Research on University Energy Environmental Protection Monitoring System Based on Computer Network Technology

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Abstract. The issue of campus energy and environment has become one of our increasing concerns. Environmental issues have become an important assessment index restricting the development of schools and students' self-improvement. Only the sustainable development of the environment can ensure the smooth implementation of school education. For this reason, the development of an efficient energy environment monitoring system based on computer networks is imperative. Based on this research background, the paper analyses the needs of an efficient micro-energy environment monitoring system, and discusses the functions of the monitoring system and related hardware and software. Finally, the system was tested to verify the feasibility of the system.

Keywords: Computer network technology, university energy system, energy environmental protection, monitoring system.

1. Introduction
With the continuous development of environmental science, the methods of environmental monitoring continue to be advanced, and the scope of monitoring is getting larger and larger. Environmental monitoring of universities has also become the focus of attention. Simply put, environmental monitoring in colleges and universities is the use of advanced scientific instruments to monitor the temperature, humidity and harmful substance concentrations in the environment of colleges and universities [1]. For the environmental monitoring of colleges and universities, the analysis and research are mainly carried out from the current status of domestic environmental monitoring and the current status of foreign environmental monitoring.

There are many reasons for the impact on the environmental quality of colleges and universities, such as decoration, the inflow of outdoor pollutants, the air-conditioning ventilation system is not cleaned in time, and so on. Different instruments need to be monitored for different pollutants. It is more difficult to monitor the air quality in public places. More precise instruments are needed for real-time monitoring. Research and practical methods to improve the environmental quality of colleges and universities.

2. University micro-environment monitoring system based on Internet of Things
The concept of the Internet of Things (IOT) is based on the "Internet concept", which is to extend and extend its user terminal to any item and item for data exchange and interchange. A network concepts.
As early as 1999, an expert in the United States had proposed it, which was then called a sensor network. It is defined as: through radio frequency identification (RFID), infrared sensors, global positioning systems, laser scanners and other information sensing equipment, according to the agreed protocol, any item is connected to the Internet for data exchange and interchange to achieve intelligence A network concept for identifying, locating, tracking, monitoring, and managing. To put it simply, the Internet of Things is to connect all things with the Internet through information sensing equipment, so as to exchange information, that is, the things are intertwined, to realize the intelligent identification and management of "everything". The Internet of Things technology can not only be applied to the fields of digital logistics, smart home, intelligent transportation, etc., but also widely used in environmental monitoring systems such as atmospheric monitoring, water quality monitoring, ecological monitoring, and marine monitoring. The principle is to use real-time IoT technologies to collect the concentrations, sources, and trends of toxic and harmful substances in the atmosphere, soil, and water in real time, and monitor pollution trends such as noise, light, malodour, solid waste, chemicals, and motor vehicles. Provide real-time dynamic information for environmental protection departments, supervision departments, etc., and provide powerful data protection for early detection, early prevention, and early rectification. Figure 1 shows the application of the Internet of Things in environmental monitoring.

Figure 1. Application of the Internet of Things in environmental monitoring.

3. System requirements analysis

3.1. General overview

The name of the system studied in this paper is: Miniature Environmental Monitoring Transmission Storage System. In the following, the system is summarized in terms of the technical field, application background, development background, product scope, functions, and user characteristics of the system.

3.1.1. Technical Field. The system relates to a building physical environment detection device, in particular to an intelligent control, automatic and efficient building physical environment detection system that can simultaneously detect multiple parameters such as wind environment, thermal environment, and light environment.

3.1.2. Environmental Background With the development of China's economic construction and the acceleration of urbanization. The physical environment of the building has received more and more attention from all sides. Conditions such as temperature, humidity, ventilation, lighting, and lighting not only determine the usability and comfort of the building, but also the core conditions for building evaluation [2]. Especially in recent years, the popularization and promotion of the concept of green building, the physical environment comfort as an important part of the evaluation of green buildings,
how to scientifically, efficiently and accurately measure the wind, light, heat and humidity parameters of buildings has become an urgent problem. At the same time, historically protected buildings, especially ancient buildings, are most sensitive to changes in the natural environment and are extremely vulnerable to erosion and damage. Especially in recent years, with the large-scale development of urban construction, the ecological environment of ancient buildings has also undergone huge changes, and its degree of influence on colour paintings has also increased, causing colour paintings to crack, fade, and chalk. Phenomenon [3]. How to determine the effects of natural environmental factors such as wind speed, wind pressure, light, temperature, and humidity on the colorimetry, lightness, and chroma of colour paintings is another issue that has attracted much attention.

