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Research Article

Construction of Wireless Sensor Model for Carbon Neutralization and Environmental Protection from the Perspective of Energy Internet of Things Transformation

Huawen Tian ,[1] Liwen Jiang ,[2] and Jie Zhang[3]

[1]*School of Grammar and Law Shandong University of Science and Technology, Qingdao 266590, China*
[2]*School of Economics and Management, Shandong University of Science and Technology, Qingdao 266590, China*
[3]*School of Management, Shandong University of Technology, Zibo 253770, China*

Correspondence should be addressed to Huawen Tian; skd992912@sdust.edu.cn

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Carbon neutral environmental protection is an important way to effectively control the rapid rise of global temperature, promote the green transformation of energy utilization, and promote green, low-carbon, and other technological progress. It is a new driving force for world economic development and growth. This paper explores the construction of wireless sensor model for carbon neutralization and environmental protection from the perspective of the transformation of energy Internet of things. This paper analyzes the development background and research status of energy Internet of things technology at home and abroad and determines the overall design scheme of environmental monitoring Internet of things system. Then, we design the overall scheme of wireless sensor model under the environment monitoring Internet of things system. An experimental test platform was built to test the performance of the environmental monitoring Internet of things system. The test results show that the wireless sensor can monitor and respond to physical impact, and the generated energy can realize wireless data transmission of about 20 m; the regional coverage and fixed-point Internet of things system can realize the real-time monitoring of environmental parameters such as light, temperature, humidity, and dust, interact with the data and instructions of the cloud platform normally, and work stably. The basic functions of the whole Internet of things system have been realized, including the alarm function of passive wireless impact sensing, the cloud real-time monitoring function of environmental data and the real-time sending function of cloud instructions, and the real-time monitoring of indoor and outdoor environment under two working modes. The task objectives set in the early stage of the whole system are realized.

1. Introduction

Climate change has a profound impact on the earth's environment, which is a great challenge facing mankind [1]. In order to cope with global climate change and realize the progress of human civilization and the sustainable development of the earth's ecosystem, the 21st United Nations Climate Change Conference adopted the Paris climate agreement, which proposed to achieve the goal of "net zero emission" of CO_2 around 2050, that is, carbon neutralization [2]. Broadly speaking, carbon neutralization refers to the dynamic balance between carbon source systems such as human fossil energy utilization, land use, and natural volcanic eruption carbon emission and carbon sink systems such as earth's carbon cycle system, marine carbon dissolution, and biosphere carbon absorption. In a narrow sense, carbon neutralization refers to the CO2 emission of an organization, group, or individual in a period of time, which is offset by forest carbon sink, artificial transformation, geological storage, and other technologies to achieve "net zero emission" [3]. Carbon neutralization is an important way to effectively control the rapid rise of global temperature, promote the green transformation of energy utilization, and promote green, low-carbon, and other technological progress [4]. It is a new driving force for world economic development and growth [5]. Realizing carbon neutralization will improve the earth's ecological environment on which human beings depend and reduce environmental problems caused by human activities [6]. In 2019, the World Health Organization announced that air pollution and climate change ranked first among the top ten health threats in the world [7]. It is estimated that from 2030 to 2050, climate change will cause about 250000 new deaths from malnutrition, malaria, diarrhea, and excessive temperature in the world every year, and 7 million people will die prematurely from diseases such as cancer, stroke, heart disease, and lung disease every year [8]. Carbon neutralization will promote the transformation of human energy system to green, low-carbon, and carbon-free, realize the substitution of carbon-free new energy for high-carbon fossil energy, and drive the growth of jobs and GDP in the field of new energy industry [9]. It is estimated that by 2050, the average annual investment in the field of global energy low-carbon transformation will exceed US $3.2 trillion, the cumulative investment will exceed US $95 trillion, and more than 100 million jobs will be provided [10]. Carbon neutralization is the common goal and pursuit of all mankind. The global cooperation mechanism with consultation as the main body is the premise and guarantees to achieve carbon neutralization [11]. In the process of actively promoting carbon neutralization all over the world, it is necessary to carry out carbon neutralization research guided by scientific issues [12].

