
Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org
© 2024 SCPE. Volume 25, Issues 4, pp. 2210–2219, DOI 10.12694/scpe.v25i4.2820

ENVIRONMENTAL PROTECTION CONTROL SYSTEM BASED ON IOT AND DEEP LEARNING INTELLIGENT MONITORING SENSORS

SHICHAO CAO, XIAOYING LIU, AND NAN LI*

Abstract. In order to improve the multi-sensor intelligent control performance of environmental pollution detection, this paper proposes a design model of environmental pollution detection intelligent system based on Internet of Things technology. Firstly, this paper uses ZigBee's Internet of Things networking technology to design the network of the pollution detection system. Secondly, in order to verify the effectiveness of the environmental pollution detection method, this paper carries out system debugging analysis and simulation test, and uses visual dsp++simulation system to debug the system. The network of ZigBee Internet of Things networking technology is adopted to realize the network design of pollution detection system, and VIX bus technology is adopted to carry out environmental pollution detection data communication and information processing, so as to realize the optimal design of intelligent system of environmental pollution detection system. Finally, the experimental test and analysis were performed. The collection period of environmental pollution data is 10 s and the monitoring time is 22 h. Finally, according to the environmental model and parameters, we determine that the system can accurately detect environmental pollution information, and the results are accurate and reliable.

Key words: Internet of Things, Intelligent detection, Sensor, Environmental protection

1. Introduction. With the continuous progress of environmental protection and ecological governance in China, the density of environmental pollution monitoring is increasing, combined with artificial intelligence Technology, environmental pollution detection, improve the real-time environmental pollution monitoring and treatment ability. The detection of environmental pollution is mainly for the detection of air pollution and water pollution.

The architecture of intelligent environmental monitoring system is mainly composed of three parts: sensor, data center and user interface. The sensor collects environmental data by monitoring environmental parameters, such as temperature and humidity. The data center is a centralized server for storing and managing environmental data, and uses data processing and analysis algorithms. The user interface displays environmental data and reports. Sensor is one of the most important components in the intelligent environment monitoring system. The sensor can measure various environmental parameters through corresponding sensor technology. For example, temperature sensors use thermocouples or thermistors to measure temperature. Humidity sensors can use capacitive or resistive sensors to measure humidity. The pressure sensor can use piezoresistive sensor or capacitive sensor to measure the pressure.

Internet of Things IoT (Internet of Things) refers to the deployment of various information sensing devices with certain sensing, computing and execution capabilities in the entities of the physical world, which implement information transmission, collaboration and processing through network facilities, so as to realize the information exchange and exchange between people and objects in a wider or larger scope.

The sensor can use infrared or chemical sensors to measure the concentration. The data collected by the sensor is transmitted to the data center through the communication link of the Internet of Things. The user interface is the final interface of the environmental monitoring system. Its purpose is to make the environmental data easy to understand and access. The user interface can now be a Web application or an application. Users can view environmental data and reports and get updated data at any time [1,2].

Combined with intelligent computer processing and chip control technology, the optimization design of environmental pollution detection equipment is conducted, and the intelligent environmental pollution detection system is constructed to improve the detection efficiency of environmental pollution. Intelligent environmental

*Hebei Vocational University of Technology And Engineering, Hebei, Xingtai, 054000, China (Corresponding author: Shichao Cao)