3.1.3. Development Background This system is a new product. It was developed under the background of the development of China's economic construction, the acceleration of urbanization, and the increasing importance of the building physical environment in all aspects. With the refinement, localization and diversification of physical environment monitoring, the current system is far from meeting current needs. Therefore, according to the current business needs, Tianjin University has developed a set of new products to fill the vacancy in demand.

3.1.4. Product range. The micro-environment integration system is a 7 * 24 fully automatic micro-environment monitoring system. After deploying the host and the space location of interest, relevant users can continuously monitor a variety of physical environments in the local space, such as wind, thermal, light, humidity, and acoustic environments. This provides data support for subsequent decisions. This system greatly improves the work intensity of the data collection personnel and saves manpower, material and financial resources. What's more important is to realize 7 * 24 hours of uninterrupted monitoring, thereby overcoming the limitation of the frequency and period of blind spots in the previous manual collection.

3.1.5. Product Features. This system should realize 7 * 24 full-automatic miniature environmental monitoring tasks. This system integrates three basic functions of acquisition, transmission, and persistence, and can expand the function of providing data analysis support according to needs in the future.

3.1.6. User characteristics. This system is mainly aimed at users who need data to support decision-making, so there are relatively high requirements for the accuracy and completeness of the data. On the other hand, users have high requirements for the scalability of data types, and the system must be able to support dynamic changes of data types.

3.2. Hardware environment

The hardware environment is shown in Table 1 below. It consists of three parts. The server, host, and sensor groups are shown separately.

| NO. | Device name | Related composition description | Quantity |
|-----|-------------|---------------------------------|----------|
| 1   | Dell Blade Server | CPU: Xeon e5450 * 2 (octa-core)  
Memory: 4G * 6  
Hard Drive: Seagate 2TB  
CPU: ARM | 1 |
| 2   | Host        | Storage: 8G SD card WIFI / 3G: Network module  
ModBus industrial bus | <100 |
| 3   | sensor      | Various types of sensors | <25500 |
3.3. Software environment
Table 2 summarizes the software environment in which the system runs and its uses.

Table 2. Software operating environment

| NO. | Support software                      | use                        |
|-----|---------------------------------------|----------------------------|
| 1   | Ubuntu Server12.04                    | Server operating system    |
| 2   | RT-Thread real-time OS                | Host operating system      |
| 3   | ModBus master-slave protocol stack    | Host and sensor communication |
| 4   | JVM                                   | Server program running environment |
| 5   | Mysql5.1                              | database                   |

3.4. Communication environment
The communication task of the system is mainly concentrated on the server side and the host side. The communication requirements of the entire system design mainly include: the server and the host need to support the TCP / IP protocol stack. The server requires the entire network IP. The / 2G communication network topology is a server-centric star-structured transport layer protocol using the TCP protocol. Both the server and the host need to request a corresponding data type within the timeout period. The data type consists of machine code and text formats.

4. System functions and design analysis

4.1. System Design
The main definitions of system design include: microenvironment refers to the local environment of space, which is three-dimensional, local, and small-scale. For example, near the east and west windows of the same room, there are two different miniature environments [4]. Host: The host refers to the integration of multiple sensors, controllers, processors, and communications in this miniature environmental monitoring transmission storage system, and is placed at the location to be monitored to collect environmental data. There are usually multiple hosts and they are placed in different locations. Server: The server refers to the server used to receive the environmental data sent by the host in the micro-environment monitoring and transmission storage system. Generally, only one server is required.

Before the overall design, all aspects need to be further clarified, including the requirements of the host, server, and performance functions. 1) Host function: a) Timing data sampling: The embedded program of the host sends data requests to the sensors regularly to collect data by polling. b) Data transcoding: Different sensors have different data formats and structures, which require transcoding to be stored in the local storage. At the same time, the host also needs data transcoding when sending data to the server. c) Local persistence: The host can store the collected sensor data locally in the format after transcoding. d) Monitoring sensor group: The host can monitor the working condition and status of the sensor group in real time. e) Initiate data transmission: When the host has a network connection environment, it can initiate a data connection request to the server through the network connection. After the request is successful, the host can automatically transmit a data packet of a specific format to the server. f) Control parameter pairing table: The host updates the local parameter pairing table information according to the parameter pairing table information returned by the server. Supports multiple types of sensors, supports connection of multiple sensors at the same time, and supports hot plugging of sensors.

2) Server function: a) Listening and distributing connections: Listening for connection requests from various hosts and distributing connections. b) Identity authentication: authenticate the identity of the connected host. c) Data decoding: Decode the transcoded data from the host. d) Database persistence: The server stores the received data in a local database. e) Monitor the main control process: monitor the status of the server and the main process of the server to prevent the process from
closing unexpectedly. f) Control parameter pairing table: The server updates and synchronizes the parameter pairing table information with the host according to the request of the host.

