Display Application of Risk Control of Power Grid Operation Based on VR/AR Technology

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Abstract: With the improvement of the current demand for power supply quality, the number of equipment to be maintained in the power network is increasing. However, in recent years, the repeated safety accidents have highlighted the importance of power network risk control. It is an innovative measure of power grid risk control to let operators truly feel the risks of power grid operation and maintenance through display. Visualization technology is widely used because of its interactive nature, and it also has application in the display system of power grid operation risk control in recent years; but the original 2D virtual experiment teaching system has such shortages as colorless test effect, unitary man-machine interactive way, unintelligent system and so on; therefore, this paper puts forward the application of VR/AR technology, introducing efficient Unity3D game engine and innovating display applications, to provide a reference for power grid operation risk control display.

1. Design of Augmented Reality System in Power Grid Operation and Maintenance

1.1. Design principles

Principle of emphasizing knowledge and skills. Knowledge is of great significance to improve the quality of trainees; system operation data, equipment information and working principle are more directly and clearly displayed, which can provide fast and accurate equipment information for front-line operation and maintenance personnel [1], providing strong support for normal operation of business system, so as to improve operation efficiency and to reduce the incidence of human error.

Principle of emphasizing standards and specification. The specification in power system, such as Electricity Safety Regulation is summed up with the blood; the system should be designed according to the code of the electric power industry, to ensure that the staff work in accordance with the specifications set by the system, to avoid the possibility of danger in work, so as to ensure the safety of personnel and to reduce the loss [2].

Principle of emphasizing simplicity and ease of use. Most users of the system are not very proficient in computers, and due to the great number of tasks, the system needs to be easy to use, friendly in interface, direct and convenient, making the system more convenient and efficient to use.

1.2. System framework

Based on the idea of mobile augmented reality technology, this system realizes four functions. First is recognition system. In order to realize function of finding out the object in the real world, in the serve huge amounts of data related to operation are stored and the model is established; when the intelligent terminals submit real scene pictures, the server get the image data matching the information feedback to the user after analyzing these complex images through the extraction of characteristic value[3]. Second is target tracking and positioning; it can meet users' demands for real-time monitoring of the current scene, and assist the registration of virtual information by using the accurate scene and object orientation and location information of various detection data. Third is

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virtual information registration; it is to superimpose text, video, audio, image and other virtual information into the matched real scene to ensure the spatial geometric consistency between the real scene and virtual auxiliary information [4]. Fourth is the rendering of virtual information, which is based on the real scene. The real scene after superimposing virtual information is transmitted to the intelligent terminal, so that users' perception of the real world scene information is strengthened.

1.3. Functional framework

The display system should be real-time, fast, highly available, safe and easy to maintain. It makes work guidance by identifying and judging the running condition, so that operation and maintenance personnel can intuitively understand the running condition at that time. This platform adopts A/S approach in software framework [5]. In order to reduce data processing time, the mobile end and the server end are used to process information data together, and the calculated results of the server end are fed back to the mobile end display through wireless network. The functional structure of this system is divided into two parts: mobile terminal and server terminal. Mobile terminal is the mobile terminal APP application software with android as the operating system, and server terminal is the application service with X86 server as the hardware carrier. Develop mobile terminal APP and corresponding service terminal to realize three advanced functions of equipment identification, holographic display of equipment data, and procedural operation support (operation guidance).

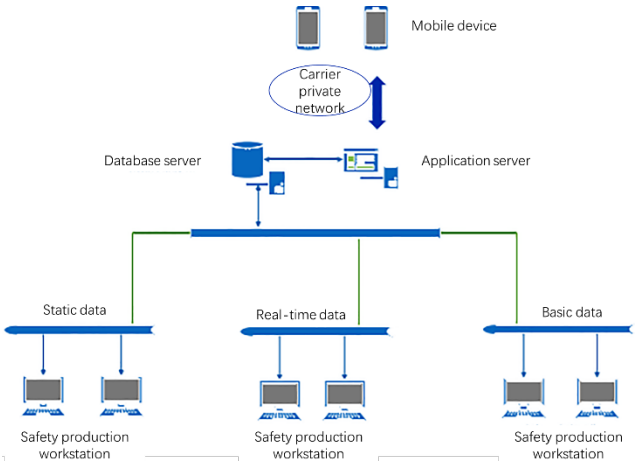

Figure 1: Figure of system framework

2. Model of Holographic Data Display of Equipment State

2.1. Functional overview

Various data on protection and switch quantity for electrical equipment (remote communication), including all kinds of remote communication values, such data as protection fault, protective action, reclosing action and switch abnormity, and equipment running status (remote sensing), also including all kinds of electric parameters data (active value, inactive value, three phase current), as well as the equipment parameter and component parameter information. Establish a unified, coordinated equipment status holographic data display model.