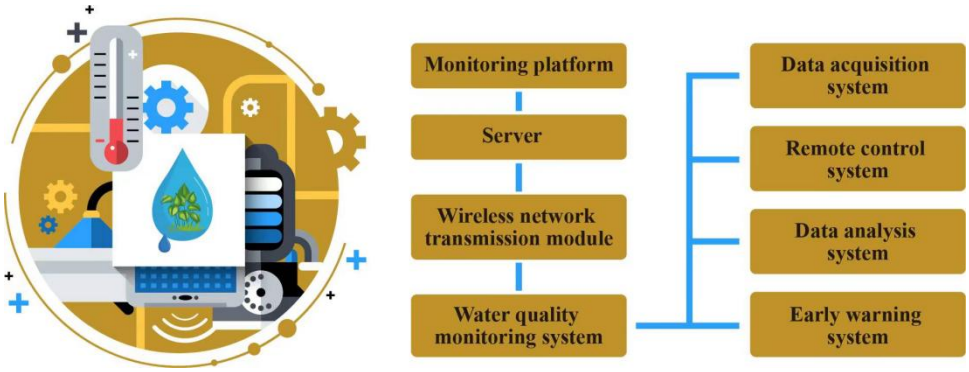


Fig. 1.1: Intelligent monitoring sensor

monitoring system can be applied to various scenarios, such as indoor and outdoor environmental monitoring, urban air quality monitoring, garbage can emptying plan, etc. The environmental monitoring system can track the changes of environmental parameters and help users understand and manage environmental conditions. In addition, it can also help users formulate appropriate policies and take corresponding measures to promote environmental protection and sustainable development.

Under the Internet of Things technology, combined with the ZigBee network protocol, the wireless sensor network design of the environmental pollution detection system is carried out, and the Internet of Things network optimization technology is used to conduct multimedia environmental pollution detection, so as to improve the network control ability of environmental pollution detection and improve the efficiency of environmental pollution detection (as shown in Figure 1.1).

Using iot technology and wireless sensor networking technology, introduced into the environmental pollution detection system design, environmental pollution information collection and data analysis, put forward a kind of environmental pollution detection based on the Internet of things intelligent system design model, environmental pollution detection overall structure of intelligent system design model to establish the embedded ARM kernel based on the ZigBee Internet of things network technology for pollution detection system network design, using VIX bus technology for environmental pollution detection data communication and information processing, realize the optimization design of environmental pollution detection intelligent system. Finally, the experimental test and analysis were performed.

2. Internet of Things technology. In order to realize the optimal design of the environmental pollution detection intelligent system and the system for environmental pollution detection, the system bus design and software development are based on the Internet of Things technology system. The Internet of Things technology is to integrate TCP / IP protocol into the BSDUNIX communication system, and combine GPRS technology and ZigBee technology to realize the sensor network design of environmental pollution detection. The sensor communicates with the Internet to ensure the intelligent recognition of the target. With the passage of time, the scope of network development has gradually expanded, but it is often mistaken for directly transmitting information and acquiring computer data through wired sensors and wireless networks. Effective information should be identified to ensure the links between projects or people and projects, and increase access to information and communication technologies [3,4].

(1) Sensor network layer. The sensor network layer mainly connects the physical sense world and the actual information network world through the virtual hardware network, and senses the internal environment or the external environment attributes of the material.

(2) Network layer. The network layer is mainly responsible for transmitting information directly from the physical sense network layer to the actual application, using the network layer.

(3) Application layer. The application layer collects and converts data, processes data through subsystems, and provides services for related industries.

2.1. Structural design of intelligent environmental monitoring system. The overall structure model of environmental pollution detection intelligent system design is established based on embedded ARM kernel, combined with fuzzy PID integration detection method for pollution information acquisition and intelligent information processing, the system includes multi-sensor intelligent control module, environmental pollution detection information processing module, multi-threaded control module, cross compilation module and human-computer interaction module, etc.

(1) Main program structure of the system. The intelligent environment monitoring system is divided into two parts, namely hardware design and software design. The software design also includes three parts, namely data acquisition, data transmission and control output. Each part uses multiple processes to cooperate to complete the function. Each process has a single responsibility, but it is also mutually cooperative. In this system, Contiki embedded operating system is used to schedule the task process of each part.

(2) Data collection process. Data acquisition mainly refers to the use of special software to read the digital signals output by each sensor, and directly cache these digital signals with relevant instruments, and then wait for the data transmission process to extract data. It mainly includes the reading of digital signals obtained from environmental information sensors with corresponding instruments.

(3) Data transmission process. The data transmission process mainly refers to the process of using the special FIFO queue to extract the sensor data according to the JSON format, and then using the serial port to transmit the data through WI4I. The detailed process is as follows:

Use the sensor data byte stream bytes of the sensing layer to transfer to the FIFO node structure - put it into the receive FIFO cache queue - read the bytes from the receive cache in turn - judge that the protocol packet header is equal to read the entire header to check the header to read the data domain - check the entire data to store the data in a special structure to store it in the receive packet buffer queue to remove the protocol packet from the receive packet - judge the target address of the packet - delete the response packet-send response packet - process the packet [5,6].

