

Application of Power and Environmental Monitoring System in Intelligent Data Center Construction: Postprint

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Abstract

Power and environmental monitoring systems play a crucial role in the intelligent construction of data centers. In newly constructed facilities, these systems enable intelligent monitoring of air conditioning systems, power distribution systems, environmental conditions, and fire suppression systems, transmitting real-time alarm signals upon detecting failures. For legacy data centers, intelligent monitoring of power and environmental systems can also be implemented through retrofitting.

Full Text

Application of Power and Environment Monitoring Systems in the Intelligent Construction of Computer Rooms

Abstract: Power and environment monitoring systems play a crucial role in the intelligent construction of computer rooms. In newly built facilities, these systems enable intelligent monitoring of air conditioning, power supply, room environment, and fire protection systems, sending real-time alarm signals when faults occur. In older facilities, intelligent monitoring of power and environment systems can also be achieved through retrofitting and upgrades.

Keywords: power and environment; monitoring; intelligent; alarm

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With advances in technology and the continuous development of intelligent software and hardware, intelligent applications have become increasingly

widespread. Intelligent management of computer rooms has grown in importance within the design and construction of smart facilities. An intelligent computer room not only enables intelligent management of servers and network switches but also implements intelligent monitoring and management of systems such as air conditioning and power supply. Currently, most newly constructed computer rooms can achieve the aforementioned intelligent management capabilities; however, many older facilities still lack adequate intelligent management for air conditioning and power systems, requiring retrofitting and the installation of intelligent devices to enable smart monitoring and management.

The power and environment monitoring system introduced in this paper can be applied not only in newly built computer rooms to enable real-time monitoring of equipment operating status for air conditioning and power systems but also in older facilities to monitor these same systems, thereby upgrading management capabilities, improving intelligence, and reducing operational costs.

1. Composition of the Power and Environment Monitoring System

The power and environment monitoring system collects signals from various acquisition devices and monitors equipment operating status through signal variations. The collected signals are diverse, including equipment run/stop status, whether voltage and current parameters fall within reasonable ranges, and the presence or absence of monitoring levels. By acquiring these signals, the system monitors equipment operating status and issues alarm notifications to relevant management personnel when faults occur, enabling timely and effective responses that minimize the impact of equipment failures.

[Figure 1: see original paper]

As shown in Figure 1, the power and environment monitoring system consists of eight main components. The water leakage monitoring system detects whether air conditioning systems leak during operation. Sensors collect leakage signals and transmit them through transmission equipment to the server, enabling monitoring of air conditioning system leakage. Sensors can be fixed single-point, regional linear, or regional multi-point types. When leakage occurs, the sensor generates a closed-circuit signal that is transmitted to the server, triggering an alarm.

The UPS (Uninterruptible Power Supply) monitoring system acquires signals from UPS battery banks and their associated switchgear within the computer room. The main parameters transmitted to the server include voltage, current, and load data, enabling monitoring of UPS system operating status. The fire detection system monitors the status of the fire protection system main unit, smoke and temperature sensors, and gas extinguishing devices within the computer room. By collecting the operating status of the fire protection system main unit, the system determines the operational status of fire protection facilities. When any sensor triggers an alarm, the system issues a warning.

The air conditioning monitoring system monitors the operating status of air conditioning units and their associated external fans through signal monitoring modules within the computer room air conditioners. Key parameters include air conditioning run/stop status, temperature and humidity data, and external fan run/stop status. The temperature and humidity monitoring system detects temperature and humidity data throughout the computer room using temperature and humidity sensors. When detected values exceed preset reasonable ranges, the system issues an alarm.

The power monitoring system monitors the status of utility power connected to the computer room by sampling and converting each phase of the three-phase power supply. Changes in voltage and current parameters for each phase enable monitoring of utility power operating status. Finally, the server aggregates all collected data for storage and runs monitoring software to visually represent data changes from various sensors and monitoring modules in real time, meeting comprehensive computer room environment monitoring requirements.

2. Composition of the Configuration Software

The software system comprises configuration software and application software. The main components of the configuration software are shown in Figure 2.

[Figure 2: see original paper]

As illustrated in Figure 2, the configuration software consists of seven components: service management, database configuration, device management, network management, video management, port management, and alarm configuration.