3) Performance requirements: a) Stability, the host is exposed to outdoor environment for a long time. It takes a long time to run stably, the process does not stop unexpectedly, and a daemon can restart the main process after the process stops unexpectedly. b) Scalability: One server can connect and authenticate multiple hosts, and store data from different hosts. One host can support multiple types and a large number of sensors, and supports hot-swapping of sensors. At the same time, the system can ensure the scalability of data sensor data types. c) Security: After receiving the host request, the server needs to verify the identity of the host before data transmission. The following figure shows the related overall design of the system.

![Figure 2. Overall functional design of the system.](image)

In the top-level architecture of the system, a tree structure is formed. The server is the root node of the tree structure, and the first-level node is the host. That is, a server can connect multiple hosts. The host and the server are connected through a wireless network (2G, 3G, Wi-Fi) connection. The last layer of nodes are various types of sensors, that is, a host can insert multiple sensors, and the host and the sensor are connected via Modbus [5].

1) Sensor behaviour package: Use the C language embedded programming to implement the corresponding function of the sensor. Each sensor uses its own data collection mechanism and temporarily stores the data in the sensor module in a certain format. When the host sends a data request to the sensor, the sensor sends data to the host according to the Modbus bus protocol. The sensor and the host are hot-plugged, so that the sensor module and the host module are loosely coupled.

2) Host behaviour package: C programming is used to implement data transcoding and decoding, local persistence and other business logic. It also involves initiating a connection request to the server via the TCP / IP protocol.

3) Server behaviour package: The server is implemented using java + MySQL, which mainly communicates with the host through TCP / IP protocol and stores the received data in the database. The implementation of wireless network connection also implements the host module and server module loose coupling.

4.2. System functions
The system structure diagram is shown in Fig. 3, which illustrates that this micro-environment monitoring transmission storage system is mainly composed of three parts. The first part is the most basic part, which is a variety of sensors, mainly including light sensors, temperature sensors, humidity sensors, etc. These sensors are connected to the Host through an interface. A Host can connect
multiple multi-type sensors. The sensors are responsible for collecting various data in the environment. The Host is responsible for obtaining data from the sensors at a specified period, and encapsulating them into a complete and unified record in a pre-constrained format. The server is mainly responsible for communicating with all other hosts, obtaining the data records obtained by each host, performing proper check and integration, and finally persisting the data.

The other main part of the system is the communication between the host and the server. For security reasons, the system sets the host to actively request to connect to the server, and the server performs a simple verification check on the host. After the verification is passed, the server and the host can transmit instruction and data records according to the agreed standards [6].

The overall state diagram of the system shows that the server and the host are started manually. After the server is started, it listens to the host and actively establishes a connection by shaking hands with the host. The host needs to manually insert the sensor and then enter the data acquisition state. After collecting the data, the host first performs a data persistence work locally, and then transmits it to the server through the previously established connection. Data persistence on the server.

![Figure 3. Timing data sampling and local persistence state diagram.](image)

After the server is started, it first enters the suspended state for timing. When the specified time is reached, the timer is triggered and the host starts detecting the inserted sensor. If a sensor is detected, then reading data from the sensor is started. If no sensor is detected, the default data is supplemented and the operation is continued (error processing should be performed on this link in subsequent system design). After obtaining the read data, format the data. If the formatted data fails, the sensor detection fails, and the next sensor detection needs to be continued. The process of formatting data is a unified format for the data from different sensors. If the formatting is successful, you need to write to the file. The write needs to be exclusive to this file. Use mutex to lock this file. After the lock is successful, the file is in the write state. Then enter the tail detection state. The reason for tail status detection is that the data written by the sensor may sometimes be incomplete, so it is necessary to perform status detection on the end data [7]. Specify a trailing string as the trailing string for tail debugging. Only after the tail is debugged can the writing actually take place. Otherwise, the data written is completely wrong. Then write the data. Due to the file system used, there is a limit to the size of a single file, so when a file is full, a new file needs to be opened for writing. When the writing is completed, the current data acquisition and local persistence of this sensor are completed, and the next sensor detection and data acquisition are required. If the currently inserted sensors have been detected and data acquisition has been performed, the host enters a suspended state and waits for the timer to trigger the next cycle.
5. Conclusion
This paper systematically analyses and establishes the functional and non-functional requirements of university environmental monitoring systems. Unlike traditional monitoring systems, this system aims to refine, localize and diversify physical environment monitoring. Specifically, the micro-environment monitoring system aims to achieve 7 * 24 full-automatic micro-environment monitoring tasks, and integrates three basic functions of acquisition, transmission, storage (persistence), and can analyse data in the future to better the system serves the actual life of human beings.

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