Ekoloji 28(108): 759-764 (2019)

LETTER TO THE EDITOR

An Early Warning System of Mountain Skiing Ecological Environment Based on Zigbee

Yi Yuan*
School of Physical Education, Hunan University of Science and Technology, Xiangtan 411201, China
*Email: ly1342218648@163.com

In view of the disadvantages of traditional mountain skiing ecological environment monitoring system, such as difficult wiring and poor flexibility, a monitoring and early warning system for mountain skiing ecological environment based on ZigBee wireless sensor network is designed. The system integrates ZigBee network communication technology, embedded Web server technology and GSM communication technology, and uses terminal nodes to collect and monitor indoor temperature and humidity, carbon monoxide volume fraction, formaldehyde concentration and other environmental information in real time. Users can complete local and remote monitoring of mountain skiing ecological environment by opening Web pages. When a fire or gas leak occurs, users will receive alarm messages in time. Experiments show that the system has the advantages of stable operation, simple use and good flexibility, and has high practical value and wide application prospects.

ZigBee; Environmental Monitoring; Embedded Web Server; ENC28J60; GSM

1 Introduction

With the development of the times, safe and healthy living environment has become the goal pursued by more and more people. However, with the development of economy and the improvement of people's living standards, the ecological environment problems seriously threaten human health. Healthy ecological environment is closely related to everyone's life, so a set of flexible, practical and stable ecological environment monitoring and early warning system will be more and more applied. At present, most eco-environmental monitoring systems use wired mode, which requires a lot of wiring, and the cost of system maintenance is high. When one node fails, it will affect the work of other nodes. The flexibility and stability of the system are poor. ZigBee is a wireless network protocol based on the IEEE802.15.4 standard. It is a short-range, low-power wireless communication technology characterized by close range, low complexity, self-organization, low power consumption, low data rate, Low cost, suitable for the construction of mountain ski ecological environment monitoring network.

LiyangZheng, Xinling Zhang published an article in the Ekoloji (Issue 107, 2019), entitled "Network Monitoring and Early Warning System of Economic Benefit Decline in Ecological, Agricultural and Pastoral Areas" (Zheng and Zhang 2019). In this paper, a new network monitoring and early warning system for economic benefit decline in agricultural and pastoral areas is designed to solve the problem of unreliable prediction results caused by neglecting the prediction of economic benefit turning point (Janowski and Rapinski 2017). The system is composed of four modules: data management, external interface, economic benefit prediction, monitoring and

early warning by B/S mode. Data acquisition is accomplished by hardware. The economic benefit data of farming and pastoral areas are inquired through multi-index trees. According to the characteristics of the chaotic correlation dimension, the data are classified to realize the data processing of the economic benefits of agricultural and pastoral areas. The external interface hardware structure is designed to achieve communication. The economic benefits of farming and pastoral areas are predicted by grey model. The overall structure of the monitoring station is given (Xu and Chen 2012). The diffusion index is calculated. By using a set of traffic control red, yellow, green, light blue and blue lights to identify economic fluctuations, the indicators reflect the early warning of economic performance decline. The results and conclusions of the design system are accurate, and the overall performance of the system is strong. The viewpoints put forward in this article are novel. Therefore, this paper draws on the viewpoints and conducts research.

According to Yu (2017), an automatic early warning system for ginseng growth monitoring and environment-sensitive diseases based on ZigBee network was designed to solve the problems of difficult monitoring of growth environment factors, slow disease detection and low automation level in ginseng planting management. ZigBee wireless monitoring node is used to collect environmental factors of ginseng growth, and data transmission gateway collects relevant information and sends it to remote server. The system automatically pushes real-time monitoring data to client after extracting feature data processing and analysis. At the same time, it sends out disease warning analysis to prompt managers to make countermeasures. However, the system cannot better monitor the environment, while the system wiring is difficult and flexibility is poor. Therefore, this paper proposes an early warning system of mountain skiing ecological environment based on Zigbee. Employing ZigBee network technology, embedded Web server technology and GSM communication technology, a monitoring and early warning system for mountain skiing ecological environment is designed. Users can use Internet devices such as mobile phones and computers to complete the local and remote monitoring of mountain skiing ecological environment, to ensure the safety of mountain skiing ecological environment, and send alarm messages to users in time when the environment is abnormal. This system overcomes the limitations and regionality of traditional methods, and has the advantages of simple use, strong flexibility and good real-time.

