Research on the application key technology of AR technology in power simulation training

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Abstract. AR virtual simulation technology is a comprehensive technology that integrates into multiple disciplines. It uses special intelligent equipment and computers as tools to dynamically analyze actual assumptions with the help of system models. Combining virtual simulation technology with power skills training is helpful to mobilize people's senses and mind, improve learning ability, help power inspection personnel to quickly accept knowledge, and improve the efficiency of knowledge application. This paper combining with the key AR technology analyzes the power professional skills training and AR virtual simulation technology from three aspects of interaction, display and positioning, and explores the application of AR technology in power plant operations by analyzing the virtual technology simulating the operation process of workers means for worker training.

Keywords: AR technology; virtual simulation; training guidance

1 Introduction

The development of electric power enterprises has been unable to adapt to the current social development situation and training needs according to the previous personnel structure system, the planning is unreasonable, and it is difficult to play the actual effect. Such as artificial expansion of team personnel, incoordination of personnel, and in coordination between team management and team interests, and relying on traditional power inspection methods, which are time-consuming and labor-intensive, and reduce the operation and maintenance efficiency of enterprises [1, 2]. At present, power companies divide the power plant maintenance personnel into three parts according to the step-by-step distribution method, one is the basic employees; the second is the core team members; the third is the team leaders. This paper focuses on the application of technology, analyzes basic employees and core technical personnel, and further improves the professional ability of personnel through virtual training guidance, determines training content according to differentiated standards, and optimizes training management methods [3].

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2 Analysis Of Key Technical Points For AR

The key AR technology involves various fields, such as computer vision, computer graphics, human-computer interaction, etc., and has been widely used in agriculture, education, electric power and many other industries [4]. Therefore, the using of AR technology can solve many key technical problems, and promote the efficiency of enterprises to deal with problems, which realize scientific operation management, and let employees at different levels play their job skills [5]. Among them, relying on technical efficiency, strengthen the contact of personnel in various regions, carry out various businesses, strengthen personnel training and management, and give full play to the advantages of talents to help the development of various businesses of the enterprise. The following will discuss the application effect of AR technology from the three technical dimensions of interaction, display and positioning.

2.1 Interactive technology

Different from the touch operation mode of traditional smart devices, AR technology is to present a scene other than reality, so as to realize a more natural interaction between users and the virtual information of the real scene. Interactive technologies include gesture manipulation, voice recognition, and somatosensory manipulation [6]. The current voice recognition assistant has a low recognition rate and can only be used as an auxiliary tool for AR devices. Gesture operation can wear the corresponding device, and manipulate virtual objects and menu interfaces through operations such as clicking, dragging, and stretching with fingers in the air. Somatosensory technology is a technology that is currently valued in the field of science and technology. This technology has a RGB resolution of 1080P and a depth resolution of VGA. The functions include gesture recognition, 3D face recognition, 3DAR, speech recognition, Unity toolset, object tracking, expression detection, background removal, browser support, etc. At the same time, the AR system needs to obtain data by tracking the registered device, which determine the specific behavior instructions issued by the user to the virtual object, and analyze the behavior instructions to generate corresponding feedback results [7]. As a user interface, it is different from the traditional interface and is a typical Non-WIMP interface. The interface refers to a user interface based on windows, icons, menus, and pointers. Through the AR system, human-computer interaction is realized in the following three ways. The first method is the spatial point interaction method, which selects virtual objects in the scene through the spatial point position, which is the most basic interaction method in AR. The system determines whether the virtual object is selected by the point coordinates. Space points generally require two-dimensional or three-dimensional coordinate designation. For example, using the mouse to select a three-dimensional target in the screen projection space, the system uses one or more two-dimensional markers as input conditions, and uses coordinate changes to correspond to the three-dimensional coordinates of the space point [8]. The second way is the command interaction mode. The command in AR is a specific gesture or state composed of one or more spatial points. The user can issue different behavioral commands such as selection, deletion or movement to virtual objects through the combination of spatial points, and perform various operations. The third way is to use the interactive way of special tools, which generally combines system software and spatial point input tools. The system software can be expressed as a virtual control panel, and then the virtual target and control panel can be manipulated through the space point tool to enhance the interaction ability for specific applications.

