Design of Embedded Terminal Data Remote Transmission Control System in Internet of Things

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Abstract. The underlying data exchange system of the Internet of Things is an integrated system for data collection and information transmission of the Internet of Things. The design method of the underlying data exchange system of the Internet of Things based on embedded is proposed. The embedded data remote acquisition system designed in this paper, the main communication control module and data acquisition and processing module are relatively independent. The embedded microcontroller AT89S52 is used to realize the main data transmission function. In the hardware design, the selection of A/D analog-to-digital converter is fully considered. A scheme of remote monitoring system based on the combination of communication network and Internet is proposed, and an embedded system based on DSP chip is further selected to design and implement the data transmission terminal of the remote monitoring system. Combined with Visual DSP++4.5 development platform, the integration processing and information processing of the Internet of Things bottom data are carried out. The VIX bus transmission foundation is adopted to realize the data exchange control of the Internet of Things bottom, and the hardware design and software development of the system are completed. The test results show that the stability of data exchange at the bottom of the Internet of Things is good and the output error rate of data exchange is low.

1. Introduction
The Internet of Things is the second industry wave of information technology after personal PC and network. It integrates traditional infrastructure with highly developed information network [1]. According to the statistical prediction of the World Association for Mobile Communications; The emergence of Internet of Things has provided new possibilities for remote data collection and processing. With the help of the Internet of Things, people can realize high reliability and high efficiency data communication [2]. The Internet of Things is divided into three parts: the bottom layer, the middle layer and the application layer. The bottom layer is the basic layer to realize the collection and transmission of the original physical data. In the Internet of Things system, effective bottom data interaction is required. It combines computer science, management science and mathematics, and uses traditional methods and principles for reference to develop the monitoring image transmission control system [3]. The current monitoring image transmission control system cannot be well designed around this principle and cannot meet the needs of modern monitoring system development. This leads to new thinking: whether embedded terminal equipment can be remotely controlled through the widely existing Internet. The remote control method mentioned in this paper came into being on the basis of this concept.
2. The Overall Scheme Design of the System

2.1 Remote Communication Technology
The public switched telephone network is mainly composed of two parts: switching system and transmission system. At present, almost all of them are digital networks. With the help of telephone lines, the microcontroller chip and the chip can be used to form a transmission interface for sending and receiving embedded data to realize the function of data transmission. The connection between field instruments and monitoring terminals adopts a many-to-one mode, and all field environment monitoring terminals share the same data center server, which is a many-to-one mode or a many-to-many mode [4]. The application mainly uses the Internet as a transmission platform, and each user can remotely control the networked embedded terminal through any networked computer and mobile phone. The microcontroller of the control end and the chip form the calling end, and the remote controlled end forms the called end by the microcontroller and the chip. The equipment remote monitoring and fault diagnosis system is actually running a series of closely cooperative equipment state monitoring and fault diagnosis systems connected through various networks to realize distributed control, resource sharing, dynamic expansion, remote scheduling, expert diagnosis and other functions [5]. The upper computer system is responsible for data collection, pretreatment and transmission, and then through the lower computer system, the data are comprehensively processed and finally fed back to the upper computer, thus realizing remote control.

2.2 Terminal Wireless Scheme
Infrared technology is a point-to-point short-range wireless data transmission method [6]. The wireless wavelength used for communication with infrared standard is within . Due to the short wavelength of infrared ray, its transmission is greatly affected by obstacles. Users can use browsers to view and modify the working status of household appliances through mobile phones, PC and other terminals, and display the user's operation results through browsers.

The hardware structure of the sensing terminal mainly includes an information acquisition and processing module and a data transmission module [7]. The information collection and processing module is mainly responsible for the collection and simple processing of data information. The data transmission module is mainly responsible for the wireless transmission of data. The hardware structure diagram of the sensing terminal is shown in Figure 1.

![Figure 1 Hardware Structure Diagram of Sensing Terminal](image)

Sending an authentication instruction to the server side via the Internet. The server side has a strict user account management system to ensure the security of user accounts. The user can check the status of the embedded terminal under the user name after logging into the server through the account. Therefore, the wireless communication equipment using infrared technology must interconnect and transmit data in a small range and in a short distance, and cannot deflect in the direction. Otherwise, the two ends of the transmission may not be able to normally establish connection or lose connection due to the absence of effective infrared signals, and the barrier shall be avoided as far as possible.
between the two points of infrared transmission [8]. An open system that takes into account the characteristics of concurrency, distribution, reliability, security, sharing, confidentiality and intelligence of the system. In the embedded environment, Internet/Intranet is used to realize the interconnection of massive database information in the Internet of Things environment, and data exchange optimization design is carried out by combining data mining and embedded control methods.

