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Application of Virtual Reality Technology in Inspection Service Training of Power Grid

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Abstract. Virtual reality technology creates a visual simulation environment using the computer graphics technology. By simulating the human body's visual, auditory and tactile real feeling, participants in the virtual environment can obtain the same or similar experience in real world. In order to let the in-depth knowledge of inspectors on typical natural disasters that affect the stable operation of power grids feel easier to understand, and enhance the rescue and disaster relief skills of inspectors which to aware disaster prevention and reduction, we should take a large amount of training. However, subject to site, weather and technical standards limit the scope and effect of traditional training. In this study, a virtual reality technology-based service training system was presented and applied in the education and training of power grid inspectors. By simulating the disaster site circumstance and operation flow, the trainee intuitively understands and grasp the methods of emergency rescue operation of transmission lines, while minimizing the risk of training tasks and protecting the life safety of inspectors.

Keywords: virtual reality, power grid, training.

1. Introduction

Virtual Reality (VR) is a comprehensive information technology emerging in the late 20th century. It combines a variety of computer science and technologies, such as computer graphics technology, multimedia technology, sensor technology, human-computer interaction technology, network technology, stereo display technology, and simulation technology. Virtual Reality technology uses computer multimedia technology to create a virtual environment that simulates the true sense of sight, hearing, and taste. Additionally, VR can also simulate the touch of the human body through hardware devices [1]. In this way, participants can experience the same or similar experiences in a real environment with the help of VR. Its earliest application was in military and aerospace fields. In recent years, VR has been involved in medicine, education, research, film, manufacturing, engineering training and other fields.

With the development of science and technology, multimedia, simulation, intelligent guidance, computer interactive training, web training and virtual reality training have greatly contributed to the development of new training methods. Research shows that people have far greater ability to respond and understand sensory information (e.g., images, sounds, motions, and tactile sensations) than the abstract information such as numbers and words[2]. Therefore, the introduction of digital technology into all phases of training will significantly enhance the efficiency and effect, thus avoid potential safety problems. Digital technologies, represented by virtual reality, are increasingly applied in various training in the fields of medicine, education,

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industry, military and aerospace industries. Particularly，digital technology has been applied in the field of training in China's power system, which is mainly used in simulating operations in substations

The virtual reality-based training has been widely used in substation training because substation operations involve many switch operations and equipment status inspection and their misuse can cause serious accidents. For example, Xuzhou Power Supply Company used the military simulated battlefield and aircraft simulation virtual reality to develop a set of inspection and training system on a substation primary equipment inspection tour [3]. That completely changed former China's substation simulation machine based on a device inspection processing method. According to realistic models and the sophisticated model library of equipment defect, the virtual training system significantly attracts and interests the trainees through simulating the production site and inspection in substations. Consequently, a great training effect will be achieved. At first, the training simulators of foreign power systems developed, and mainly concentrated in thermal power plants. Afterwards, training simulators were successively demonstrated in the training of power grids and substations. For instance, the practical thermal power simulation system, power grid simulation system and substation simulation system have appeared in Canada and other western countries early in the beginning of this century. On the basis of summing up the successful experience of simulation training in power system application and combining with the research of power grid inspection at home and abroad after many years, the research and implementation of the inspection training system based on virtual reality will fill the gaps in this field between China and developed countries.

2. Related Work

2.1. Application of VR technology in training system

The virtual training system refers to a type of system with a virtual environment that is generated by using virtual reality technology and suitable for education and training. It can be the realization of a real-world training base or facility or a world of virtual ideas. Trainees immerse in learning and training relying on the virtual training system. In the 21st century, various new types of military schools, driving schools, medical schools, sports schools employ the virtual reality technology to help trainees receive various training in a virtual environment [4]. The training system supported by VR will make it easy for military personnel, aircraft pilots, medical staff and athletes to acquire perceptual knowledge and practical experience in a safe virtual environment.

Compared with the real education and training base or facilities, the virtual education and training environment supported by the virtual reality technology has the following advanced characteristics:

(1) Highly consistent virtual reality combined scenes

With the support of virtual reality technology, the virtual training facility has the same function as the real training facility, and the method of operation is also the same. Trainees can train their skills through the virtual training facility as well as in the real training base. This is because the virtual training environment is both virtual and lifelike, both for the sub-reality environment and for the imagined environment. The ideal virtual environment should not be distinguished true from fake by the trainees, For example, the viewable scene should change as the viewpoint changes), audio-visual integration, or even more real than true (such as achieving more realistic lighting than the reality and sound effects).

(2) Openness

The virtual education and training system may provide a wide range of training places for any trainee at any time and any place. The connotation of the virtual training environment is wide-ranging. Unlike the traditional concept of a training base, it certainly has the same environment as a traditional training project but it is better for trainees to be trained in the training program Realistic environment among objects. Any trainee can learn or train certain skills through operating the virtual training system to a certain training environment.

(3) Hyper space-time

The virtual training system has the characteristics of time-space. It can organically represent or combine the objects and events in the past world, the present world, the future world, the micro world, the macro world, the objective world, the subjective world and the fantasy world separately.

(4) Interactivity

Trainees can use specialized equipment to manipulate objects or events in a virtual environment, whether it simulates a real environment or an imagined environment, with human natural skills as it is in a real world. For example, a trainee can grab an object in a virtual environment, turn it around, move it, and more. Operability, which not only allows trainees to learn the practical training courses but also achieve real distance education and training, is an essential feature of the virtual training environment in practice.