2.2 Display technology

Display technology is also as important as interactive technology [9]. For example: dynamic digital light field display technology, which can be understood as a four-dimensional light field display technology, as shown in Fig.1.

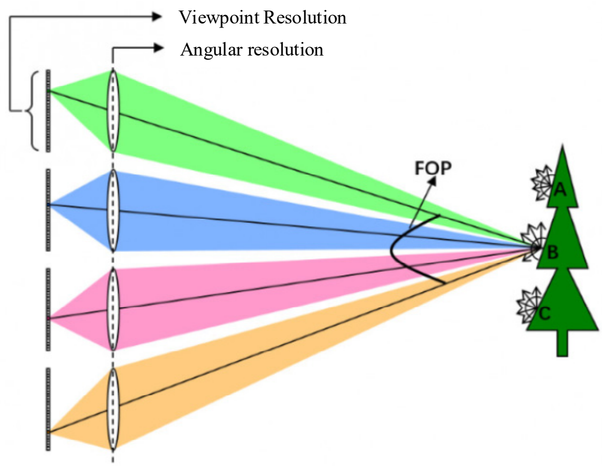

Fig. 1. Schematic diagram of light field display

Compared with the traditional two-dimensional display technology, the biggest advantage of the four-dimensional light field display is that it can display images of different depths [10]. Users can see the real focus and defocus effects whether they are observing a close-up view or a distant view. Just as we stand in front of the window and look out at the beautiful scenery, we can also enjoy the scenery from other perspectives in front of the window from the left and right directions of the window. In other words, the window is converted into a display screen, the display screen only has a frontal viewing angle, but cannot see things from left and right angles. The light field display technology can solve this problem and realize the idea of multi-dimensional observation [11]. At the same time, there is also holographic projection technology, which is also a category of display technology. This technology needs a medium to function, and it needs to be carried out in real time to interact with people. At present, companies such as Musion, AV Concepts and Hologramica have begun to use this technology, which create a realistic one-to-one size 3D projection image. In addition, display technology is one of the key technologies of AR systems. The display technologies used in AR systems mainly include video see-through display and optical see-through display. The video perspective display use the helmet display to simulate the real scene through the video camera. These scene videos are combined with the virtual image generated by the virtual information generator, and the image result is output based on the video perspective helmet display, so that the user can observe with the naked eye [12]. The world is the same scene, so as to realize the fusion of real environment and virtual information. The virtual information generator can automatically track the position, calculate and generate virtual scene information, use the optical perspective to display the effect of the helmet display to enlarge the scene, and reflect the real scene to the human eye through the transflective mirror.

2.3 Positioning Technology

Take image recognition technology and tracking registration technology as examples. Image recognition technology is a technology that presents different patterns of targets through computer processing, analysis, and recognition of images. Image recognition technology can be used to determine the location of objects and 3D coordinates and other information [13]. Different from 3D positioning in other fields of technology, the position of objects in the AR field can be located, but it needs to be positioned according to the relative position of the observer, three-dimensional coordinates and other related information. The positioning function of the tracking registration technology is to display the virtual information in the definite position in the real environment, and this positioning process is also called registration. Among them, spatial data needs to be obtained from the scene. Since the position of the virtual information and the position of the observer are relative, the AR system needs to monitor the position of the observer in the scene in real time, and provide the system with the virtual scene information corresponding to coordinate data for the observer in the scene, which is called tracking. This technology does not require the use of smart devices like interaction or display technology. Usually, the positioning accuracy can be guaranteed [14]. The system will extract the logo from the scene, determine the orientation of the object through recognition, and process the expressed image. The three-dimensional registration process is completed by combining the perspective projection principle of computer vision. In addition, slam positioning technology has also been widely used in power training. Slam is translated as simultaneous positioning and mapping. With positioning as the core, mapping is completed on the basis of positioning, and the observed data is fused. Slam can be divided into four modules, that is, the front-end completes the VO function, the back-end optimizes and integrates the VO results; builds a map on the optimized positioning results, and performs global optimization through loopback when reaching the previous position.

