

The Design of Intelligent Building Environment Monitoring System Based on NB-IoT

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Abstract

In recent years, with the rapid development of Internet of Things technology and computer technology, various intelligent building environment monitoring systems have emerged. This paper designs an intelligent building environment monitoring system based on NB-IoT. By intelligently managing the building environment, it provides users with a comfortable, safe and efficient working and living environment, and provides convenient and intelligent management for building managers. Means and reduce building energy and operating expenses by optimizing equipment operation and management. Through the terminal system, the Internet of Things platform and the intelligent building environment monitoring platform, real-time monitoring of building environmental parameters and remote control of equipment are realized. On the basis of fully studying the characteristics of NB-IoT technology, STM32L151C8T6 is used as the main control chip, BC95-B5 chip is the narrowband IoT communication module, DHT11 temperature and humidity acquisition module and device control module, combined with C language to complete the softness of the terminal system. Hardware development, the transmission of building environment parameters and the receipt of commands. The China Telecom Internet of Things Developer Platform was used to complete the access design and development of the Internet of Things platform. The platform realized the encoding, decoding and forwarding of data transmission between the terminal equipment and the intelligent building environment monitoring platform. The system application server was built on Huawei cloud, and the intelligent building environment monitoring platform was designed and developed by J2EE architecture. The platform uses the B/S architecture mode, and the user can access the platform using the browser of PC or smart phone. The platform mainly realizes Real-time display of building environmental parameters, equipment management, historical data viewing, alarm information display, remote control and other functions. The test environment was built to complete the functional test of the entire intelligent building environment monitoring system. The test results show that the NB-IoT-based intelligent building environment monitoring system works stably, has a simple structure and is convenient to use, basically realizes the design expectation and appears in the system test. The problem was analyzed and summarized, and the optimization of the whole system was put forward.

Keywords

Intelligent building,; NB-Io T; STM32; J2EE.

1. Introduction

In recent years, with the rapid development of economy and science and technology, people have put forward higher requirements for the safety of buildings, the comfort and convenience of working and living environments, and the energy-saving performance of energy consumption. This also makes modern buildings Moving towards the direction of intelligence,

intelligent buildings have also emerged. Intelligent building refers to the monitoring and control of the built environment through computer and information communication technology, providing people with a safe, comfortable, and convenient working and living environment, and at the same time providing building managers with efficient and intelligent management methods, and through optimization Equipment operation and management to reduce building energy consumption and operating costs.

As a key technology of intelligent buildings, building monitoring technology has also been continuously developed. The building environment monitoring system is a subsystem of the intelligent building monitoring system. It uses the building as the platform, the central monitoring and management platform as the core, and the terminal node as the perception and control layer. Environmental control The building environment monitoring system can monitor various environmental parameters in the building, such as smoke concentration, CO concentration, temperature and humidity, etc. The management platform can provide management personnel with intelligent decision-making plans by processing the collected parameters.

Buildings, as people's living and activity places, must adapt to the changes brought about by informatization, and intelligent buildings will inevitably develop in the direction of systematization and standardization. Green and environmental protection are the mainstream development direction of intelligent buildings, creating a human-centered, intelligent and efficient working and living environment. Obviously, the study of intelligent building environmental monitoring system has extremely important significance for the management of people, buildings and society.

2. Current Situation at Home and Abroad

The development of building environment monitoring system has gone through the following stages: central monitoring system, distributed control system, open step-by-step control system, network integrated building environment monitoring system and wireless building environment monitoring system. The wireless building environment monitoring system mainly replaces traditional wired transmission with various wireless transmission technologies, and uses wireless communication technology for data transmission, which is more conducive to the deployment of the system. Wireless transmission technology mainly includes Bluetooth communication, infrared remote sensing, radio frequency communication, wireless sensor network, etc.

At present, a large part of domestic building environment monitoring systems also rely on wired communication networks, such as RS485 bus, CAN bus and so on. The literature uses CAN bus communication to realize intelligent real-time monitoring of the warehouse environment. Literature adoption modularized thinking, designed three types of CAN bus intelligent sections: analog signal acquisition, digital signal acquisition and switch signal control point, industrial computer, CAN bus adapter card, smart node and various environmental factor sensors constitute the hardware part of the greenhouse field layer monitoring system. However, due to bus communication, there is still a certain degree of complexity in wiring, especially in small spaces. Wired communication network has certain advantages, such as stable signal and strong anti-interference ability. But at the same time there are more disadvantages:

- (1) The amount of engineering is large. Deploying a wired communication system inside a building requires laying a large number of cables, which will undoubtedly increase the cost, and it will increase the difficulty of deployment for a small area inside the building.
- (2) The wiring is complicated. Some buildings did not consider the intelligence of the building at the beginning of the design, did not leave a suitable wiring space, and there are many

electrical equipment inside the building, the use of wired communication is bound to be quite troublesome and affects the aesthetics.

