

Design and Implementation of an Operation Monitoring and Management System for Broadcasting and Television Station Equipment Rooms: Postprint

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Date: 2023-10-08T00:00:00+00:00

Abstract

To better monitor and manage data center equipment, three-dimensional visual modeling was performed for the data center room and all equipment and cables within it, information such as network, power, environment, and equipment data of the room was collected, and an operation monitoring and management system for the data center was designed and implemented utilizing technologies such as three-dimensional virtual-real integration and intelligent management and control.

Full Text

Design and Implementation of a Monitoring and Management System for Broadcast Television Station Machine Rooms

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Abstract: To better monitor and manage machine room equipment, this paper designs and implements a machine room operation monitoring and management system that performs 3D visual modeling of data center machine rooms and all equipment and cables therein, collects information such as network, power, environment, and equipment data, and utilizes technologies including 3D virtual-real linkage and intelligent control.

Keywords: machine room management; machine room monitoring; 3D visualization; virtual-real linkage

CLC number: TN94

Document code: A

Article ID: 1671-0134(2017)07-079-03

DOI: 10.19483/j.cnki.11-4653/n.2017.07.025

1.2 Cable Distribution and Routing Visualization Management

Data center machine rooms contain diverse and complex equipment types, requiring accurate fault location, rapid response, and timely detection. Real-time understanding of data center environmental control, equipment operation and maintenance, cable connectivity status, and power energy consumption is of significant importance for machine room operations. Traditional equipment operation and maintenance models suffer from low efficiency and poor data correlation when dealing with large numbers of devices and complex maintenance environments, making rapid event location and effective resource scheduling impossible. The machine room operation monitoring and management system designed and implemented in this paper utilizes 3D simulation and virtual-real linkage technologies to perform real-time modeling, monitoring, and management of over 20 business and technical systems, thousands of devices, and more than 10,000 cables in the machine room. All monitorable and manageable cables are modeled in 3D simulation using a 1:1 real coordinate system, including optical fibers, network cables, power cables, control lines, and audio/video signal lines. These can be managed by layers according to machine room network and power pipeline configurations, making concealed wiring visible. The system supports rapid location and attribute display of network and power connections within the machine room scenario. When equipment or cables trigger alarms, the corresponding cables are highlighted in red within the machine room scene, with relevant icon information displayed.

1.3 Visualization Monitoring and Management of Operational Status

Based on the actual physical connections of equipment, the system aggregates, verifies, and processes temperature and humidity information, power monitoring data, network supervision information, and server supervision information. Using the 3D machine room model as a foundation, it enables comprehensive monitoring, management, and alarming of environmental monitoring information, network supervision information, and network security information collected from the machine room, combined with dynamic data icons, statistical charts, and alarm information for visual management. The 3D machine room model features functions including machine room roaming, viewpoint management, equipment deployment, annotation management, dynamic charts, and alarm linkage.

1.4 System Management

The system should provide various system management functions, primarily including user management, equipment management, linkage management, per-

mission management, and log management.

2. System Design and Implementation

2.1 Overall System Architecture Design

The machine room operation monitoring and management system achieves 3D visualization of equipment within the machine room through modeling of the machine room and all internal equipment, integrated through a virtual-real linkage 3D simulation driver engine. Combined with collected machine room temperature and humidity information, power monitoring data, network supervision information, and server supervision information, it completes monitoring and management of machine room operational status. The overall system architecture is shown in Figure 1 [Figure 1: see original paper].

The system platform consists primarily of a four-layer architecture:

Access Layer: The access layer comprises modules such as a shared synchronization database and customized interconnection interfaces, providing functions for data collection, control, and management of machine room equipment or various business and technical systems.

Support Layer: Based on aggregated data extracted, filtered, and organized from secondary business databases, the support layer provides foundational support for platform applications through adaptive access.

Management Layer: The management layer implements system functions, primarily including equipment and cable management, real-time alarming, linkage strategies, 3D simulation display, intelligent centralized supervision, and statistical analysis. To achieve these application functions, the system must also provide system-level functions such as a data processing engine, rule engine, and system management.

Presentation Layer: All application functions are accessed, queried, managed, and controlled through a 3D interface and intelligent human-computer interaction management console. The presentation layer serves as the interaction interface between administrators and the system, characterized by being user-friendly, intelligent, and concise.

Through the construction of a 3D integrated platform, the system achieves panoramic display and roaming of machine room layout, alarm points, and related equipment in 3D space. It integrates machine room equipment management, real-time alarming, and information display data to build a linkage mechanism for real-time monitoring and alarm processing. Upon receiving alarm signals from various systems, it can immediately display spatial information of the alarm area and push real-time information to relevant personnel through the existing SMS platform.