3 Application Of AR Technology In Electric Power Training

3.1 Build an AR teaching training system to simulate real maintenance work scenarios

The most worrying thing is safety in power plants. Many power companies will strengthen workers' safety awareness and standardize technical operations through training methods. However, in the past, the personnel-explained training method lacked efficiency under the development of the new era. Through AR teaching training, zero-error operation can be achieved, helping workers reduce the error rate [15]. Taking a project as an example, the pumped-storage power station has numerous and complicated equipment, and the operation and maintenance tasks are dangerous and heavy, and the operation and maintenance personnel cannot access various texts, drawings, photos, and videos related to the equipment at any time during the inspection process, which affects the inspection process. The efficiency of inspection is increased, and the hidden dangers of safety are increased. It is impossible to let workers have a real feeling and safety awareness through interpretive training. However, the introduction of AR technology into teaching training can well help operation and maintenance personnel to solve the existing pain points, promote the improvement of the skills of operation and maintenance personnel of pumped storage power stations, and understand abstract and difficult professional knowledge with an intuitive and real experience. Power plants need to build a complete AR training system. By simulating real power detection and operation and maintenance scenarios, simulation training is carried out, so that workers can test various functions, performances and pressures of the power system to ensure that AR teaching and training are proficient. Operation of power plant work in the simulation, the proficiency of workers is increased through the study of details, data analysis, observation and localization of the root cause of the problem, so as to reduce the error rate [16]. During the simulated operation of workers, workers can wear smart devices and AR glasses to participate in skill training close to the real scene. The AR glasses are scanned to form 3D materials, accurately locate the fault location of the system, and disassemble, overhaul and troubleshoot key parts. At the same time, wearing AR glasses equipment can browse the training courseware and the actual operation at the same time, and operate the equipment through touch, voice control, etc. However, before using AR glasses for training, it is necessary to clarify the training objectives, and to form a feasible practical training AR training courseware after processing. 3D odel, dismantling simulation, configuration management, and production of courseware contents such as operation principle, introduction of practical training operation, etc.

3.2 Intelligent operation and maintenance and guided operation

In many electric power practice scenarios, various full-body safety belts are worn, a high-voltage electroscope is carried, and a ground wire weighing more than ten kilograms is carried on the back to climb a ten-meter-high outlet tower. After prying off the cover, the cable contains a lot of cobweb and dust. In these complex work scenarios, avoiding risks and ensuring safety are the priority issues. AR simulation can not only restore the real scene, but also simulate danger, however, it is more difficult than the actual situation. The operation is safer, which not only ensures the training effect, but also ensures the personal safety of the personnel during the training, so that the workers can perform various practical operations with confidence. It can also give a corresponding sense of reality in terms of vision, hearing and somatosensory, stimulate the human senses, and allow the trainer to have a real experience [17]. For example, through the 3D modeling technology of AR training equipment and the application form of 3D modeling technology, towers, guide lines, and surrounding environments can be used as data analysis and research objects, and 3D point cloud data can be formed through technical processing. Trainers can feel the real inspection path and working environment, and establish a three-dimensional model for measurement and analysis, so that trainers can make three-dimensional modeling and virtual practice scenes according to the operating environment in the equipment virtual simulation training system. The operating procedures are consistent with the actual operation, which can achieve a real operating experience. In the process of assessment and training, the 3D modeling technology of AR equipment allows trainers to operate in a virtual environment with a high safety factor, which is worried about misoperation increasing the probability of accident risks [18]. The equipment system will also set risk points and early warning, when the trainer makes a mistake, a corresponding prompt will also be generated.