2.2. Significance of intelligent environmental monitoring system in practical application.

(1) Comprehensive monitoring and perception. Multi-dimensional environmental monitoring is the basic link for the environmental protection department to carry out environmental protection work. Massive data can be obtained through the intelligent environmental monitoring system. On the one hand, it can help the environmental protection department understand the specific situation of the current environment, and take corresponding measures to solve the environmental pollution problem by analyzing the current environmental situation; On the other hand, help environmental protection departments to study the relationship between environmental quality and pollution sources, so as to better prevent environmental pollution from the source. According to the current application of the intelligent environmental monitoring system, the overall application effect is very good. It can expand the range of environmental perception. More importantly, the intelligent environmental monitoring system can obtain more complete and accurate environmental data, so as to reduce the probability of error reporting of environmental data, so that the environmental protection department can put forward more feasible governance plans based on the data [7,8].

(2) Multi-network integration, chimera transmission. In the process of processing environmental data, the distributed collaborative processing mechanism is adopted. Massive raw data is transmitted to the system, and through the front-end collaborative processing, more high-quality information data is refined and transmitted to the system platform. In order to ensure the efficiency of data and image information transmission, appropriate communication protocol system will be supplemented to greatly improve the efficiency of data transmission. In the design of network transmission system, a scientific combination of sensor networks, wireless networks, wired networks, satellite networks and other networks is adopted, and the principle of flexible, fast, reliable and applicable is always adhered to to to transmit sensing data to the common platform of the environment-friendly Internet of Things, and to provide reliable network resources and traffic management for heterogeneous transmission networks [9].

(3) Massive computing, intelligent analysis. Massive environmental data has mixed objectives, and the environment is always in the process of change. The content of environmental protection is also very complex. In the process of data analysis, it is necessary to predict the change of the comprehensive quality of the early warning environment in combination with meteorological, water conservancy, land, agriculture and forestry

departments. All of the above need to identify, sort, filter, classify and analyze massive data, which requires the intelligent environment monitoring system to have fast computing ability to calculate massive data and lay a complete data foundation for intelligent analysis.

2.3. Practical application architecture of intelligent environmental monitoring system. Based on the Internet of Things technology, the intelligent environment monitoring system uses various advanced sensing methods to comprehensively and thoroughly perceive the environmental objects, and transmits the sensed information to the intelligent analysis platform based on cloud computing at high speed for intelligent analysis such as data mining and model calculation. The conclusions and rules from intelligent analysis are provided to the intelligent management system for scientific decision-making. Relevant personnel carry out environmental governance and ecological restoration activities according to the decisions and governance measures made by the intelligent management system, so as to continuously improve the environmental quality. According to the existing environmental monitoring capacity of City A, the system is divided into four levels, namely: perception interaction layer, network transmission layer, basic support layer and intelligent application layer [10].

(1) Network transport layer. Based on the application design of the front-end intelligent environment sensing layer, with the goal of achieving more comprehensive interconnection, build a high-speed, seamless and reliable data transmission network that integrates sensor networks, wireless networks, wired networks, satellite networks and other network forms, and can flexibly and quickly transmit sensing data to the intelligent environment monitoring system management center. One of the key points is to carry out online data transmission of 86 existing water quality monitoring equipment, 70 pollution sources online monitoring, and 13 atmospheric monitoring equipment, so as to realize networked high-speed data transmission and centralized management of efficient equipment for environmental monitoring of water, air, noise, soil, and hazardous waste.

(2) Foundation support layer. Based on cloud computing technology, the city cloud service platform will build the most advanced high-performance computing and massive data storage support platform for multi-dimensional environmental protection information in China on the basis of high-performance parallel computing technology, massive data mining technology, data visualization technology, and other technologies with industry universality. The research results of environmental protection theory and various environmental protection expert experience models are widely combined. Through high-performance calculation and data mining of a large number of real-time and historical data, the environmental conditions and change trends are accurately judged, and the calculation tasks such as early warning, situation analysis, emergency linkage, etc. of environmental protection emergencies are rapidly provided with accurate results [11].