2.3 Forwarding Control Platform

The determined long-range communication scheme for Internet interconnection and terminal wireless transmission scheme need to consider the switching of signals in these two different channels, i.e. the forwarding and transmission of network data and wireless terminal data. There must be some kind of bridge between them before transmission can proceed normally [9]. The command sent by the user is encapsulated by the server end into a command recognizable by the embedded terminal. The terminal device analyzes the command according to the protocol and completes the corresponding operation, and feeds back the result to the user through the network to establish a data real-time interactive transmission platform.

Server-side network communication program: mainly uses the application program to call WinSock API to realize inter-process communication. Therefore, the data sent by the remote sensing terminal can be received and sent to the display program or stored through SQL statements. At the same time, instructions and data from the application service center can also be sent back to the sensing terminal (Figure 2).

![Figure 2 Architecture Diagram Of Application Service Center](image)

Users use special equipment (acquisition and transmission module) to monitor the status of different measuring points, obtain various signal files (including fault information), and transmit them to the application server console through the network (transmission medium) custom protocol. So as to establish a data transmission connection with it, and then the wireless main control device endpoint can obtain the data transmitted from the network and send it out through the wireless channel. This intermediate platform is very important for this wired-to-wireless and wireless-to-wired forwarding process [10]. The Linux kernel is adopted to realize the online compilation of embedded Internet of Things bottom data, and the Linux kernel file z Image is directly downloaded to the embedded control system to locate and manage the Internet of Things bottom data.

3. Modular Design and Implementation of the System

3.1 Bus Transmission Module

The bus transmission module uses a 16-bit current oscillation controller to control the transmission of the underlying data of the Internet of Things, and uses VXI bus to control the remote transmission of the underlying data. The short message service center completes the storage and forwarding functions. It is a modern communication mode with the characteristics of low charge, receiving and sending anytime and anywhere, being able to carry a variety of data, being able to implement two different working modes of push and pull, and being able to ensure the safety in transmission. The bus data transfer rate is 40Mbyte /sec, and the BMODE bit in the configuration register (SYSCR) samples the
After the 4G driver and PPP protocol are added, the corresponding script file, domain name resolution server and dial-up Internet configuration file can be selected according to the corresponding 4G standard. Because of the WCDMA network selected by this system, it will be further configured below. The flow chart is shown in Figure 3.

![Dial Script And File Configuration Flow Chart](image)

Figure 3 Dial Script And File Configuration Flow Chart

At the same time, the wireless transmission of temperature data is realized through the wireless radio frequency module in the Internet of Things. In the Internet of Things, authorized equipment can receive data through matching wireless, then transmit the data to a microprocessor for processing and store the data in a database. The maximum transmission rate of 171.2Kbit/s per user can be achieved only by adding corresponding functional entities and partially reforming the existing base station system. The server-side software is deployed on powerful servers, and the operating system adopts embedded Linux system. The software design is divided into two parts, server software and database storage, using Apache as the server software and MySQL as the database software.

### 3.2 Sensor Data Acquisition Module

The sensor data acquisition module adopts AD design to realize digital-to-analog conversion and amplification filtering of the interactive data at the bottom of the Internet of Things. The sensor module is designed in embedded ARM. The information data with a certain signal bandwidth to be transmitted is modulated by a high-speed pseudo-random code with a bandwidth much larger than the signal bandwidth, so that the bandwidth of the original data signal is expanded, and then modulated by a carrier wave and transmitted. The receiver uses exactly the same pseudo-random code to correlate with the received bandwidth signal. The database records user account information, operation information and feedback information of corresponding embedded terminals, etc., which is convenient for users to query, count and add corresponding management and control modules in the later period.