The automatic identification center established by MIT proposed a radio frequency identification system-item loading sensing equipment [13]. Through the application of RF technology, it is connected with other objects to realize the interconnection of objects and form an intelligent control system [14]. Internet of things is another widely concerned network in the network field after the Internet. It is based on standards and has the ability of self-configuration and management [15]. The Internet of things supports the direct information interaction between people and things, and wireless sensor networks only support the information exchange between things, in order to provide users with the environmental information they need [16]. Therefore, wireless sensor network is the technical basis of the Internet of things and a branch network of the Internet of things. From the historical background of the emergence of wireless sensor network technology, wireless sensor network has experienced wireless data network, wireless ad hoc network, and wireless sensor network [17]. The traditional environmental detection method is to manually obtain various material samples in the environment, such as air, water, and soil, and test the collected samples on the instruments in the laboratory [18]. Such a sample acquisition method can only collect limited data, and the data is not reliable. In order to meet people's demand for various resource monitoring in the future and maintain the sustainable development of economy and environment, we need to obtain a large amount of environmental information timely and accurately [19]. Because of its own characteristics, wireless sensor networks are different from traditional fixed networks. They have the characteristics of limited resources, self-organization, dynamic network, wide scale, and high density [20]. The characteristics of wireless sensor network, such as single deployment, low cost, network self-configuration, and no manual maintenance, make it suitable for the field of environmental monitoring. Multiple nodes carrying various sensors are distributed in the required monitoring environment, and the nodes cooperate to complete the remote monitoring task [21]. Although the research time of wireless sensor network is very short, a large number of sensor network research and application make its technology develop rapidly. With the continuous exploration of wireless sensor networks all over the world, the application of wireless sensor networks has widely existed in all fields of production and life [22]. It is the research focus and application technical basis of wireless networks in the future. Wireless sensor networks (WSNs), which combine sensor technology, microelectronics technology, and wireless technology, are a powerful network. It has been widely used in road traffic, military safety, environmental monitoring, intelligent life, and other aspects. Today's society is affected by the technology and application of WSN [23]. Wireless sensor networks play an important role in monitoring, such as the concentration of carbon dioxide in the air, air humidity, and light intensity. The monitoring of these indicators can well reflect the results of carbon neutralization and provide an important basis for the early realization of carbon neutralization. This paper analyzes the development background and research status of energy Internet of things technology at home and abroad and determines the overall design scheme of environmental monitoring Internet of things system. Then, the wireless sensor network model is applied to the detection of air quality in the environment to detect the content of CO2 in the air more accurately, which is of great significance to achieve the goal of carbon neutralization as soon as possible.

2. Related Work

The Internet of things takes data networking as the essential core, while the energy Internet of things has a large number of users and devices, and the data collected by its measurement and perception is very valuable. On the one hand, the use of massive data enables the energy industry to fully understand its own characteristics and provide new technical support means for low-carbon green development, energy efficiency improvement, energy conservation and consumption reduction, economic operation, and system planning of the energy industry; on the other hand, data analysis and processing based on deep learning, artificial intelligence and other technologies can improve the production efficiency of the energy system, provide better consumer services for users, and provide more efficient decision support for system operators. The Internet of things and wireless sensor networks have been widely favored all over the world. In 1991, the concept of "pervasive computing" proposed by the United States involved perceptual technology, and then, MIT first proposed the "Internet of things" [24]. IBM announced the "smart earth" plan to the outside world in November 2008. Immediately, the plan received strong support from the government and jointly developed smart grid and smart medicine [25]. Carbon neutralization means that enterprises, groups, or individuals calculate the total amount of greenhouse gas emissions directly or indirectly generated within a certain period of time to offset their own carbon dioxide emissions through afforestation, energy conservation, and emission reduction, so as to achieve "zero emission" of carbon dioxide. As a new form of environmental protection, carbon neutralization has been adopted by more and more large-scale events and conferences. Some other developed countries have also set development goals and taken a number of feasible measures to promote their rapid development. In the field of agricultural environmental monitoring, data transmission technology and environmental data acquisition technology have been developed [26]. In terms of data transmission, there are two measures to ensure the correctness of data transmission: the optimal network protocol and the appropriate network deployment [27]. The correctness of agricultural environmental data transmission first needs the optimal network protocol. The agricultural environment monitoring based on wireless sensor network needs to deploy the network according to the characteristics of the monitoring area. When wireless sensor networks need a single network in a small-scale agricultural monitoring environment, the physical layer and data link layer of the network protocol are the same [28]. However, when wireless sensor networks need composite networks in complex environments, different network layer and application layer specifications are formulated due to specific network protocols. It can be seen from the literature that the fusion between networks requires standards to agree on the communication between different networks [29]. According to different monitoring environments, the research focus of routing algorithm is also different. It can be seen from the literature that the protocols related to wireless sensor networks are appropriately tailored to meet the characteristics of agricultural monitoring environment. Second, select the appropriate topology to deploy the network nodes to make the network reach the optimal state, so as to transmit data reliably [30]. Wireless sensor networks deployed in various regions as the experimental field of project research have promoted the rapid development of Internet of things related technologies. Gong and Jiang [31] proposed a smart city Internet of things system for monitoring indoor temperature, humidity, and CO_2. It uses PIC24F16KA102 chip as the main control and NRF24L01 RF module with 2.4 GHz bandwidth as the transmitting and receiving node to collect temperature, humidity, CO_2, and other sensing data, transmit it to PC through USB, and transmit the data to mobile phone app through the Internet, so as to obtain, save, and process environmental data. Liu et al. [32] proposed a low-power Internet of things system for long-term monitoring of outdoor environment. It is composed of sensor node, gateway node, application server, and back-end alarm equipment. The sensor node collects temperature data through the main control and sends the sensor data to the gateway equipment through CC1150 RF module; the gateway device collects RF data through the 433 module and drives the GPRS module to transmit the data to the application server through the main control module; the application server stores and provides data support for the back-end alarm device; the back-end alarm device runs data query and alarm functions. Vijayalakshmi et al. proposed a real-time environment monitoring Internet of things system using solar energy self-power supply [33]. It is composed of solar panel, power management module, main control module, XBee RF module, and sensor module. Solar panels generate electric energy during the day, provide electric energy for system operation, and charge 50 f capacitors; The main control module collects the information of temperature, humidity, CO, CO_2, and LDO sensors and transmits the data through XBee module. The power consumption of the whole system is about 4.907 mW. At the same time, the 50 F capacitor can be charged to 4.6 V by the solar module during the day; when the operating voltage of the system is between 3.6 V and 4.6 V, the 50 F capacitor can provide the power of the whole system for 12 hours at night [34]. Muthukumaran et al. [35] put forward a cloud service monitoring system for diabetes patients. In the system, the sensor node layer is composed of two parts. One part collects indoor environmental information, such as temperature, humidity, time, location, and air quality, and the other part collects patient information, such as heart rate and body temperature; the gateway is responsible for local data storage, data packaging, data push, and other functions; the cloud service layer is responsible for cloud data storage, data query, and other functions; the equipment terminal can view the information of patients and rooms in real time. The sensor node layer communicates through a 2.4 GHz radio frequency module; the sensor node and gateway transmit data through WiFi module.