(3) Smart application layer. The construction of intelligent environmental protection comprehensive management service platform in the intelligent environmental monitoring system can be divided into the following four centers: monitoring and early warning center

The pollution source monitoring center, emergency command center and data exchange center form an efficient "intelligent environmental protection" integrated management service system platform, which can provide decision-making departments, environmental protection management departments and citizens with effective management of environmental protection data, strict implementation of environmental protection regulations, and support for in-depth scientific research.

The intelligent environmental monitoring system makes full use of advanced technologies and concepts such as the Internet of Things and cloud computing to significantly improve the environmental monitoring capacity of regional environmental protection departments, and generally achieve the goal of "accurate measurement, fast transmission, clear calculation and good management" [12,13].

3. Overall design description and functional component analysis of pollution detection system.

3.1. Overall design framework of environmental pollution detection system. In order to realize the optimal design of the intelligent system for environmental pollution detection, this paper carries out the system bus design and software development based on the Internet of Things technology system. The Internet of Things technology is to integrate TCP/IP protocol into the BSD UNIX communication system, and combine GPRS technology and ZigBee technology to realize the sensor networking design for environmental pollution detection. We use Zig - Bee for environmental pollution detection data communication and processing, use test instruments such as analog bus for environmental pollution detection and control, and use the unique bus

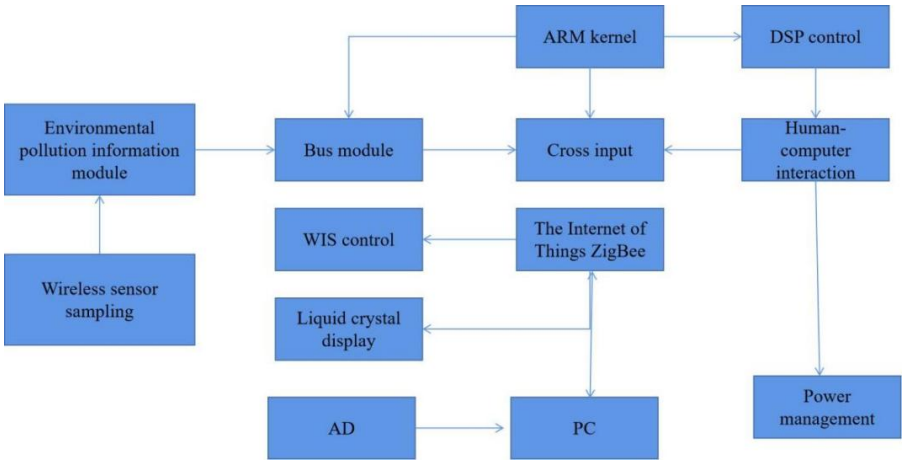


Fig. 3.1: Overall system architecture

data transmission function of the Internet of Things transmission channel to call the re - evfrom function to receive the air pollution, water pollution and other monitoring data of the environmental pollution detection intelligent system. The remote transmission of air pollution, water pollution and other monitoring data in the environmental pollution detection system is realized by using Wi-Fi, infrared, Bluetooth and GPRS communication technology. The clock control module is established to carry out the clock AD sampling of the intelligent environmental pollution detection system, and the monitoring data distribution module and cross-compilation module of the air pollution, water pollution and other monitoring data of the environmental pollution detection system are constructed to carry out the overall development and scheduling of the intelligent environmental pollution detection system under the environment of the Internet of Things. Firstly, the collected multimedia information of environmental pollution detection is converted into digital and analog through AD module, and the ZigBee network application service layer is constructed. The network service application layer is divided into four spaces of BASE2-5, which can meet the requirements of reading and analyzing the monitoring data of air pollution and water pollution in the multi-channel environmental pollution detection system. According to the above design idea, the designed environmental pollution detection system is obtained. The overall hardware design framework of the system is shown in Figure 3.1 [14].

3.2. System development environment description and functional component analysis. According to the overall design framework of the environmental pollution detection system shown in Figure 3.1, the functional modular design of the system is carried out. The designed environmental pollution detection system adopts a three-layer architecture, including the perception layer, the network layer and the application layer, and uses TCP/IP server or UPD server to build the network transmission protocol under the Internet of Things technology mode. Data transmission is carried out through the LTGA bus, and the overall design and functional component analysis of the environmental pollution detection system are carried out. In the database management module of the environmental pollution detection intelligent system, the monitoring data bus scheduling of air pollution, water pollution and other monitoring data in the environmental pollution detection system and USB serial port communication are realized. The functional and technical indicators of the designed intelligent system for environmental pollution detection are described as follows:

1. ZigBee and wireless sensor network are used to form the environmental monitoring network, with 4-channel environmental pollution detection information input function. The internal storage area is divided into 11 sectors. 16-bit fixed-point DSP is used to adjust the stability of the environmental pollution detection data output. Cross-compiling is performed in the B/S network architecture system. The multimedia information of the environmental pollution detection system is scheduled through dual-port RAM cache control.