(3) Poor scalability. After the construction of the communication line of the entire system is completed, it is necessary to lay a new line if you want to add new functional modules, which makes the system's scalability poor.

(4) Maintenance is difficult. When a certain node or line of the system has a problem, troubleshooting is complicated and difficult, which increases maintenance time and economic costs.

With the continuous development of the Internet of Things and wireless communication technology, the use of wireless communication technology to monitor the building environment has attracted more and more people's attention. Wireless communication can completely avoid the problems caused by wired communication, and is very conducive to the expansion and maintenance of system functions, and reserves space for the later upgrade and transformation of the building environment monitoring system.

When designing a building environment monitoring system, the communication range, network access mode, power consumption, security and other aspects of the system should be considered. NB-IoT is a technology provided by telecom operators for unified network access. It is a global standard communication technology that supports global roaming. Each device installed with NB-IoT communication module can be directly connected to its own or other third-party service cloud through the telecom operator network only after being authorized by the user. The large capacity of NB-IoT supports the access of a large number of devices, avoiding the problem of inaccessibility of smart devices due to the limitation of the number of access to home routers. Therefore, NB-IoT makes it possible to unify the intelligent terminal node access configuration, simplify the installation access configuration process, and effectively reduce the labor installation cost. The NB-IoT network is a dedicated IoT communication network constructed and provided by professional telecom network operators. It uses a dedicated authorized frequency band that is different from the Wi-Fi shared frequency band. At the same time, the NB-IoT technology itself has higher coverage capabilities and is relatively Compared with the existing mobile communication network, it increases 20dB coverage, which can provide better indoor coverage. It can solve network coverage problems such as scattered installation and complex installation location conditions, making it easier to achieve access and stay online for a long time. Different from the traditional perception layer, the networking structure of NB-IoT is more clear, and the perception layer nodes can directly communicate with the cell base station, thus avoiding potential security issues such as the ZigBee networking process. NB-IoT's telecommunication network is a network based on authorized spectrum, which has high security guarantee. NB-IoT provides three network modes. Terminal devices can choose different modes according to their own power consumption requirements to meet the requirements of the intelligent building environment monitoring system for energy saving and environmental protection.

Through the above comparative analysis, this article proposes to use NB-IoT technology as the wireless communication method of the intelligent building environment monitoring system.

3. NB-IoT

3.1. NB-IoT Technology

In recent years, IoT has developed rapidly, including high-rate services and low-rate services. According to incomplete statistics, low-rate services account for more than 67% of IoT services, and low-rate services currently do not have good technology to provide support. With the continuous development of the Internet of Things, the communication technology of the

Internet of Things has also been rapidly improved. Long-term evolution CAT-NB1 derived from 2G, 3G, 4G, and 4G-based evolution, also known as Narrow Band Internet of Things technology. NB-IoT is developed on the basis of LTE and has been modified according to its own characteristics. The Internet of Things will have an incomparable number of users in existing mobile communications in the future, and major telecom operators have allocated spectrum resources for NB-IoT. NB-IoT supports 3 deployment scenarios, namely independent deployment, guard band deployment and in-band deployment. The NB-IoT network is mainly composed of the following five parts: NB-IoT terminal, NB-IoT base station, NB-IoT core network, NB-IoT cloud platform and vertical industry center. Related applications supported by NB-IoT have the following characteristics: low rate, high delay, low frequency and weak mobility.

3.2. NB-IoT Communication Module

The NB-IoT communication module is the network connection unit of the intelligent building environment monitoring system, and it occupies a very important part of the entire system design. The communication module is responsible for the data transmission between the terminal equipment and the IoT cloud platform. The NB-IoT communication module uses serial communication with the STM32 core controller, and uses the CoAP protocol to communicate with the IoT platform.

The NB-IOT module has three working states by default:

(1)Connected: The module is in this state after registering to the network and can send and receive data. After a period of time without data interaction, it will enter the Idle mode, and the time can be configured.

(2)Idle: Data can be sent and received, and when receiving downlink data, it will enter the Connected state. When there is no data interaction for more than a period of time, it will enter the PSM mode, and the time can be configured. The idle state can be configured to execute DRX or e DRX mode. Among them, DRX stands for discontinuous reception mode, which has high requirements for downlink service delay; e DRX stands for extended discontinuous reception mode, which has higher requirements for downlink service delay. The message can be cached or sent immediately according to whether the device is in the dormant state.