2 Idea description

2.1 System's overall structure

Monitoring and early warning system of mountain skiing ecological environment consists of three parts: information monitoring center, routing node and terminal node. The overall structure of the system is shown in Figure 1. The information transmission network is constructed between the information monitoring center and the terminal node through the hierarchical design. The terminal node transmits the real-time collected ecological environment information of mountain skiing to the ZigBee coordinator node of the information monitoring center through the hierarchical network. The routing node is responsible for data forwarding and intra-network path maintenance; the terminal node is a data acquisition node with sensors, which is responsible for real-time collection of mountain ski ecological environment parameters (temperature and humidity, CO volume fraction, formaldehyde concentration, etc.). The collected data is sent to the ZigBee coordinator node of the information monitoring center; the information monitoring center stores the important mountain skiing ecological environment information on the SD card, and updates the latest mountain skiing ecological environment information to the web server. The user can remotely open the web server webpage through the Internet to view the mountain skiing ecological environment information (the user owns the public network IP), and directly connect the system router network locally to complete the comprehensive monitoring of the mountain skiing ecological environment (Wei and Wei 2017, Zhang and Li 2014). When there is an environmental anomaly, the information monitoring center

will send an alarm message to the user in time to make an early warning through the GSM module.

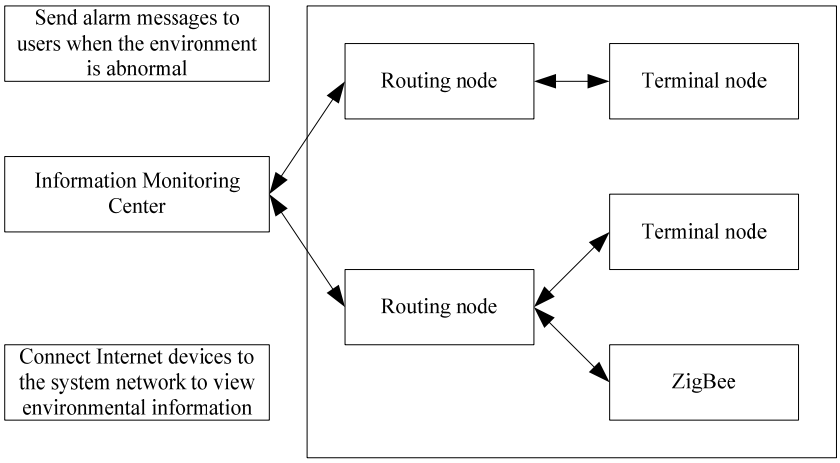

Figure 1 Overall structure of the system

2.2 System hardware design

The network node of ZigBee wireless sensor selects Texas Instruments' CC2530F256 chip as the processing core in hardware. The CC2530 is a 2.4GHz system-on-chip that conforms to the ZigBee standard. It is suitable for various ZigBee and ZigBeePROCC2530F256 integrated 8051 cores, 256KB system programmable FLASH, 8KBRAM, with a wealth of peripheral devices, node transmit power up to 4.5dB. The AN9520 patch antenna is used in the antenna part, which not only ensures the stability of the communication of the network node, but also greatly reduces the size of the node, and is suitable for the construction of the home indoor network.

2.3 Terminal node hardware design

A terminal node is a network node with sensors. It mainly includes three parts: node core CC2530, sensor module and power management module. The hardware block diagram of terminal node is shown in Figure 2.

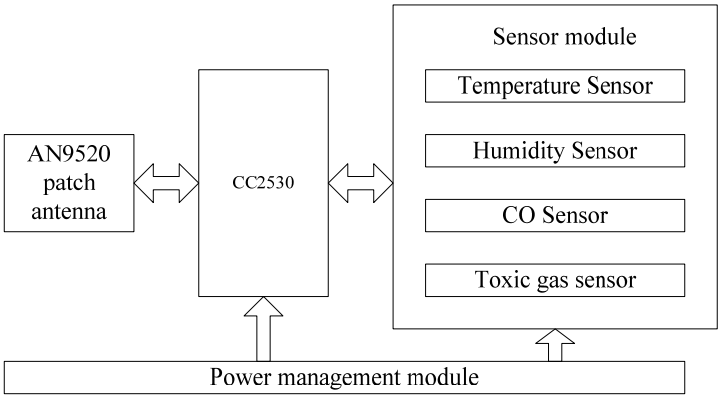

Figure 2 Block diagram of the terminal node hardware

The sensor module is an important part of the terminal node. The type of sensor can be flexibly determined according to the actual needs of the user. In this experiment, the system selects SHT10 digital temperature and humidity sensor, MQ-7 carbon monoxide sensor and MQ-138 toxic gas sensor. The SHT10 digital temperature and humidity sensor adopts full-scale calibration and two-wire digital output. The CC2530 can directly read the indoor temperature and humidity information through the peripherals (Zhao and Lin2018, Yang et al. 2017). The gas detection module consists of a gas sensor and a voltage dividing resistor and voltage amplifying circuit. The CC2530 reads the voltage value through A/D and sets the threshold value after multiple tests. When the MQ-7

carbon monoxide sensor or the MQ-138 toxic gas sensor detects that the toxic gas exceeds the standard, the threshold is set to exceed the standard, then the terminal node sends the information to the information monitoring center for processing.