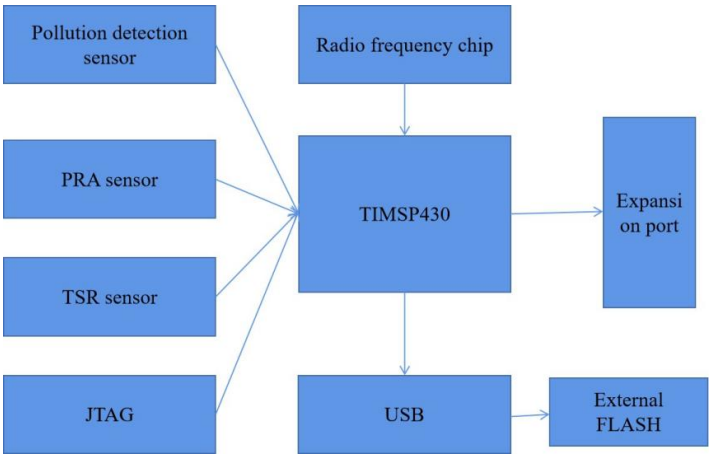


Fig. 3.2: Component composition of system functional structure

2. The full-duplex communication design of the environmental pollution detection system is carried out through the real-time control protocol (RTCP). The monitoring data of air pollution and water pollution in the environmental pollution detection system are transmitted by the DMA controller. The address communication range of the system is 00H-16H.
3. The data memory address range of the intelligent system for environmental pollution detection is 32K words, the off-chip 16K (address range 0000H FFH), and the serial port clock is LA B1:28. The dual-port data bus transmission of air pollution, water pollution and other monitoring data in the environmental pollution detection system is realized through PCI data bus [15].
4. Set the status register (Status) for data cache management and base address allocation of the environmental pollution detection intelligent system, use four AD8582 for multiplex transmission control, and access the L0OCAL local register through the Zig - Bee network at the PCI end. According to the above design indicators, the functional structure components of the environmental pollution detection system are shown in Figure 3.2.

3.3. System development design and implementation. The overall structure model of the design of the intelligent system for environmental pollution detection is based on the embedded ARM core and combined with the fuzzy PID integrated detection method for pollution information collection and intelligent information processing. The system includes multi-sensor intelligent control module, environmental pollution detection information processing module, multi-thread control module, cross-compilation module and human-computer interaction module. The development and design of each functional module are described as follows:

3.3.1. Multi-sensor intelligent control module. Multi-sensor intelligent control module realizes pollution data collection and information output functions, installs data collection sensors in the application layer of the Internet of Things system, and uses different databases to store environmental pollution information. DSP integrated signal processor is used for environmental pollution energy consumption data acquisition and real-time information processing to improve the intelligent control ability of environmental pollution detection. We use the Internet of Things technology for the network design of environmental pollution detection, and get the structure of the multi-sensor intelligent control module as shown in Figure 3.3.

3.3.2. Environmental pollution detection information processing module. The environmental pollution detection information processing module is the core of the whole system. It is connected to the I0 port of CC2530 at the OUT port. The infrared sensor is used as the bottom module of the pollution detection system. In the environment of the Internet of Things, Zigbee network is formed through self-organization, and the general PPI mode and ITU-656 PPI mode are used for A/D sampling to realize the environmental pollution detection information processing.