3. Research Methods and Key Technologies

3.1. Transformation of Energy Internet of Things. This paper will explore the path description and research methods of energy Internet of things transformation and discuss how to use power system, Internet of things, and social factors to strongly support energy transformation. In 2015, the proportion of nonfossil energy power generation was 30%. The schematic diagram of energy transfer path is shown in Figure 1, showing the change curve of the proportion of renewable energy in primary energy. Under the goal that the proportion of nonfossil energy power generation will reach 80% in 2050, there can be different paths to achieve this goal, and different paths will have different effects on the national economy. How to plan the energy transfer path can take into account the constraints of coordinated economic development and carbon emission, which is worthy of in-depth research.

In many paths, the transformation task can be allocated to each year by linear method; we can also increase the amount of renewable energy as soon as possible, so as to obtain carbon emission benefits as soon as possible and save resources. However, due to immature technology and other reasons, the investment will increase. Or use the opposite method to accumulate experience at the beginning and accelerate the pace of transformation when the technology is mature. Therefore, among many paths, how to find a feasible method to compare different paths and select the

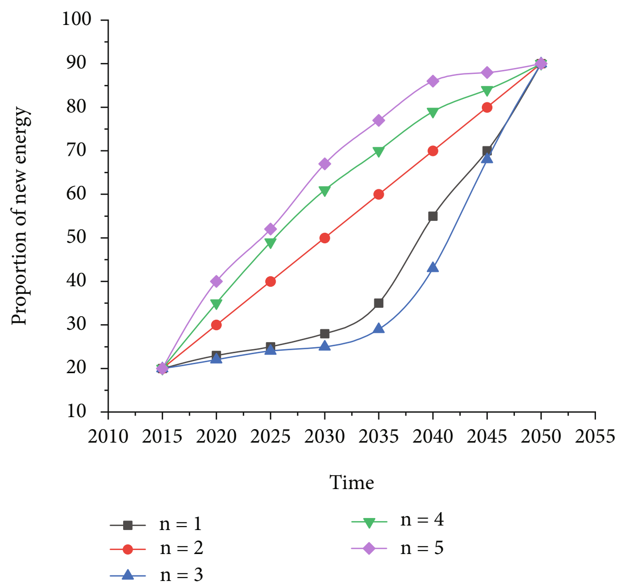


FIGURE 1: Schematic diagram of energy transfer path.

optimal path has become an urgent problem to be solved. The proportion of nonfossil energy power generation is used as the characteristic quantity of energy transformation, as shown in Figure 1. The time series trajectories of different transformation curves are marked with typical power functions. The power of the transformation curve is represented by n, the linear transformation curve is a special case where the power is equal to 1, and n represents the power of the transformation curve. $R0$ represents the initial proportion of new energy, Rf represents the target proportion, $t0$ and tf represent the starting year and target year, respectively. In year t, the proportion of new energy can be expressed as

$$C(t) = C0 + \left(\frac{A1 + A0}{A1A0}\right)\sqrt{\frac{(t1 - t0)^2}{2}}, \quad (1)$$

$$C0 = \int_{t=0}^{n} A0(1 + 2.3a\%)^n t, \quad (2)$$

$$a = \frac{C(t) - C0}{C(t)}. \quad (3)$$

3.2. Key Technologies of Energy Internet of Things. The network nodes in the energy Internet of things can ensure the comprehensive monitoring of the external environment and improve the overall quality of data transmission. In environmental monitoring, we need to improve the security and stability of data transmission. Combined with the actual characteristics of the Internet of things, we can optimize the design of link layer data transmission and enhance the security of data. We can also establish the reliability analysis method of data transmission of the Internet of things system and take corresponding management measures to ensure the overall effect of data transmission of the Internet of things. The Internet of things system mainly includes three parts: application layer, perception layer, and network layer. The sensing layer is composed of various sensor devices, including reader, terminal camera, and GPS. It can sense the external environment and collect a variety of signals and physical information. The network layer refers to the IOT network communication system, including information processing center and intelligent control center, which can process information quickly and timely.