(5) Correspondence

Trainees' training content closely corresponds to the virtual environment. For example, trainees should learn aircraft driving skills, then the virtual environment is the simulation environment of the aircraft flight. When in the practice of anatomy, the virtual environment may be a virtual hospital. Correspondence will enable trainees to set various complex situations to improve the resilience of trainees. Training courses in super-hard and ultra-wide areas for athletes, security guards, fire-fighters, and surgeons will be set up such that they are able to deal with all kinds of situations with ease in real situations. Additionally, virtual reality technology can correspondingly carry out individualized education and training according to the foundation and ability of each trainee.

The use of virtual reality for staff training is a trend. For example, Intel Corporation has developed a warehouse-based employee training program based on virtual reality, which saved 500,000 US dollars each year only for training costs [5, 6]. The U.S. Motorola Company and Nortel Corporation used virtual reality to create a virtual factory to train employees to familiarize themselves with the environment, facilities, and operation of the complex and inerrable equipment for assessment. The results not only increase the learning interest and efficiency of employees but also significantly reduce the turnover rate of novice appointment.

2.2. Power grid inspection service

Transmission line inspection is the inspecting the risk of lines defects, which is often said in the professional inspection of transmission defects. Line defects come from two aspects. On one hand, there is the existence of equipment body problems, such as product material problems, aging products, vibration missing pieces, distortion. On the other hand, they are from the outside risks, such as man-made damage, weather, geology Changes, the pollution caused by candlesticks and other risks. They all pose a threat to the safe operation of transmission lines. These defects have a certain regularity in their formation, existence, and development. Therefore, we can classify the equipment by constructing the grid-based training system with virtual reality technology in the past few years to calculate the operating data and defect statistics of a certain transmission line.

3. Method

The key technical achievements of the virtual training system are mainly reflected in the following points. Model interactive editing, model material editing, camera control module, related animation production, multimedia embedding, GUI interactive interface editing, script trigger editing, and special effects editor. The specific functions are as follows:

Functions	Interaction	Model Material	Camera Control	Animation Connect	Multimedia	GUI	Script	Effect
Scenario	●	●	●			●	●	
Equipment	●	●	●	●	●	●	●	
Information					●	●	●	
Training Content	●	●	●	●	●	●	●	●

The virtual training system can control the entity changes and the viewpoint in the virtual environment through the data pad, the mouse, the keyboard, the data glove and other external devices. In order to facilitate the trainees to use the system, the mouse and the keyboard are mainly used to interact with each other. The trainee can map the actions in the real world directly to the virtual environment, and use the two-dimensional

mouse to control and manipulate the translation, rotation and another movement of equipment components in the three-dimensional space and then make a series of changes.

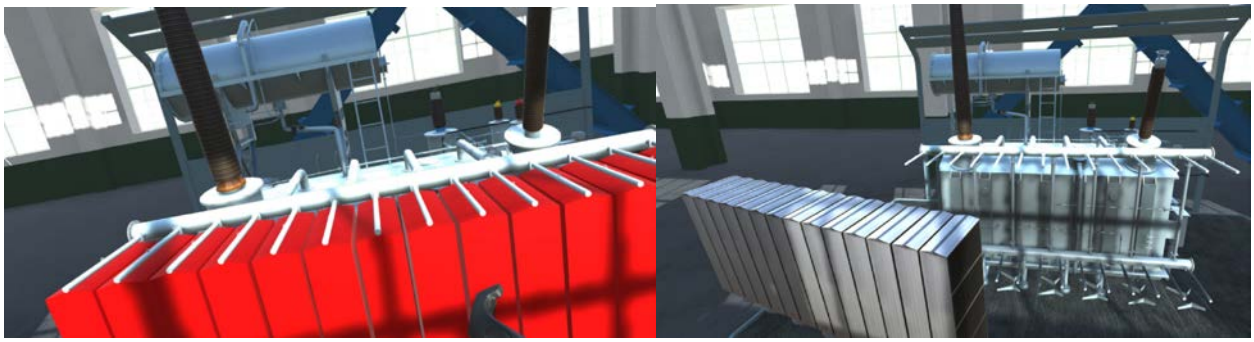

Fig. 1: The training scene of transformer dismantling.

In the course of translation and rotation, the collision between objects due to the distance of translation and the angle of rotation is considered. Collision detection mainly adopts the method of "bounding box". Object rotation and translation in three-dimensional space can be realized by using the geometric transformation principle of three-dimensional graphics transformation matrix (i.e., translation transformation, proportional transformation, rotation transformation) in computer graphics. After the objects are manipulated through the transformation of objects in three-dimensional space of the target coordinate value, thus completing the manipulation process and the rapid transformation of the device components, in order to obtain the dynamic changes in the interactive display process. For the entire virtual training environment, you can browse at any angle. For a single piece of equipment, trainees can observe the structure of the equipment at different angles by selecting, move, manipulate, scaling, etc. to learn more about the composition of the equipment. Figure 1 shows the training scene of transformer dismantling, and Figure 2 shows the cognitive training scene of power line substation.

Fig. 2: The cognitive training scene of power line substation.

4. Discussion

Through the virtual reality technology, the training cognitive process of power network inspection from two-dimensional to three-dimensional is more realistic, rich and specific. Meanwhile, the power network training system virtually simulate the high-risk, high-cost and the difficult working environment through computer graphics, and cooperate with the immersive hardware environment to enable the user to be in the state of checking the cognitive work. Not only can we save money and reduce risks, but we can also make these links more closely. Hence, trainees can get an in-depth understanding of each part and can often learn objects that cannot be touched in reality. Both for employees to provide knowledge learning opportunities, and improve their operating skills to provide training places.

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