This kind of teaching and training method can greatly reduce the trial and error cost of workers, and can also play a warning role in ensuring the safety of personnel, and improve their own safety awareness, resilience and handling skills. Therefore, it needs to be strengthened from two aspects: on the one hand, it is necessary to build an operation and maintenance system based on smart wearable devices to realize the digitization of unit information on the job site, the remote collaborative guidance of smart wearable devices of AR technology, and the unified data based on the company. The operation and maintenance of the platform supports three functions of the system. On the other hand, strengthen the application of various AR key technologies, guide training with technical efficiency, and standardize personnel operations. For example, using interactive technology and remote guidance technology to achieve video interaction, and accurately identify, track and locate images. In the operation process of the training managers and the workers in the video screen observed by professionals in the background, the voice recognition function is used to provide real-time guidance, and the video screen is captured to mark key parts. The system will also automatically identify and optimize the virtual training process and training results.

3.3 Dataization of crew information, virtual and real remote guidance

The goal of digitizing the unit information at the job site is to transmit the unit's drawings, maintenance procedures, asset information, historical operation and maintenance data, historical fault data, historical maintenance data and other information to the smart wearable device through wireless signals. The specific information can be obtained from the established 3D visualization management platform through the relevant communication technology to obtain equipment operation data. After the data center is developed and gradually improved, it reads and downloads data according to the requirements of the enterprise data center, and obtains equipment operation data with a new data protocol. At the same time, the expert terminal provides voice training guidance for workers' technical operations based on the research and reference of AR technology video interaction, image recognition and tracking technology. The remote collaborative guidance technology is used to simulate the scene of the turbine governor and the switch station, so that the background professional can observe the operation video images of the workers during the training process in real time. At the same time, tracking and registration technology can be used to achieve precise positioning without resorting to complex equipment. The identification-based tracking and registration technology requires staff to set up markers in the training environment in advance as the benchmark for tracking, and then use technical means to superimpose real objects in reality and virtual scenes to establish a corresponding relationship. The trainers extract the logo according to the system, and use the recognition function to find out the posture and orientation of the logo, and process the image accordingly.

3.4 Scenario simulation and maintenance training guidance

The application scenario design needs to plan for the core inspection and maintenance work of the inspection department and the maintenance department, and carry out training guidance by wearing AR glasses to complete the daily inspection tasks. Taking daily inspection work as an example, plan a simulation training program. As shown in Fig.2.

Fig. 2. Equipment diagram of the unit

The intelligent inspection process is shown in Fig. 3. First of all, it is necessary to configure the inspection operation route, inspection equipment, inspection items, and inspection methods on the background management terminal, refine the inspection content, and issue inspection instructions. For example, equipment appearance inspection, interval inspection, meter inspection in the inspection route, etc. Trainers can use display technology, interactive technology based on augmented reality system, combined with human vision and intelligent equipment comprehensive design, using graphic images as information output and training carrier, which use the video-based see-through helmet display, provides trainers with scenes in the real world through video cameras, and realizes the fusion of real scenes and virtual images under the application of virtual information generator. In this way, the trainer can output through the display on the see-through helmet, call up the corresponding inspection task, and complete the inspection operation training task according to the intuitive process guidance of the task. Secondly, an attention-based mechanism is established. The attention mechanism has high application value in the fields of image description, speech recognition, natural language processing, etc. The attention mechanism can be introduced into the OCR recognition module for worker training guidance. Through this mechanism, the ROI of the feature vector of the entry image can be focused and the focus and accuracy of the Encoder-Decoder model in the network can be improved. In this way, workers can effectively use limited vision to process information resources. Trainers only need to select parts of a specific area of vision and focus their attention, which can effectively improve the efficiency and accuracy of information processing. Finally, the built-in camera of the AR glasses can automatically identify the inspection objects in the video, accurately detect the indicator light status of the protection device, the indicator light status of the trip matrix, the pressure plate status, etc.