A large number of microsensor nodes are arranged in the monitoring area to realize the self-organizing network system by means of wireless communication. Various microsensors can be integrated to realize the real-time reception and transmission of information. Wireless communication transmits various data information, and the information obtained by the sensor can also realize the development of integration, miniaturization, and networking, as shown in Figure 2. Wireless sensor network integrates embedded computing, sensor technology, wireless communication technology, and modern network technology, which can enhance the perception ability of the whole device. It is an important prospect in the field of Internet of things.

3.3. Construction of Wireless Sensing Model under Energy Internet of Things Technology. Under the condition of Internet of things technology, it is necessary to analyze the application characteristics of ecological environment, meet the overall needs of system architecture, and improve the overall quality of service monitoring. Wireless sensor nodes with self-organizing function are connected in the form of wireless transmission, which can conduct three-dimensional and comprehensive monitoring of the ground, underground, and air environment, forming a 3D Internet of things environment monitoring system, as shown in Figure 3. The detection system uses Ethernet to monitor different indicators in the environment, such as temperature and humidity. Then, it is transmitted to the remote client through the network.

The core node design of the Internet of things needs to be composed of control and information processing unit, storage unit, and communication unit, and the distributed power supply is used to provide support. Build a monitoring system suitable for the ecological environment of different villages and towns, analyze it combined with the Internet of things node technology and ecological environment sensing data, and develop a sensor module to meet the monitoring of multi environmental parameters such as gas, water, and soil. In order to improve the security and reliability of data and information transmission in the Internet of things, it is necessary to effectively control the nodes of the whole data transmission, design specific methods such as error recovery, congestion control, and flow control, establish sensor models, comprehensively optimize the deployment and coverage of regional sensor nodes, and take corresponding management measures to ensure the quality of information transmission.

The whole IOT monitoring system can realize two working modes to adapt to different application environments.

The situation in the working mode of the area coverage monitoring system is as follows. As shown in

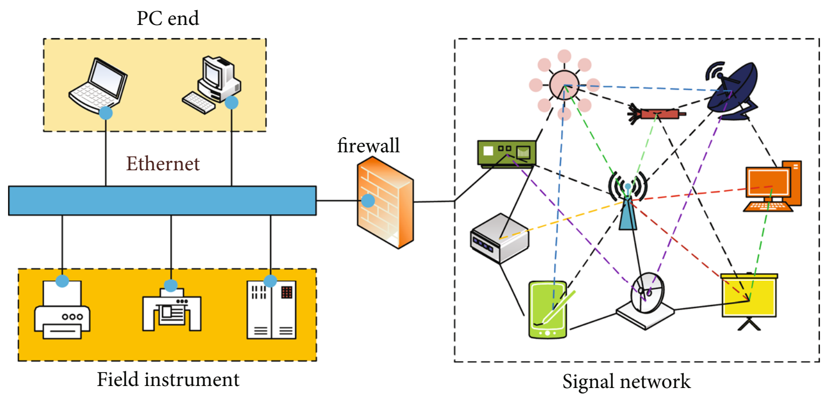


FIGURE 2: Wireless network sensor.