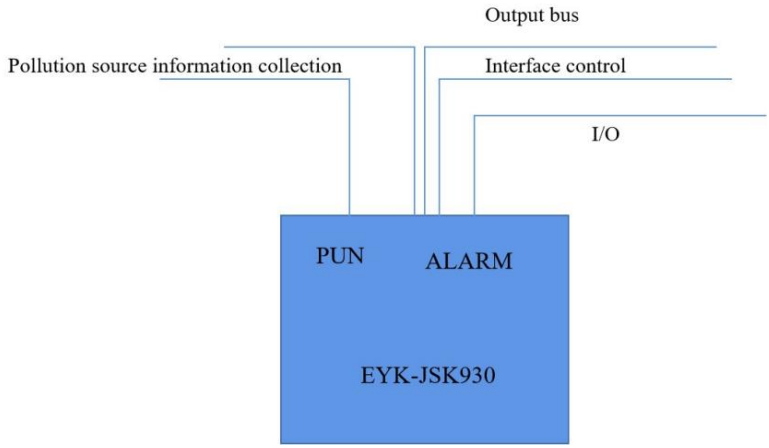


Fig. 3.3: Multi-sensor intelligent control module

3.3.3. Multi-thread control module. Based on the embedded ARM kernel, the multithread control module combines the fuzzy PID integrated detection method to collect pollution information and process intelligent information. The 8-bit A/D chip is used for AD conversion control of environmental pollution real-time monitoring information, and the floating-point DSP and fixed-point DSP are used for cross-compilation design to carry out integrated control of environmental pollution detection system [16].

4. Experimental test. In order to verify the performance of the method in realizing the environmental pollution detection, the system debugging analysis is carried out. In the experimental establishment of Simulink, the visual dsp++simulation system is used for system debugging. The cycle of the collected environmental pollution data is 10s, and the monitoring time is set to 22h. According to the above simulated environment and parameter settings, the environmental pollution detection is carried out, and the detection output is shown in Figure 4.1 (a) (b). According to the results of environmental pollution data in the figure, the system can accurately test environmental pollution information, and the collected results are accurate and reliable.

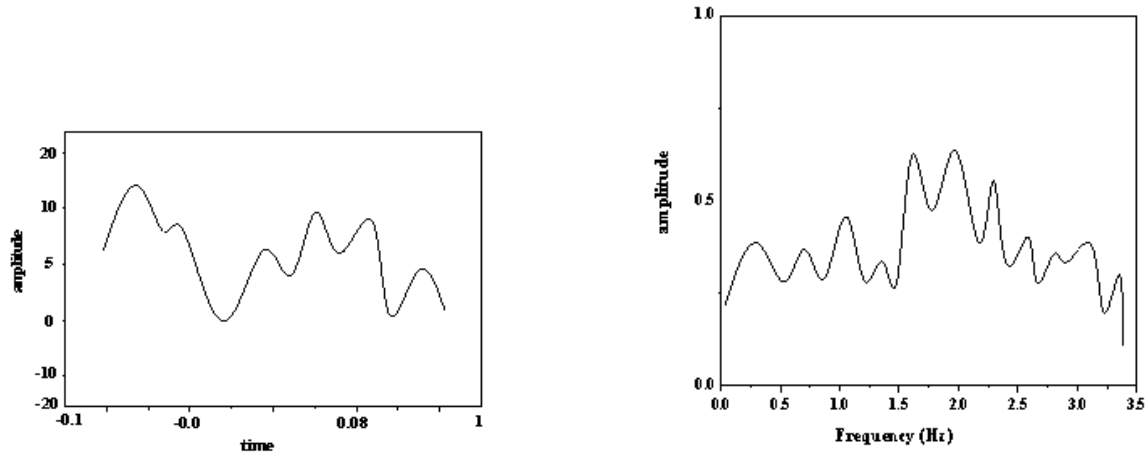
The environment monitoring system based on intranet technology mainly includes the on-site monitoring system and platform, which is responsible for the on-site data collection, processing and transmission operation. The monitoring platform is responsible for receiving data from the aircraft site. According to the characteristics of monitoring, a system structure is implemented, including environmental video observation, geographic information system and short message function module [17,18].

4.1. Environment video control. As a visual monitoring module, the environment video control can view the environment through video. During the monitoring process, it sends commands to the monitoring camera. The camera loads and saves the video. The video can be saved before viewing. Search equipment can find surveillance video [19].

4.2. Geographic information system. GIS spatial data management technology can effectively select and manage data. Considering different geographical coordinates and the need for multi-point operation of current environmental monitoring, GIS research can directly reflect the status of geographic information and more effectively disseminate relevant information.