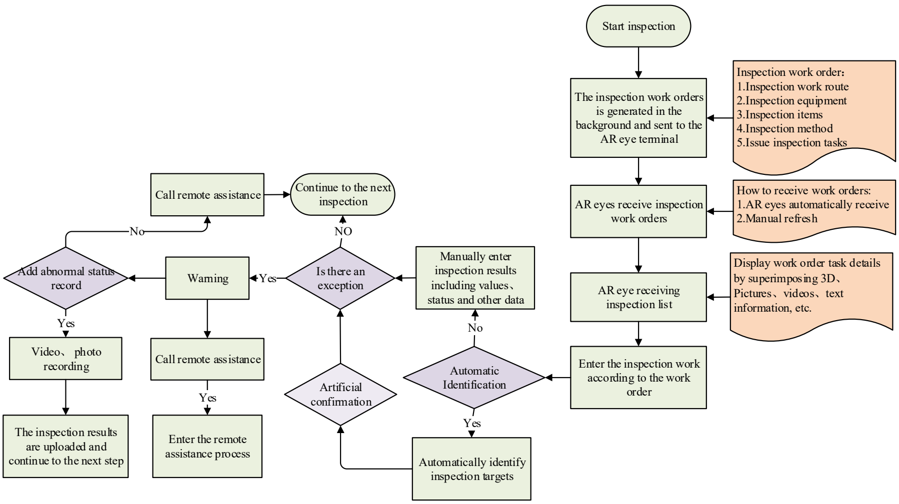

Fig. 3. Flow chart of intelligent inspection

During the inspection, if there is an abnormal situation, a warning will be automatically issued, which can ensure the safety of the training personnel, and remind the personnel to diagnose and troubleshoot the alarm information in the three-dimensional corresponding position of the AR glasses in order to control safety risks and avoid hidden dangers.

3.5 Standardized work instruction system

To establish a standardized operation instruction system, it is necessary to base on AR equipment information, rely on the information process platform, start with the standard operation of electric power enterprises, and establish a standardized operation instruction system in the form of a standard information database to realize management standardization, training standardization, and standardization of operation instructions. From the actual function of the work instruction, firstly, the trainers can intelligently generate the system function model according to the standardized work instruction according to the predefined catalog template and the specified equipment, retrieve the relevant knowledge points, and automatically generate the visual work instruction in word format. Secondly, through the construction of an information-based and intelligent power management platform, system management can be realized in the whole process of guide book compilation and review. During practical training, trainers can share information between the guide book system and multiple management system interfaces. According to intelligent chemical equipment intelligently generates operation instructions around the nature of maintenance work, equipment type, model and other information to meet the requirements of different training tasks. Finally, Combined with the positioning of training functions, based on the premise of conforming to the actual situation, synthesizing the experience of standardized maintenance operations of power companies in different regions and the maintenance and operation experience of power system equipment manufacturers, the maintenance work instructions for different generating capacity units and auxiliary equipment are compiled to strengthen the guiding role and Strengthen the training effectiveness of personnel.

4 Conclusion

Based on the above analysis, AR technology can simulate various real scenarios according to the training scenarios and training guidance requirements, provide various job sites for power plant workers, ensure personnel safety in real experience, and allow workers to use AR technology to achieve high-altitude operations and accident sites, which Combined other scenes with virtual image scenes to achieve independent visit, browsing, learning, experience and training. At the same time, using AR visual technology and language recognition function in interactive technology, training managers can observe from the background whether workers are operating correctly according to the training instructions, which can set up drill plans around specific problems, analyze the root cause of system failures, and provide practical information for practical operations.

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