(3)PSM: In this mode, the terminal turns off the signal transmitter and does not monitor the paging on the wireless side. Therefore, although it is still registered on the network, the signaling is unreachable, and the downlink data cannot be received, and the power is low. The duration is configured by the core network, and when there is uplink data to be transmitted or the TAU period ends, it will enter the Connected state.

4. Design of Intelligent Building Environment Monitoring Platform

4.1. The Functional Structure Design of the Monitoring Platform

According to the results of the demand analysis of the intelligent building environment monitoring platform, the platform mainly includes a real-time display module of building environment parameters, equipment management module, data receiving module, command issuing module, historical data query module, alarm information module and database module. Among them, the real-time data display module, the historical data query module, and the alarm information module belong to the query module. Through the query of the database, the results are displayed on the page in a graphical interface. The data receiving and command issuing modules both use HTTP communication to interact with the IoT platform. The intelligent building environment monitoring platform implements data reception and command issuance by calling the interface API of the IoT platform.

4.2. Development Environment Configuration

The HTTP protocol is used for communication between the IoT platform and the application server. The callback address of the application server should be the public network IP address. This system uses Huawei cloud server as the application hardware platform. The Tomcat open source server is selected as the application container. Tomcat is a Servlet container developed by the Apache Software Foundation. It implements the Servlet and JSP specifications in Java EE and also provides HTTP services. It is a very popular Java Web container on the market. Download and install the Tomcat server on the server, install the JDK and configure the environment variables. This article uses the JDK1.8 version and modify the Tomcat default listening port number to 8080.

Web application development is inseparable from the support of a powerful programming software. My Eclipse supports Java Servlet, AJAX, JSP, JSF, Struts, Spring, Hibernate, EJB3, JDBC database link tool and many other functions. Almost all the exclusive eclipse development tools for current mainstream open source products are included. After the application is developed, it needs to be deployed to the Tomcat container of the cloud server to run. Considering that the server is running under the Linux operating system, all operations are done in the DOS command window. Two softwares, Xshell and Xftp, are used to assist in application development.

Choose My SQL database to store the data received by the application server. My SQL is a relational database management system. It uses SQL language to access the database. SQL language has the characteristics of small size and fast speed, especially the open source code, which can complete the storage of various data in the application. Download the My SQL database and install it. At this point, the configuration of the development environment for Java Web applications is complete.

4.3. Design and Realization of Functional Modules

The functions of the device management module mainly include adding, viewing, modifying and deleting devices. The rapid expansion of the equipment is realized through this module. Terminal devices need to be registered on the IoT platform before they can transmit data with the IoT platform. The equipment management module can realize equipment registration through the management platform and store equipment information in the database at the same time. This article completes the device registration by calling the API interface of the registered direct-connected device of the IoT platform. Use the PUT method of the HTTPS protocol to send a request to call this interface. The PUT method is to include the request in this text and complete the device registration by calling the registered direct device API interface of the IOT platform. The data receiving module mainly realizes the receiving of data reported by the terminal equipment. The data reported by the device is forwarded to the application server for storage via the IOT platform. It mainly includes: obtaining authentication, subscribing to IoT platform business data and writing callback interface programs. The HTTP protocol is used for communication between the application server and the IoT platform. The command of the intelligent building environment monitoring platform is sent by the application server to the IoT platform, and the json format message is encoded into a binary message through the custom codec plug-in in the Internet of Things platform and assembled into a COAP message, which is then issued to the terminal device. The device executes corresponding operations after receiving the command data, thereby realizing remote control of the device.

5. Development Prospect

NB-IoT's intelligent building environment monitoring system not only improves the management efficiency of managers, but also plays a key role in meeting the various needs of

users. Moreover, compared with the many problems of traditional wireless communication, wired communication is more conducive to the expansion and maintenance of system functions, and reserves space for the later upgrade and transformation of the building environment monitoring system. On the one hand, the NB-IoT intelligent building environment monitoring system not only solves the wiring, expansion and maintenance deficiencies of traditional wired communication environment monitoring systems for data collection, on the other hand, it also solves the problems of self-organizing wireless sensor networks. Routing security issues fully demonstrate the superiority of NB-IoT communication capabilities. And in terms of using NB-IoT technology, it saves more cost, and has safety, energy saving and environmental protection. The system not only provides people with a safe, comfortable and convenient working and living environment, on the other hand, it provides low-energy consumption and low-consumption services, but also makes the management of building managers more convenient and efficient. The system also uses the Internet of Things platform to realize the unified management of various NB-IoT device data so that customers can enjoy a better NB network service performance experience. Today, as the construction of smart cities at home and abroad is accelerating, it is an indispensable trend to strengthen the construction of the NB-IoT smart building environment monitoring system.

Acknowledgments

This work was partially supported by Quzhou University Science and Technology Innovation Program for College Students (No. Q20X031).

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