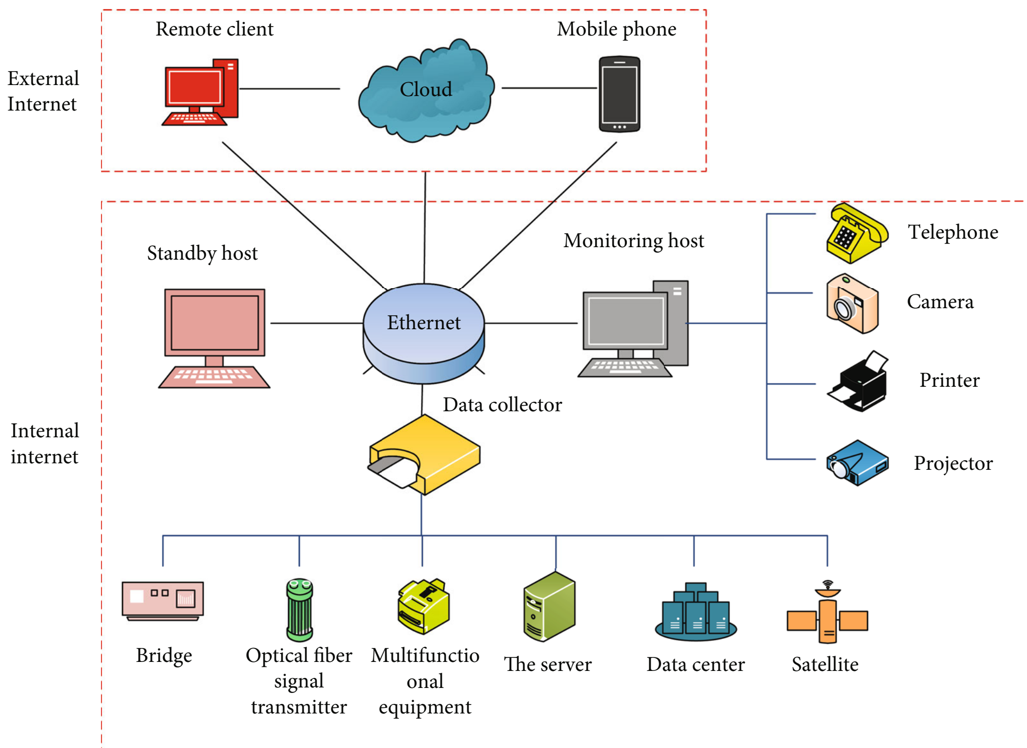


FIGURE 3: Environmental monitoring system.

Figure 4, the regional monitoring system includes LAN nodes, main control module, and data cloud platform. It can carry out real-time environmental monitoring for large areas, upload data to the data platform in real time, and synchronously monitor the information of each node (impact, temperature, humidity, light and general ad data, etc.).

The working mode of the fixed-point direct connection monitoring system is as follows. Based on the regional coverage monitoring system, the fixed-point direct connection monitoring system removes the monitoring ability of multinode environment and retains the passive wireless impact sensor node network. Its environmental data collection mainly comes from the data collection of the main control module (impact, temperature, humidity, light, dust, general AD data, etc.). At this time, the monitoring range of fixed-point direct monitoring becomes smaller, but the data acquisition frequency increases, which is mainly applicable to scenes with high data requirements. Its design architecture is shown in Figure 5.

4. System Test and Analysis

This chapter mainly tests the environment monitoring Internet of things system, including passive wireless impact sensing module, area coverage monitoring system, and fixed-point direct connection monitoring system, tests and detects the overall function of the system, and verifies the function of the whole system.

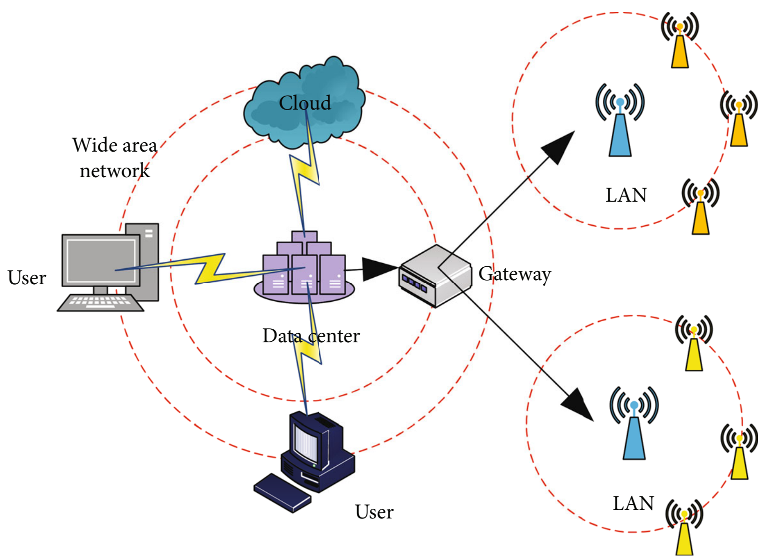


Figure 4: Schematic design architecture of regional coverage monitoring system.

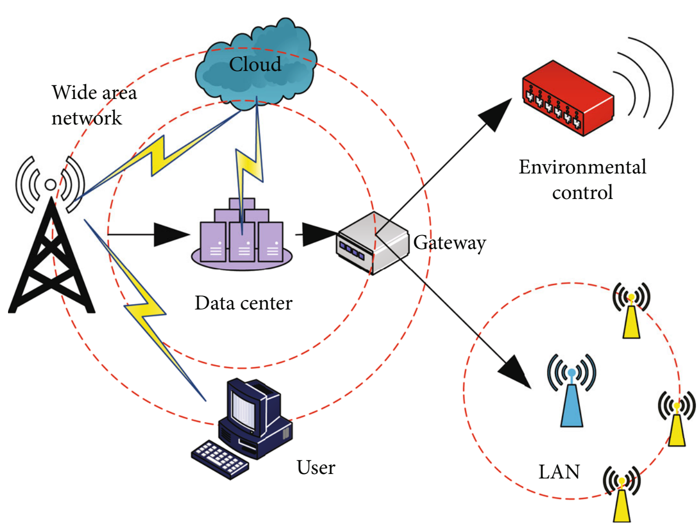


Figure 5: Overall scheme design architecture of fixed-point monitoring system.