The transmission of data information of the sensing terminal is carried out through the 4G mobile communication network. After data collection is completed, the data sending thread will package the data information according to the communication protocol defined above and then send it. The information transmission flow chart is shown in Figure 4.
It uses the USBHub chip to realize the expansion of four interfaces. The expanded USB interfaces correspond to each other, and the device can be normally used in the expanded USB interface only by adding corresponding device drivers in the kernel. The main realization is the collection of the Internet of Things bottom data and the sampling of the original information, providing the original data for the Internet of Things bottom data exchange and information management system. After A/D conversion of each state quantity collected by the sensor, the compressor operation is controlled. We will use these installed sensors to collect compressor status information and remotely monitor the data source of the system, which can reduce the development cost of the whole system.

3.3 Integrated Control Module

The integrated control module is the core of the underlying data exchange system of the entire Internet of Things. ARM integrated controller and single chip microcomputer are used for AD control and clock sampling in the underlying data exchange process. The mechanisms of inter-task synchronization and communication in most real-time operating systems are: messages, events and semaphores. Some real-time operating systems still use mailbox mechanism, while others provide inter-task communication mechanism for sharing memory. Actively establish TCP connection with Network Layer of server-side software. The embedded terminal Control Layer that receives the control information sent from the server-side Network Layer and transmits it to, and transmits the feedback information of the Control Layer to the server-side Network Layer through the network. The main purpose of the terminal node is to realize data information collection and network connection, send the collected information to the network, and realize the corresponding network connection request. Because information collection is slow, data can only be uploaded once per second. Generally speaking, the memory management of the real-time operating system and the optimal allocation of
memory are all aimed at reducing the memory occupation of the whole system. The software design uses the operating system abstraction layer to manage system resources, uses polling to design the main program, and effectively implements ZigBee node joining, event handling and networking operations. The control program fills the Data field with the operation result, fills the Cmd field with the return command, and sends the protocol back to the Server. The Server returns the protocol to the requesting accessor based on the Client ID.

3.4 Output Interface Module and Upper Computer Communication Module

The output interface module uses SENSE pin to control the transmission of Internet of Things bottom data, uses double operational amplifiers LM358 to carry out communication transmission of upper computer, and 12-channel DMA to carry out integrated exchange of Internet of Things bottom data and wireless sensor networking control. Interrupt management service is a core and basic function of real-time operating system. Interrupt management of real-time operating systems has its own special requirements, that is, interrupt handlers should be short to reduce interrupt prohibition time and interrupt delay time. All fields of protocol data exist throughout the protocol transmission process, even if they are not used.

As can be seen from Figure 5, the main task of real-time video monitoring is to collect scene image data driven by a camera. After the collected data is compressed and encoded by H.264, the data will be uploaded to the application service center through the network for decoding and display.

Figure 5 Architecture Diagram Of Real-Time Video Monitoring

Radio frequency channel scanning is realized after adding the terminal node, and then the coordinator receives the joining application and judges the number of nodes until the joining node is greater than 1, which indicates successful networking. Therefore, it is necessary to transplant an operating system. In addition, embedded real-time operating system is a kind of real-time operating system specially designed for embedded system. It is the foundation and development platform of embedded application software. It is a piece of software embedded in the target processor. Other application programs of users are built on this operating system platform. After realizing the video recording of the wireless monitoring system, it is necessary to realize the compression coding of the video image. Video compression coding has many ways, in which the information location of video monitoring area can be realized and the size of video itself can be reduced, thus saving the storage space of the system.

4. Experimental Test

In order to verify the application performance of the method in realizing the underlying data exchange control of the Internet of Things, an experimental test was carried out. The experiment was carried out on the Visual DSP ++ 4.5 platform, and the underlying data processing module of the data exchange system was configured via BASE0 and BASE1. We will place the monitoring center server in a parallel position with it. The acquired ip address is the internal ip address of the enterprise assigned by DHCP server, assuming 172.18.224.202. At this time, a port mapping instruction needs to be made on the firewall, assuming the selected port is 80001, and selecting to map the 80001 port to
According to the user's login account and password, searching in the database, and initializing the user if the login is successful; Otherwise, the login request is rejected. After successful login, all login activities are logged. According to the above test environment description, the bottom data exchange of the Internet of Things is carried out in the embedded platform, and the comparison results of bit error rate are shown in Table 1. After completion, after logging into the terminal management system of the website through a browser, different download terminals can be remotely controlled and managed according to the registration information of each download terminal on the management system.