2.4 Hardware design of information monitoring center

The information monitoring center is mainly composed of a central processing unit, a storage unit, a ZigBee coordinator node, an Ethernet controller module, a GSM module, and a router. The hardware structure of the information monitoring center is shown in Figure 3.

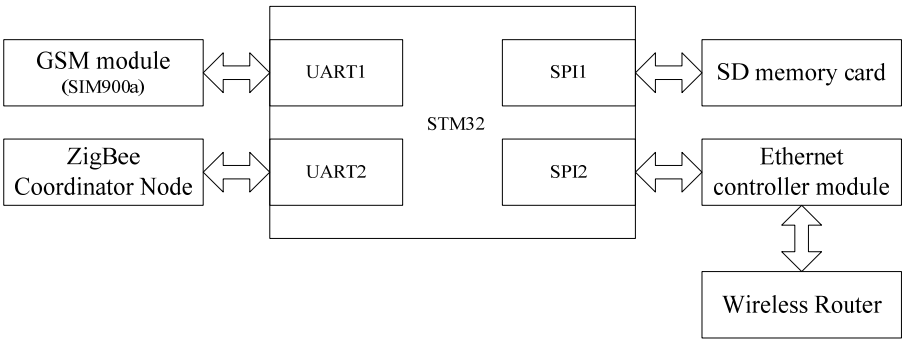

Figure 3 Block diagram of the information monitoring center hardware

The central processing unit of the information monitoring center uses STMicroelectronics' STM32F103RET6 microcontroller. The STM32F103RET6 features an ARM Cortex M3 core with a maximum operating frequency of 72MHz, built-in 512KB of flash memory and 64KB of SRAM, and a powerful peripheral interface. It is a low cost, low power and high-performance microcontroller solution. The information monitoring center uses an SD card as a storage unit to store important environmental data. The ZigBee coordinator node adopts the same CC2530 chip as the routing node and the terminal node, which receives the mountain ski ecological environment information sent by the terminal node and sends the environment information to the central processing unit STM32 microcontroller. The Ethernet controller module uses the ENC28J60 Ethernet controller, which is an independent Ethernet controller with an industry-standard serial peripheral interface. It conforms to all IEEE802.3 specifications and has a data transmission rate of up to 10Mb/s, showing the mountain skiing ecology. The web server for environmental information is realized by transplanting the uIP1.0 Ethernet protocol stack in STM32. The ENC28J60 Ethernet controller can connect the web server to the wireless router network, which is convenient for users to access the web server page to monitor the mountain skiing ecological environment. GSM module adopts SIM900A module, SIM900A belongs to dual-frequency 900/1800MHz module. It can be controlled by AT command, which has stable performance and high cost performance. It is an ideal choice for short message alarm module. STM32 sends AT command "AT+CMGF=1" to SIM900A through serial port when the system starts. Setting SIM900A to TEXT mode, STM32 sends instructions "AT+CMGS=mobile phone number + return car", "short message content", "1A+return car" through serial port to complete the sending of alarm short messages.

2.5 System software design

Based on versatility and ease of development, Texas Instruments' ZigBee2007-based protocol stack Z-Stack-CC2530-2.3.0 was added to the CC2530 of the terminal node, routing node, and information monitoring center coordinator node, enhancing the stability and flexibility of wireless sensor networks. The terminal node has a sensor module for detecting the ecological environment of mountain skiing, and is an important component of the monitoring and early warning system for mountain skiing ecological environment. In order to save power consumption, after the terminal node is successfully connected to the ZigBee network, the ecological environment

information of the mountain skiing is periodically collected and detected. Outside the detection period, the terminal node enters a sleep state until the detection period arrives and then wakes up. The working process is as follows: firstly, the terminal node device is initialized, and then the terminal node is connected to the ZigBee network. After the detection period is reached, the terminal node collects the sensor data, and sends the sensor data to the ZigBee coordinator node of the information monitoring center to continue to sleep status.

The ZigBee Coordinator node of the Information Monitoring Center mainly receives the sensor data sent by the terminal node and sends the sensor data to the STM32 microcontroller of the information monitoring center. The information monitoring center takes the STMicroelectronics STM32 microcontroller as the core, and implants the uIP1.0 Ethernet protocol stack in the STM32 to establish a Web server to display the mountain ski ecological environment information. The working process is: (1) initializing the STM32 device; (2) initializing the uIP1.0 protocol stack, the web server, and the ENC28J60 Ethernet controller; (3) setting the SIM900a module to the TEXT short message receiving mode through the AT command, completing the GSM The initialization of the module; (4) start the ZigBee coordinator node, wait for receiving the environmental data collected by the terminal node sensor, and after receiving the sensor data, first update the mountain ski ecological environment information in the web server, and then store the important environmental data to The SD card is used for user inquiry. When the environmental data exceeds the warning value (for example, the temperature exceeds 40 °C, etc.), the STM32 microcontroller sends an AT command to the GSM module to send an alarm message to the user in time. The ZigBee coordinator node of the information monitoring center mainly receives the sensor data sent by the terminal node, and sends the sensor data to the STM32 microcontroller of the information monitoring center.