4.3. SMS function. The SMS function is to transmit the pollution information to the controller in time. The monitoring personnel can obtain the environmental pollution information in time, respond to the pollution emergencies in time, and effectively carry out the environmental protection work.

4.4. Discussion. The construction of intelligent environmental pollution detection system can improve the detection efficiency of environmental pollution. Under the Internet of Things technology, we combine ZigBee network protocol to design the wireless sensor network of the environmental pollution detection system,



(a) (b)

Fig. 4.1: Detection output

and propose a design model of the environmental pollution detection intelligent system based on the Internet of Things technology. The overall structure model of the design of the intelligent system for environmental pollution detection is built on the basis of the embedded ARM core, combined with the fuzzy PID integrated detection method to collect and process the pollution information, and the overall design framework of the environmental pollution detection system is carried out. The system includes multi-sensor intelligent control module, environmental pollution detection information processing module, multi-thread control module, cross-compiler module and human-computer interaction module. We use ZigBee's Internet of Things networking technology to carry out the network design of the pollution detection system, establish the Internet of Things network system of the environmental pollution detection intelligent system on the basis of ZigBee and GPRS, and use VIX bus technology to carry out the environmental pollution detection data communication and information processing, to achieve the optimal design of the environmental pollution detection intelligent system. The research shows that the method has high accuracy and system reliability for environmental pollution detection [20].

Build an intelligent environmental pollution detection system to improve the detection efficiency of environmental pollution. Under the Internet of Things technology, Combined with the ZigBee network protocol, Conduct wireless sensor network design of environmental pollution detection system, To propose an intelligent system design model for environmental pollution detection based on the Internet of Things technology, Based on the basis of the establishment of embedded ARM kernel, Combined with the fuzzy PID integrated detection method for pollution information collection and intelligent information processing, The overall design framework of the environmental pollution detection system, The system includes multi-sensor intelligent control module, environmental pollution detection information processing module, multi-threaded control module, cross-compilation module and human-computer interaction module, Network design of the pollution detection system using the networking technology of the ot of ZigBee, Using the IEEE802.15.4 protocol standard, In the ZigBee vs on the basis of GPRS, the Internet of Things network system of environmental pollution detection intelligent system is established, and VIX bus technology is adopted to conduct environmental pollution detection data communication and information processing, so as to realize the optimal design of the intelligent system of environmental pollution detection.

5. Conclusion. The architecture of the intelligent environment monitoring system mainly consists of three parts: sensor, data center and user interface. The sensor collects environmental data by monitoring

the environmental parameters such as temperature and humidity. A data center is a centralized server for storing and managing environmental data, and uses data processing and analysis algorithms. The intelligent environment detection system based on the Internet of Things designed in this paper has achieved the expected function, and can collect the environmental parameters that need to be investigated remotely. This paper also analyzes and processes the collected data in order to understand the environmental conditions of the monitored area and better propose corresponding measures to prevent and improve the local environment.

This paper uses the Internet of Things network technology of ZigBee company to design the network of pollution detection system. Secondly, in order to verify the effectiveness of the environmental pollution detection method, this paper conducts a system debugging analysis and simulation test, and adjusts the system using a visual dsp + + simulation system.Environmental pollution data were collected for 10s and monitoring time for 22 h. Finally, according to the environmental model and parameters, we determine that the system can accurately detect the environmental pollution information, and the detection results are accurate and reliable.

The intelligent environment detection system replaces the traditional detection method, and makes up for its shortcomings, so as to better play the role of the intelligent environment detection system in environmental monitoring.

REFERENCES

[1] Chang, V., Ramachandran, M., & Li, C. S. . (2022). Special issue editorial on emerging trends in internet of things for e-health and medical supply chain systems. Expert systems: The international journal of knowledge engineering23(4), 39.

[2] Dolfsma, W., Mahdad, M., Hasanov, M., & Isakhanyan, G. . (2022). A smart web of firms, farms and internet of things (iot): enabling?collaboration-based business models in the agri-food industry. British Food Journal, 124(6), 1857-1874.

[3] Egwuonwu, A., Mordi, C., Egwuonwu, A., & Uadiale, O. . (2022). The influence of blockchains and internet of things on global value chain. Strategic change: An international journal of management theory and practice42(1), 31.