| Serial number | Traditional switching system (%) | This article exchange system (%) |
|---------------|----------------------------------|---------------------------------|
| 1             | 95                               | 45                              |
| 2             | 90                               | 37                              |
| 3             | 91                               | 31                              |

The experimental results show that the error rate of the two switching systems is much lower than that of the Internet of Things underlying data exchange in traditional switching systems, which indicates that the embedded Internet of Things underlying data exchange system proposed in this paper is feasible. In the data acquisition box are the monitored compressor operating parameters, including various temperatures and pressures. The data displayed in the data error reporting column cannot be recognized by the system due to data coding format problems, which are generally caused by network errors in communication. At present, after many times of debugging and verification, the connection between the server and the download terminal can be established, and the functions of startup, shutdown, restart and download of the download terminal can be successfully controlled, thus realizing the original plan.

To sum up, the system designed in this paper can realize the data exchange at the bottom of the Internet of Things, with low output error rate and good stability.

5. Conclusion
The Internet of Things has been widely used in the field of control, especially the low cost of embedded controllers, which further promotes its rapid development. The software development and design of the underlying data exchange system of the Internet of Things are carried out under the embedded Linux platform, and the intelligent information processing of the underlying data of the Internet of Things is carried out by combining the Visual DSP++ technology. On the basis of the operating system, the system design is simplified through task management, the software and hardware interfaces are realized through bottom-level drivers, and the system requirements are realized through various tasks of the application layer. The use of Internet of Things technology in intelligent systems provides people with a reliable, safe and comfortable home environment, which has attracted much attention from users and enterprises. Middleware such as task management and interface are adopted, thus simplifying the system software design, improving the reliability, real-time and portability of the system, providing new ideas for the software design of remote monitoring terminals, and facilitating future software upgrade and maintenance. Tests show that the embedded terminal data remote transmission control system designed in this paper has good stability, high compatibility and good application value.

References
[1] Suiyan T, Xu M A, Wenhao D, et al. (2017). Design of Rice Nursery Tray Images Wireless Transmission System Based on Embedded Machine Vision[J]. Transactions of the Chinese Society for Agricultural Machinery, 48, no. 4, pp. 22-28.
[2] Wang X, Zhang Y, Xu M, et al. (2017). Development of integrated network platform for heterogeneous agricultural information remote monitoring terminal[J]. Nongye Gongcheng Xuebao/Transactions of the Chinese Society of Agricultural Engineering, 33, no. 23, pp.
211-218.

[3] Chen C, Xu X. (2017). Design and application of traceability and supervision platform for broiler based on Internet of Things[J]. Transactions of the Chinese Society of Agricultural Engineering, 33, no. 5, pp. 224-231.

[4] Li X, Fan X, Ren H, et al. (2019). Data-Driven Feature Analysis in Control Design for Series-Compensated Transmission Systems[J]. IEEE Transactions on Power Systems, no. 99, pp. 1-1.

[5] Kuznetsov N A, Myasnikov D V, Semenikhin K V. (2017). Optimization of Two-Phase Queuing System and Its Application to the Control of Data Transmission between Two Robotic Agents[J]. Journal of Communications Technology and Electronics, 62, no. 12, pp. 1484-1498.

[6] Wu J, Li Y, Quevedo D E, et al. (2017). Improved results on transmission power control for remote state estimation[J]. Systems & Control Letters, no. 107, pp. 44-48.

[7] Perron M, Ghahremani E, Heniche A, et al. (2018). Wide-area voltage control system of flexible AC transmission system devices to prevent voltage collapse[J]. Iet Generation Transmission & Distribution, 11, no. 18, pp. 4556-4564.

[8] Stamatiou G, Bongiorno M. (2017). Power-dependent droop-based control strategy for multi-terminal HVDC transmission grids[J]. IET Generation Transmission & Distribution, 11, no. 2, pp. 383-391.

[9] Chen D, Xu D, Han M, et al. (2018). Loss Optimization Control for Hybrid Multi-terminal DC Transmission System[J]. Dianli Xitong Zidonghua/Automation of Electric Power Systems, 42, no. 10, pp. 100-105.

[10] Yongzhao L I, Dongwu R U, Zhe C, et al. (2017). Implementation method of adding the functions of alarm transmission and remote browser in working substation[J]. Power System Protection and Control, 45, no. 17, pp. 112-117.