4.1. Node Circuit Test. For the node circuit, it is necessary to test the energy storage capacitance and the operation of the control circuit. The energy storage capacitor is a 10 uF tantalum capacitor. After receiving the DC voltage converted by the impulse signal, its voltage test is shown in Figure 6. As can be seen from the figure, the maximum output voltage can reach about 7.2 V, and the voltage shows an exponential attenuation trend with time, which can realize the storage of electric energy and meet the power supply of ultralow power RF module. Since the back-end control circuit will turn on when it is above 3.2 V, the output voltage is the energy storage capacitor voltage, and the voltage of 7.2 V will burn the ultralow power RF module chip, a voltage stabilizing diode must be added at the output voltage to protect the RF chip.

Add the control circuit after the energy storage capacitor and test its output voltage, as shown in Figure 7. When the energy storage voltage of the energy storage capacitor increases from 0 V to 3.2 V, the voltage of the control circuit is 0 V; when the voltage of the energy storage capacitor is greater than 3.2 V, the voltage of the control circuit changes with the voltage of the energy storage capacitor; after that, the voltage of the control circuit will always follow the voltage of the energy storage capacitor to drop to about 1.6 V, and then turn off the output. The control time of the whole control circuit is about 40 ms, that is, the normal working time of ultralow power RF circuit; the voltage output is 1.6 V to 3.2 V, closely following the voltage change of the energy storage capacitor. The design function of the control circuit is verified.

4.2. Overall Function Test. In the overall function test, the fixed-point direct monitoring Internet of things system will be tested in the field. Through the real-time monitoring of the surrounding environment, the data of dust, temperature, humidity, and illumination of the surrounding environment

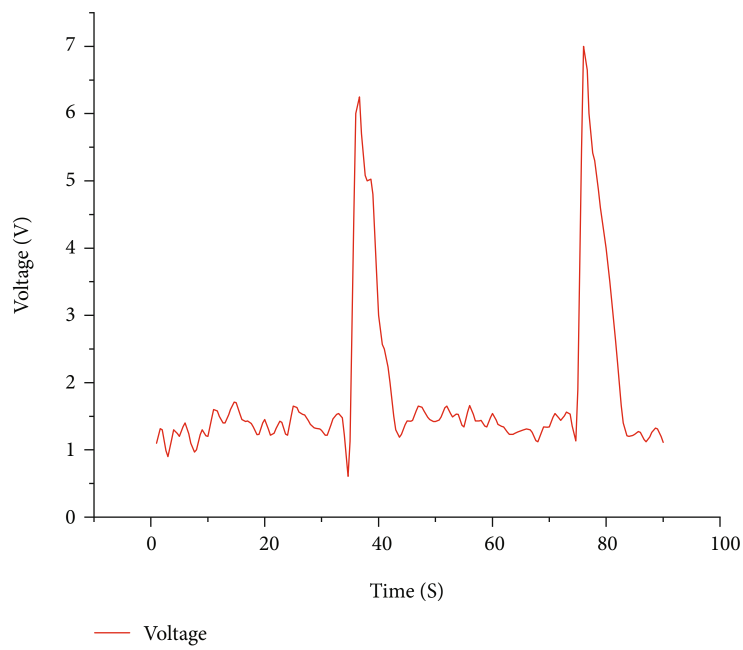


Figure 6: Voltage signal of energy storage capacitor.