2.2.1 Machine Room and Equipment Modeling

The system completes modeling of the machine room and all equipment within it, with all model parameters consistent with real equipment. Based on a unified coordinate system (including 3D spatial coordinates, time coordinates, and system equipment tree coordinates), it enables intuitive management of the entire system and supports 3D deployment and simulation display for event handling and early warning issuance.

Machine Room and Cabinet Models: Based on machine room CAD architectural drawings and actual photos, the system performs 1:1 real coordinate system 3D simulation modeling of the machine room. All equipment cabinets and power cabinets are modeled in 3D simulation using a 1:1 real coordinate system, including over 100 equipment cabinets and more than ten power column head cabinets and distribution cabinets.

Cabinet Equipment Models: All cabinet equipment in the machine room is modeled in 3D simulation using a 1:1 real coordinate system, including centralized storage equipment, core network devices, security equipment, core database equipment, and servers for various business systems.

Environmental Configuration Equipment Models: All environmental configuration equipment in the machine room is modeled in 3D simulation using a 1:1 real coordinate system, including precision air conditioners and machine room configuration monitoring equipment.

2.2.2 Cable Distribution and Routing Visualization Management

All monitorable and manageable cables in the machine room are modeled in 3D simulation using a 1:1 real coordinate system, including optical fibers, network cables, power cables, control lines, and audio/video signal lines. These can be managed by layers according to machine room network and power pipeline configurations, making concealed wiring visible. The system supports rapid location and attribute display of network and power connections within the machine room scenario, enabling alarm linkage for equipment and cables.

2.3.1 Network Management System Data Acquisition

The system establishes a protocol interface with existing network management system data to monitor parameters of machine room routers, switches, and exchange equipment. Collected data includes alarm data, service provisioning data, performance data, and diagnostic test data.

2.3.2 Machine Room Power Integrated Management Data Acquisition

The system completes data protocol interfaces for intelligent power meter equipment to receive, process, and display real-time power parameter data and alarm data. For over ten machine room cabinet columns, one multi-function intelligent digital power meter is installed in each A and B column head cabinet to

monitor power parameters of each cabinet in real time. It establishes a data exchange interface with the machine room power monitoring system to collect power equipment data. The system monitors the overall power supply situation of the machine room and the detailed power supply status of each cabinet in real time, with real-time power data including current, voltage, power factor, and frequency. It also features multi-level power consumption measurement, including power consumption in kilowatt-hours for each cabinet. The system collects monitoring information from UPS, column head cabinets, precision air conditioners, and other equipment, and integrates this information with the system.

2.3.3 Server Operational Status Monitoring Data Acquisition

The system completes reception, processing, and display of real-time server data and alarm data. It monitors the operational status of machine room application servers, database servers, and storage servers in real time, including response time, connectivity rate, CPU utilization, memory utilization, disk utilization, and hardware status.

2.3.4 Machine Room Environment Monitoring Data Acquisition

The system collects machine room environmental monitoring data and establishes machine room environmental resource information and sensor real-time data (temperature and humidity). It can push real-time data for machine room temperature and humidity, cold aisles, and micro-environment conditions.

2.3.5 Integration of Technical and Business Systems

The system completes interface protocols with existing technical and business systems such as network security, storage, and database systems to enable real-time association and retrieval.

2.4 Design of Operational Status Visualization Monitoring and Management

Based on the 3D machine room model, the system combines dynamic data icons, statistical charts, and alarm information for visual management of the machine room. The machine room modeling scenario features functions including machine room roaming, viewpoint management, equipment deployment, annotation management, dynamic charts, and alarm linkage. The scenario displays corresponding connections and parameters according to the actual installation positions of equipment. Based on actual physical connections of equipment, the system aggregates and processes temperature and humidity information, power monitoring data, network supervision information, and server supervision information. When the system receives an alarm, the machine room scene can automatically locate the alarm point position and prominently identify it in the scene to alert maintenance personnel to attend to and handle the alarm event.

The specific system architecture is shown in Figure 2 [Figure 2: see original paper].

2.5 System Development and Implementation

The system was developed and implemented under the Windows operating system. The tools and software used are listed below.

Java/JEE Core Components: Stripes, Spring, MyBatis

UI Scripts: JQuery, ECharts, Bootstrap

CSS Style Components: JQuery-validation

Server Middleware: Tomcat 6, Oracle Jdk 6

Webservice/Interface API: Apache CXF/Servlet

Utility Components: EhCache, Quartz, Xstream, Jcaptcha, Log4J

3. Conclusion

The machine room operation monitoring and management system has been applied in data center machine rooms. By visualizing the operational status of data center machine room equipment and performing operation and maintenance data collection and processing, the system achieves alarm linkage, significantly improving the work quality and efficiency of maintenance personnel while effectively reducing the workload of duty and inspection personnel. The system has played an important role in daily operations and during critical security periods.

References

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

Source: ChinaXiv — Machine translation. Verify with original.