Service management primarily configures program installation and uninstallation, software installation paths, server IP addresses, transmission and reception port numbers, and packet data sizes. Database configuration sets parameters including database IP address, server name, username and password, port number, maximum and minimum connection quantities, and retention periods for normal and alarm records in the alarm log configuration.

Device management defines the data transmitted through each COM port in server communications, specifying which ports carry temperature and humidity data, UPS data, air conditioning data, fire protection data, and power monitoring data from acquisition devices to the server for further processing. Additionally, output signals such as SMS, telephone, and voice alarms are also configured here. Network management monitors network connectivity by configuring IP address parameters for the network in use, issuing alarm signals when network interruptions or other faults occur. Video management remotely accesses surveillance camera feeds by configuring the IP address and port number of the video monitoring host. Port management configures parameters for communication transmission serial ports, including port numbers, baud rates, data bits, parity bits, and stop bits.

3. Alarm Configuration

Alarm configuration includes the settings shown in the lower portion of Figure 2. The SMS configuration utilizes an SMS alarm module with a functional mobile SIM card installed. Mobile numbers for receiving alarm messages are added to a directory. When a fault alarm occurs, the system sequentially sends alarm SMS messages to these numbers, and sends alarm clearance messages when the fault is resolved.

The telephone configuration uses a telephone module connected to a telephone line with an assigned number for making calls. When an alarm occurs, the system dials designated numbers to broadcast alarm voice messages. Unless the alarm is cleared, the system continues dialing at fixed intervals until the receiving party enters a confirmation password. The email configuration sets sender and recipient email information, sending alarm messages as emails to designated addresses when alerts occur, provided the server has internet connectivity.

Voice configuration sets parameters including volume, speed, playback count, and playback interval. When alarms occur, the system broadcasts voice alarm messages through audio equipment connected to the server voice input, or through client software running on terminals within the same network segment with connected audio devices, enabling remote alarm notification. Sound and light alarms, similar to those in fire protection systems, configure parameters such as alarm duration and trigger connected sound and light alarms to issue alerts.

Self-test configuration enables the system to automatically test added alarm modules (SMS, telephone, voice, etc.) at specified times to ensure normal operation. When self-tests detect non-functional modules, the system issues alarm signals.

4. Composition of the Application Software

The application software primarily includes six components: UPS operating status, power operating status, computer room environment status, air conditioning operating status, fire protection system status, and an alarm display window.

The UPS operating status module establishes signal connections between UPS switchgear connected to UPS battery banks and the server via signal transmission lines. The software interface then displays UPS operating parameters such as voltage, current, and load in real time. By setting reasonable parameter operating ranges, the system issues alarms when parameters fall outside these ranges due to faults or other reasons.

The power operating status module operates similarly. A power detector installed at the utility power supply location transmits detected signals via signal lines to the server, which converts and displays parameters for each phase of the three-phase power supply—including voltage, current, and power—on the

software interface. When utility power supply faults occur, the system issues alarms.

The computer room environment status module transmits signals from temperature and humidity sensors installed at the center of the computer room to the server, which processes and displays temperature and humidity information on the software interface in real time. When temperature or humidity exceeds preset reasonable ranges, the system issues alarms.

The air conditioning operating status module transmits air conditioning operating parameters—including temperature, humidity, power status, compressor pressure, fan status, and filter status—to the server via signal lines, displaying them on the software interface. When any parameter falls outside the configured normal operating range, the system issues an alarm. Computer room air conditioning systems typically operate in primary-backup configurations. When the primary unit stops due to a fault and the backup unit automatically starts, the system issues alarms indicating primary unit shutdown and backup unit activation.

The fire protection system status module displays fire system operating status on the software interface through signal line transmission, issuing alarms when fire alarms occur. The alarm display window shows all alarm information, including water leakage monitoring, along with alarm occurrence times and summary causes. When the system returns to normal, this is also displayed in the alarm window, which can also serve as a means to query historical alarm records.

5. System Limitations

The power and environment monitoring system is sensitive to its surrounding environment, which can result in false alarms during operation. However, for computer room management, it is preferable to have false alarms rather than missed alarms to ensure real-time monitoring of safe computer room operation. For alarm delivery via SMS or telephone, it is necessary to regularly check whether numbers have sufficient credit and recharge promptly to ensure signal availability. For email-based alarms, it is essential to ensure the server maintains continuous internet connectivity.

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Note: Figure translations are in progress. See original paper for figures.

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