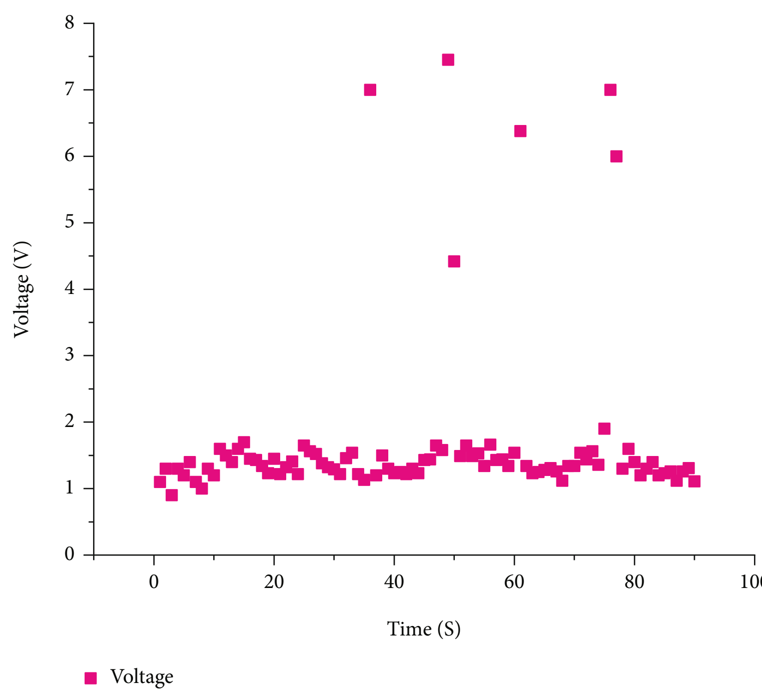
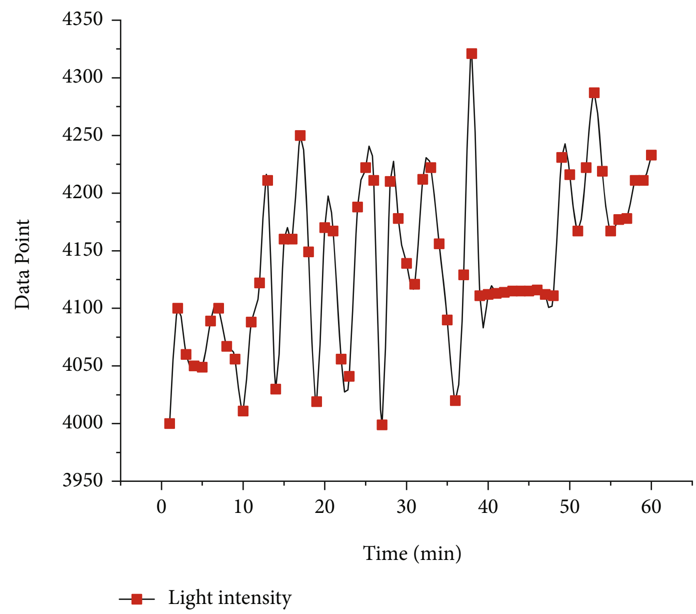


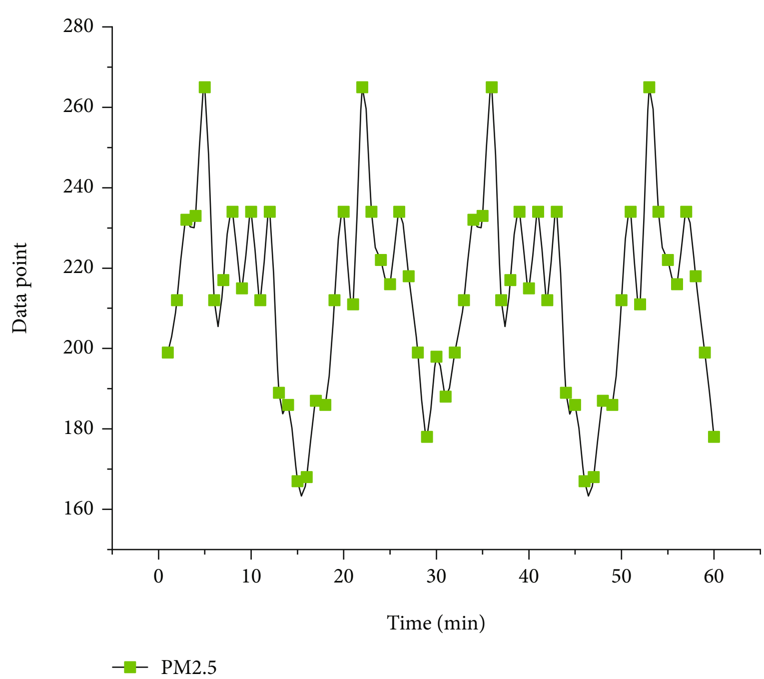
Figure 7: Voltage signal diagram of control circuit.

will be collected in real time to verify the working condition and stability of the whole system. The monitoring time is one hour, and the change curve of each environmental information is obtained, as shown in Figure 8. The system works stably, and all sensing data curves are displayed and saved in real time. At the same time, it can be seen from the data that the system can stably monitor all kinds of data information in the outfield environment.

According to the above tests, the basic functions of the whole Internet of things system have been realized, including the alarm function of passive wireless impact sensing, the cloud real-time monitoring function of environmental data, and the real-time sending function of cloud instructions. The real-time monitoring of indoor and outdoor environment has been realized under two working modes, and the task objectives set in the early stage of the whole system

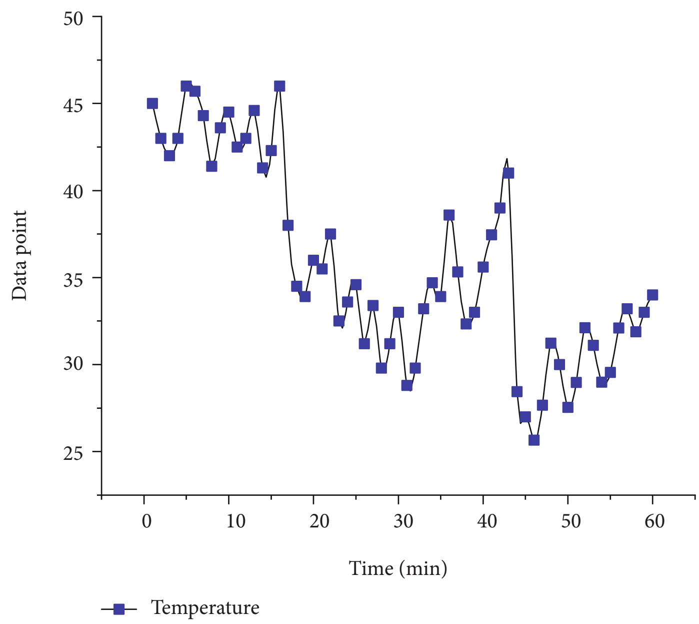


(a)



(b)

FIGURE 8: Continued.