2.2. Data content

The holographic data model contains four contents: first, equipment level account information is the basis of all accounts. For example: according to the technical requirements of equipment technical reform and overhaul, some equipment does not meet the needs of safe operation and needs to be reformed. Certain equipment must be replaced and overhauled if it reaches the specified operating period. All these need accurate equipment account as the basis of equipment overhaul. Second, the component and part-level ledger information refers to the component information of circuit breaker, main transformer, isolation switch and other primary equipment. When the

equipment fails to operate normally, it may be because of a problem with a part, which needs to be repaired or replaced. In this case, the ledger information of this part is needed. Third, real-time production data are acquired in SCADA system [6], mainly collecting two types of data: remote communication and remote metering. Remote communication, namely, state quantity, is to collect the position signal of circuit breaker, the position signal of disconnecting switch and the protection signal to upload to the monitoring background. Fourth, the equipment parameter information is the detailed parameter of the equipment, which is the material support of professional skill training. Operation, maintenance and repair personnel know the detailed parameters of the equipment to help employees better understand the equipment and understand the working principle. When employees encounter problems in work, they can find corresponding information immediately through the superposition of virtual information, provide reference information, give play to their subjective initiative, reduce the time to search for data when returning to the data storage point, and carry out operation and maintenance according to the data.

3. System Server Database Design

3.1. Data processing cycle

This platform adopts the data mining technology to collect the operation data of network equipment (routers, switches, etc.), business system server, database and other system, to store in the database, which are real-time data without processing, then it conducts filtering, consolidation and compression of the collected data, and writes to a database of information processing. This project divides the data processing process into two sequential parts: information basic database and information processing database. Information basic database stores real-time data and provides real-time query service. Information processing database is the storage of historical data and the mining and analysis of past data.

3.2. Data collection and transmission

The distributed data acquisition system designed by this system adopts asynchronous and parallel acquisition method, which can synchronously collect data from various kinds of information. The problem is that the data collection interval is very short, which leads to a large amount of basic data collection; thus, the requirements for the database are relatively high. Unstructured data mainly includes document files, audio and video files, office files and so on. For the needs of internal and external network exchange of unstructured data, the platform mainly provides cache servers to conduct unstructured data exchange by means of file synchronization. Structured data support database types mainly include Oracle, MS SQL, MySQL. To meet the demand of structured data exchange on internal and external network, the platform mainly provides cache server to conduct structured data exchange in a way of database synchronization.

3.3. Application server

Application servers implement business logic layer functions. With the Windows operating system, the application server can be distributed, so that the load is averaged on multiple servers, to improve the efficiency of the server. At the same time, the service of business logic layer can be given to Java framework, so that the state averaging and the request and response businesses that assist decision-making are completed in the business logic layer, making load balancing possible.

3.4. Script design

Scripts are designed based on business flow. Script design is mainly divided into three parts: first is to analyze operation task and to guide work, including risk display of electric grid operation and maintenance, where the system breaks down all the work steps and gathers the image of each step, to design words or pictures or video information in work instruction; each step of the design is in accordance with relevant provisions of the relevant procedures; the superposition of all these virtual information and real working environment has the effect of guiding operation. Second is to detect whether the working steps are implemented. After the completion of each step of the work, it is

necessary to confirm whether the operation is standard and conforms to the requirements specified in the regulations. For patrol tasks of equipment, collect data and pictures under normal operation state of equipment. When staff go to patrol in substation, collect real-time operation parameters or position indicator on the appearance or equipment, to compare with data in database, to judge whether the equipment is in normal state. Third is to read data; equipment operating data are shown in the background computer; after the operation personnel enter the equipment area, they will not be able to get equipment information data; after we use the technology of augmented reality, the appropriate equipment, including static data and dynamic data, can be got through database query after the camera gains equipment image; static data is equipment stand-book information obtained from the PMS system [7], and dynamic data is information of remote metering and remote communication, obtained from the SCADA system.

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