[4] Gehlot, A., Alshamrani, S. S., Singh, R., Rashid, M., & Albogamy, F. R. . (2021). Internet of things and long-range-based smart lampposts for illuminating smart cities. Sustainability, 13(11)25.

[5] Zhang, H., Uddin, M., Hao, F., Mukherjee, S., & Mohapatra, P. . (2022). Maide: augmented reality (ar)-facilitated mobile system for onboarding of internet of things (iot) devices at ease. ACM Transactions on Internet of Things23(2), 3.

[6] Rebelo, R., Pereira, S., & Queiroz, M. M. . (2022). The interplay between the internet of things and supply chain management: challenges and opportunities based on a systematic literature review. Benchmarking: An International Journal, 29(2), 683-711.

[7] Le, X., Shi, Q., Vachon, P., Ng, E. J., & Lee, C. . (2022). Piezoelectric mems—evolution from sensing technology to diversified applications in the 5g/internet of things (iot) era. Journal of Micromechanics and Microengineering, 32(1), 014005-.

[8] Gong, B., Wu, Y., Wang, Q., Ren, Y. H., & Guo, C. . (2022). A secure and lightweight certificateless hybrid signcryption scheme for internet of things. Future Generation Computer Systems, 127, (2)3-30.

[9] Lodhi, M. A., Wang, L., & Farhad, A. . (2022). Nd-adr: nondestructive adaptive data rate for lorawan internet of things. International journal of communication systems23(9), 35.

[10] Xu, W., Zhang, J., Huang, S., Luo, C., & Li, W. . (2022). Key generation for internet of things: a contemporary survey. ACM computing surveys21(1), 54.

[11] Zhang, Q. Y., Cai, B. F., MD Wang, Wang, J. X., Xing, Y. K., & Dong, G. X., et al. (2022). City level co2 and local air pollutants co-control performance evaluation:a case study of 113 key environmental protection cities in china. Advances in Climate Change Research, 13(1), 118-130.

[12] Adrian, H. . (2022). Alan d. roe. into russian nature: tourism, environmental protection, and national parks in the twentieth century. The American Historical Review25(3), 3.

[13] Nhuong, B. H., & Quang, P. T. . (2022). Are fdi inflows crucial for environmental protection in various asian regions?. Journal of Environmental Assessment Policy and Management, 24(02)36.

[14] Karam, P. A. . (2021). Accelerator radiation physics for personnel and environmental protection by j. donald cossairt and matthew quinn, 2019 (hardcover, e-book) 2021 (paperback), 322 pp, $151.96 (hardcover), $43.96 (paperback and e-book), crc press, boca raton, fl. Health Physics, 121(5), 513-513.

[15] Anastas, P. T., & Zimmerman, J. B. . (2021). Moving from protection to prosperity: evolving the u.s. environmental protection agency for the next 50 years. Environmental Science And Technology, 55(5), 2779-2789.

[16] Lu, J. . (2022). Can the central environmental protection inspection reduce transboundary pollution? evidence from river water quality data in china. Journal of Cleaner Production, 3(3)2, 130030-.

[17] Lehmann, C., Delbard, O., & Lange, S. . (2022). Green growth, a-growth or degrowth? investigating the attitudes of environmental protection specialists at the german environment agency. Journal of Cleaner Production, 3(3)6, 130306-.

[18] Wang, H. A., & Zhuang, X. B. . (2022). Financing strategy of smes based on the shortage of environmental protection funds. Procedia Computer Science, 199, 1(5)21-1528.

[19] Nielsen, Y. A., Scigata, K. A., Nockur, L., Venema, T., & Pfattheicher, S. . (2022). A cautious note on the relationship between social mindfulness and concern with environmental protection. Proceedings of the National Academy of Sciences of the United States of America.63(9), 119.

[20] Liu, X., Zhong, S., Li, S., & Yang, M. . (2022). Evaluating the impact of central environmental protection inspection on air pollution: an empirical research in china. Process Safety and Environmental Protection, 1(6)0, 563-572.

Edited by: B. Nagaraj M.E.
Special issue on: Deep Learning-Based Advanced Research Trends in Scalable Computing
Received: Nov 9, 2023
Accepted: Jan 26, 2024