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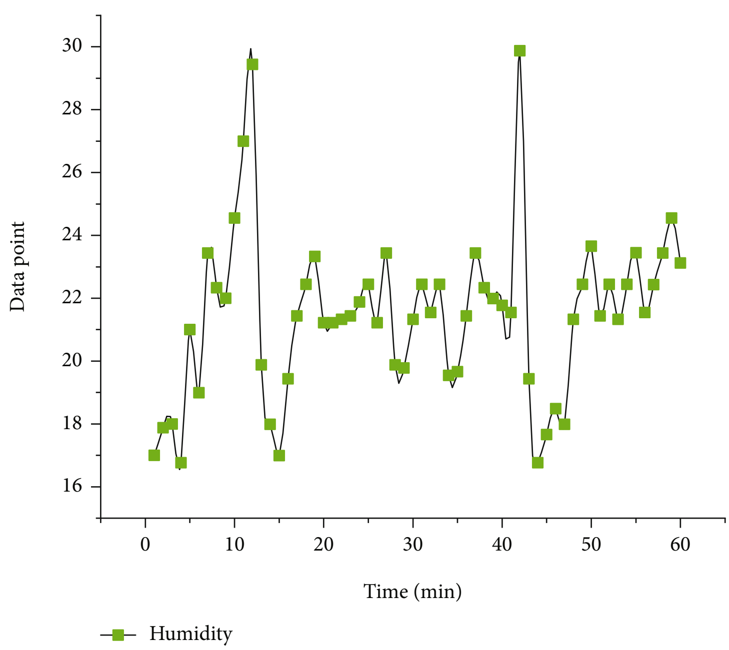

(d)

Figure 8: Environmental monitoring data curve 4.3 analysis of test results.

have been realized. The test results show that the environmental monitoring Internet of things system can realize the real-time acquisition and data transmission of passive wireless impact sensing signals, use 10 uF tantalum capacitor to store energy and complete about 20 m RF data transmission with about 42 uJ energy supply; the completed area coverage monitoring system uses five ZigBee sensor nodes and master control nodes to collect a variety of sensor data (temperature, humidity, and light) and interact with the data instructions of ONENET cloud platform, with stable operation and reliable performance; the completed fixed-point direct connection monitoring system can collect a variety of sensing data and interact with the data instructions of Alibaba cloud platform, with strong reliability and stable operation. The system achieves the expected design and functional objectives.

5. Conclusion

Internet of things technology can automatically analyze the concentration, emission, and emission speed of toxic and harmful substances in the natural environment. It can also transmit data information to the environmental monitoring and management department in real time, formulate scientific and reasonable pollution management strategies, and ensure the rapid and timely treatment of pollution problems. Wireless sensor networks are widely used in environmental monitoring. Atmospheric monitoring is mainly online monitoring or mobile monitoring. Online monitoring can realize synchronous monitoring and monitoring prediction. Comprehensively analyze the future atmospheric environment conditions, and install fixed monitoring equipment at the discharge of pollution sources to form a distributed network to comprehensively control specific pollutants. Various wireless sensor network devices can be used to collect the data of sulfur dioxide and inhalable particles of nitrogen oxides in the atmospheric environment in an all-round way and use the network to transmit the real-time data to the monitoring center to automatically analyze the environmental quality and clarify the overall effect of environmental data processing. Aiming at the environment under the background of carbon neutralization, this paper carries out the research on the technology of environmental monitoring Internet of things system, focuses on the key technologies such as multisensor terminal, local area network communication, wide area network communication, and data cloud platform, and develops a complete set of Internet of things system, which realizes the monitoring of dust, light, temperature, and real-time monitoring of humidity and other environmental parameters, and on this basis, support the scalability of the system to meet the needs of different environmental conditions. We have added relevant contents as follows: today's world is experiencing great changes that have not been seen in a century. The ecological environment is related to human survival and sustainable development, which requires the unity and cooperation of all countries to jointly meet the challenges. Carbon neutralization is a consensus reached by mankind in response to global climate change. Countries all over the world actively commit to achieving the goal of carbon neutralization. Carbon substitution, carbon emission reduction, carbon sequestration, and carbon cycle are the four main ways to realize carbon neutralization, and carbon substitution is the backbone of carbon neutralization.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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