3 Results

In order to verify the practicability of the system, a monitoring and early warning system for mountain skiing ecological environment based on ZigBee network was established. The information monitoring center is arranged in the living room, and the routing node is arranged at the entrance of the two bedrooms to monitor and warn the environmental information such as temperature and humidity, carbon monoxide and toxic gases (such as formaldehyde) of the two bedrooms. In the 2nd bedroom, the temperature around the temperature sensor is raised by electric soldering iron. The Web server of the information monitoring center can check the ecological environment information of mountain skiing. After about 2s, the user receives the alarm message sent by GSM module. Five time points were taken in one day, and the indoor temperature and humidity measurement results of the two bedroom terminal nodes 1 and 2 were respectively recorded and compared with the indoor standard temperature and humidity meter measurement results. The experimental data is shown in Figure 4.

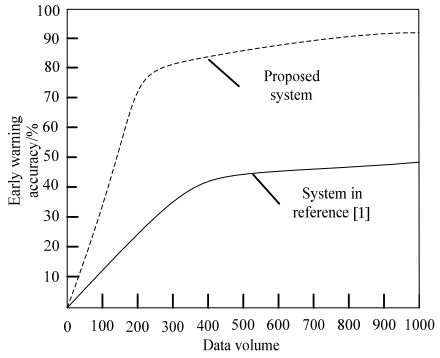

Figure 4 Comparison of the accuracy of data extraction

It can be seen from Figure 4 that the accuracy of the early warning is within the RH and the error range is small. The experiment proves that users of this system can monitor the toxic gases such as temperature, humidity, carbon

monoxide and formaldehyde. When there is an environmental abnormality (such as fire, gas leak, formaldehyde exceeding the standard, etc.), the user can receive the alarm prompt message in time.

4 Discussion

Eco-environmental problems have attracted wide attention. In the information age, it is necessary to use Internet technology to analyze the eco-environmental situation. In this paper, the software and hardware of the early warning system are designed by using ZigBee network communication technology, and the superiority of the designed system is verified by experiments. The experimental results show that the system node has the advantages of low cost, low power consumption, large network capacity, etc., and has the advantages of flexible and cheap billing, and has a wide range of applications.

5 Conclusions

The early warning system of mountain ski ecological environment detection introduced in this paper uses ZigBee network communication technology, embedded Web server technology and GSM communication technology to realize real-time monitoring and early warning of mountain ski ecological environment information such as temperature and humidity, carbon monoxide concentration and formaldehyde concentration. The experiment proves that the environmental monitoring and early warning system introduced in this paper has certain practical value. It is a monitoring and early warning solution for mountain skiing ecological environment with high accuracy, good real-time performance, convenient operation and easy expansion.

Acknowledgements

References

Janowski A, Rapinski J (2017) The analyzes of pdop factors for a zigbee ground - based augmentation systems. Polish Maritime Research 24 (1):108-114.

Wei X, Wei HC (2017) Design of Remote Environment Monitoring Human-Computer Interaction System Based on ZigBee. Modern Electronics Technique 40 (18):156-160.

Xu Y, Chen X (2012) The influence factor analysis on stability of communication links based on cluster-tree WSN using ZigBee. Beijing, China, Trans Tech Publications, 477-481.

Yang RF, Wang X, Guo CX, et al. (2017) Design and Application of Environmental Monitoring System Based on ZigBee Wireless Sensor Network. Chinese Journal of Electron Devices 40 (3):760-765.

Yu HL, Ding MQ, Huang P, et al. (2017) Ginseng Growth Monitoring and Disease Warning Based on Zigbee Network. Journal of Jilin Agricultural University 39 (1):120-126.

Zhang HW, Li N (2014) ZigBee-based Wireless Environmental Monitoring Coal Mine Alarm System. Automation & Instrumentation (10) :74-75.

Zhao J, Lin HG (2018) Development of Water Quality Monitoring System Based on Zigbee and Online Test in Complex Environment. China Measurement & Test 44 (238) (05):75-78.

Zheng L, Zhang X (2019) Network monitoring and early warning system of economic benefit decline in ecological, agricultural and pastoral areas. Ekoloji 28 (UNSP e107519107):4625-4636.