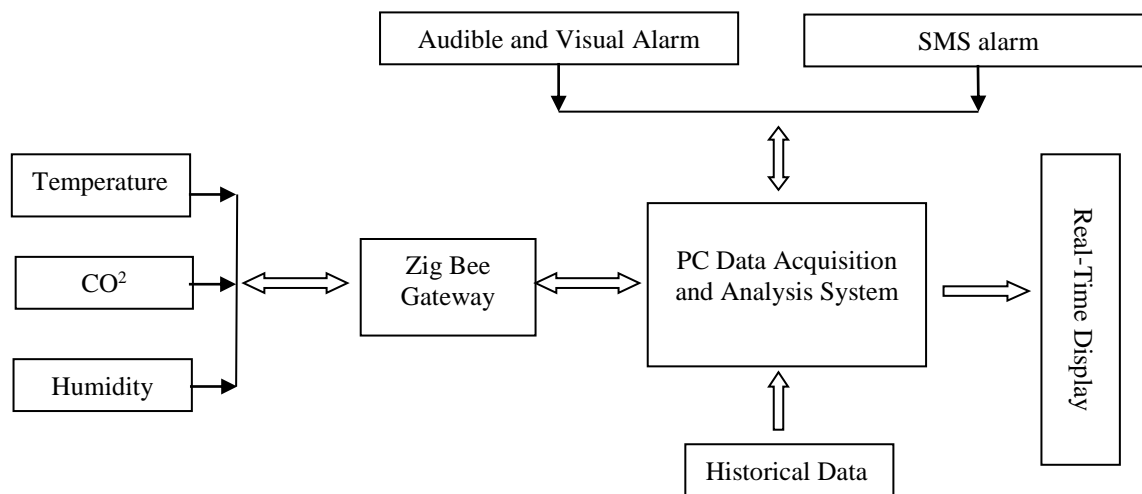
Figure 1   The structural chart of environmental monitoring system for sports stadiums and gymnasiums in colleges and universities

3.3 Network design

This system belongs to a typical Internet of Things networking application. The Internet of Things (IOT) in the network transport layer mainly consists of three parts: convergence network, access network and carrier network. Convergence network mainly uses short-distance communication technology, such as ZigBee, Bluetooth, infrared and private protocols to achieve a small range of sensing data aggregation. Access network mainly uses M2M and full IP fusion architecture to realize the access of perceived data from aggregation network to bearer network. Bearer network mainly refers to various core bearer networks, such as GSM, 3G/4G, WLAN, IP network and so on. Low-power wireless protocols such as 802.15.4, ZigBee can achieve a better balance between complexity and ease of use, and provide complete protocol architecture for the implementation of technical solutions. Balancing protocol features with simplicity and ease of use is an important choice criterion for us to consider. Based on the openness and extensiveness of the protocol, we choose to use the system architecture supporting ZigBee protocol. Zigbee network also has the advantages of fast networking speed, large network capacity and low power consumption. In this scheme, CC2530 single chip computer supporting ZigBee protocol is adopted, and the acquisition and monitoring module is placed in the venue to support ZigBee protocol networking. The acquisition module and the gateway supporting ZigBee form a network through ZigBee protocol, which consists of coordinator, router and terminal equipment. The coordinator in ZigBee network can establish and maintain the network and store network information. It is the authentication center of the network. Routers in ZigBee network mainly play an important role in the network expansion function, which can connect terminal devices and central nodes. We choose the gateway NLE-PE9000 of ZigBee protocol to support ZigBee protocol and Ethernet protocol, WiFi interface or Ethernet interface, and connect to PC network through network or wireless network. We convert ZigBee wireless protocol into TCP/IP protocol; this gateway is powerful and easy to develop and use.

3.4 Hardware and software requirements

Air temperature and humidity sensor adopts high precision two-wire serial port digital temperature and humidity sensor. The output resolution of temperature value is 12 bits, and the output resolution of humidity value is 14 bits. The voltage range of sensor power supply is 2.4-5.5V. The current consumption during measurement is about 550 muA, with an average of 28 muA and 3 muA at dormancy. Nodes can be set to timing acquisition, and after acquisition, they enter dormant state, which can further reduce power consumption. The power of photosensitive probe of carbon dioxide sensor is relatively low, less than 50mW, and the supply voltage is less than 5V. It can read

temperature and humidity data through two-wire serial port, and read illumination data indirectly through AD. Or it can transmit data through ZigBee network. Sensor terminal nodes can be burned through COM port. The gateway model is NLE-PE9000 of New World. The gateway equipment supports WiFi, RS485, Ethernet, ZigBee, USB, RFID, Bluetooth and other communication functions. It also supports capacitive touch screen. The power supply voltage is 12V. At the bottom of the gateway equipment there are Debug debugging interface, 485 interface, power button and CAN port. The debugging interface can use special debugging line to connect the gateway to the computer for debugging; the 485 interface uses special gateway connection line to connect the ADAM4150/4017 data acquisition module to obtain the wired sensor values; CAN (Controller Area Network Bus) complies with the CAN bus protocol, which is a serial communication protocol bus for real-time applications. In the Ethernet setup, the gateway can be set up to connect to the cloud platform's communication IP and port, responsible for communicating with the host computer. The gateway program is burned through USB port or Ethernet port. The short message module we adopted is RDT-S400 module, which supports standard RS232 interface. It adopts high-performance industrial GSM transceiver module with 2W transmitting power, adjustable serial port speed of 1200-115200 bps, using standard DC 12V power supply, and connecting with management server. It has a wide range of working temperature adaptability. The AT (AttenTIon) instruction set we use is the industrial standard for the communication interface of modem communication. Most mobile phones on the market now support the AT instruction set stipulated in GSM7.05. The short message module of GSM communication is controlled by AT command, and the data transmission adopts short message mode. Generally, the GSM module supports AT commands, so the computer or single chip computer can send AT commands directly to the GSM module through the serial port to facilitate the sending, receiving and management of short message SMS.

4. Operation process of environmental monitoring system for college stadiums and gymnasiums

Firstly, according to the requirements of the system design, the sensor nodes are collected, and then the program is fired, which needs to upload data every 10 minutes. After power-on, active scanning is carried out. After discovering the network and applying for joining, a short address will be allocated after successfully entering the network. Then a binding request will be made to the parent node. After success, data will be collected and sent regularly. After sending, the data will enter the sleep state, and then the data will be collected and sent at a fixed time. For the collected data, we need to correct the data. Because different sensors and testing instruments are based on different physical methods, the data obtained by testing are different. For example, when testing temperature, we use sensors, Fluke 724 temperature calibrator and other equipment to sample and test at the same point and then process these data. We use the error compensation at different temperatures to process the data in the later stage, and get more accurate temperature data. Other data processing methods are similar.

5. Conclusions

This paper aims to analyze the environmental monitoring system for college stadiums and gymnasiums the conclusions are as follows: In this paper, wireless sensor, communication gateway, wireless network and other internet of technologies are used, combined with the actual situation that the comprehensive wiring of university stadiums and gymnasiums is difficult, and the advantages of ZigBee network, such as low bit-stream transmission efficiency and low energy consumption, are used to realize the collection and processing of temperature, humidity and carbon dioxide data. Make full use of ZigBee to realize data transmission and interaction, which provides a scientific basis for environmental monitoring of university stadiums. Combined with the optimization of data processing, the system has the advantages of high accuracy, good stability and real-time, which provides scientific basis for the monitoring and processing of the venue environment.

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