# Research on multi - channel interactive virtual assembly system for power equipment under the “VR+” era

# Research on multi - channel interactive virtual assembly system for power equipment under the "VR+" era

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**Abstract.** With the development of the "VR+" era, the traditional virtual assembly system of power equipment has been unable to satisfy our growing needs. In this paper, based on the analysis of the traditional virtual assembly system of electric power equipment and the application of VR technology in the virtual assembly system of electric power equipment in our country, this paper puts forward the scheme of establishing the virtual assembly system of power equipment: At first, we should obtain the information of power equipment, then we should using OpenGL and multi texture technology to build 3D solid graphics library. After the completion of three-dimensional modeling, we can use the dynamic link library DLL package three-dimensional solid graphics generation program to realize the modularization of power equipment model library and power equipment model library generated hidden algorithm. After the establishment of 3D power equipment model database, we set up the virtual assembly system of 3D power equipment to separate the assembly operation of the power equipment from the space. At the same time, aiming at the deficiency of the traditional gesture recognition algorithm, we propose a gesture recognition algorithm based on improved PSO algorithm for BP neural network data glove. Finally, the virtual assembly system of power equipment can really achieve multi-channel interaction function.

## 1 Introduction

With the VR technology industry ecosystem gradually development and perfection, today is also known as the first year of VR.The most profound connotation of the "VR+" era is that information technology has a great change in today's society. The extensive and profound fusion of the physical world and the virtual world is an irreversible trend in the future. At present, the power industry is no exception. As part of the electric power industry, the optimization of the assembly system of electric power equipment has an important position. Safe operation of power equipment and maintenance to maintain the stability of the power system, which plays an important role in the power system. First of all, in the design stage of the power equipment, we always hope to get the information of the electrical equipment assembly and other information, which is very difficult to do in the traditional CAD/CAM software; secondly, the maintenance personnel in the maintenance operation is only a simple two-dimensional feeling, and electrical CAD map artwork, thus unable to form an overall image and three-dimensional effect. It has become a hot issue in the world to break through the limitation of the two removal and the limitation of space layout.

The virtual assembly system based on VR technology is more effective than the traditional way of power equipment assembly system in the maintenance, protection and operation of power equipment.

Three dimensional virtual assembly system of electric power equipment can form an overall, image and three-dimensional effect on the maintenance and operator's senses. VR technology can realize the integration of the real power equipment and virtual power equipment, which brings great convenience to the actual protection of power equipment. Employees can use virtual reality helmets and equipment into the virtual scene, and then interact with a variety of electrical devices. The staff will be highly consistent with the real scene from the sense of operation, or from the feedback action on the response, familiar with all kinds of advanced electric power equipment, master the normal operation, exception handling and accident analysis [1].

## 2 Research on Modeling of virtual assembly system for power equipment

In the construction of 3D virtual assembly system of power equipment, there will inevitably power equipment parts modeling issues: first we should need auxiliary high-definition digital camera shooting, image scanning and use various external devices and software means possible to acquire power equipment parts information.Then carries on the modeling process, and stored in the the type of database in the computer, and using OpenGL and multi texture technology construct the 3D graphics library. The establishment and management of model base is achieved by MicrosoftVisual C++6.0. and SQL SERVER2008.Its specific functions include:model input, model information deletion, model information search. to facilitate further research, development and utilization of [2]. In the end, we can save the model library for further research, development and utilization.

### *2.1 Research and comparison of modeling methods for power equipment*

The software mainly includes OpenGL, Direct, VRML. We compare the modeling methods from three aspects: portability, stability and efficiency.Then we compare the current market with the use of three-dimensional modeling methods to investigate the performance of the modeling platform compared to the following figure:

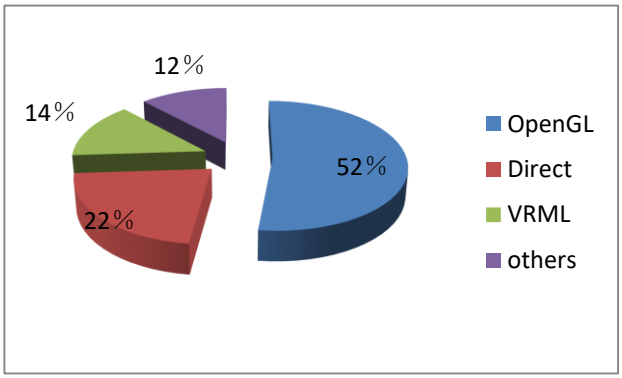


Figure 1 the current market 3D modeling approach Pie chart

Combined with various factors,finally we choose the OpenGL modeling approach to modeling of power equipment.

OpenGl is a software interface of 3D graphics hardware.Its main function is to frame buffer for drawing two-dimensional and three-dimensional objects. With the help of OpenGL library functions, we can create high-quality static and dynamic three-dimensional graphics. The main graphics operation in OpenGL until the rendering on the computer screen to draw a three-dimensional electrical equipment model. The basic steps are as follows:

1) the establishment of the entire electrical equipment model, and the mathematical description of the model (OpenGL): points, lines, polygons, images and bitmaps are used as the basic graphics unit.

2) the electrical equipment model is placed in a suitable position in a three-dimensional space, and a viewpoint (viewpoint) is arranged to observe the angle of interest.

3) the mathematical description of the electrical equipment model for rasterization.

## 3 Using dynamic link library DLL to build and package 3D power equipment model library

In order to make the model of electric power equipment visible, clear, smooth and three-dimensional display, we must solve the following problems:

1) design and develop efficient 3D model library;
2) how to save the resources of model base;
3) modular processing of the model library;
4) the model library can be easily updated and modified, and has good compatibility.

To solve the above problems, we propose the following scheme:

### *3.1 Design and development of three dimensional power equipment model library*

1) model library using software

The establishment and management of electrical equipment model library is realized by Microsoft Visual C++6.0. and SQL SERVER2008.

2) the specific function of model base

Model information entry: the choice of model files, the number of models, and the name of the model;

Modify the model information: select a record, select Modify, you can modify the selected record model file, the model number and the name of the model;

Delete the model information: select a record, select Delete to delete the selected records;

Model information search: in the search for the text box to enter the key word to search, click on the search to match all the records show.

3) system operation:

The system can add, modify and delete the mode. You can search for the required model in the model library by searching for keywords, and support fuzzy search. Finally we can make all kinds of complex structure of power equipment can be intuitive, clear, smooth, three-dimensional display

### *3.2 Using dynamic link library DLL to encapsulate the model library*

In order to solve the problem of resource saving, modular processing and compatibility of model library, we use dynamic link library (DLL) to solve the problem. Through the use of dynamic link library packaging of three-dimensional electrical equipment to generate the program to further achieve the electrical equipment to generate the hidden algorithm and electrical equipment database module[3].

Since the dynamic link library is a binary program, it also ensures the speed of the virtual reality system.

We use DLL dynamic link library to encapsulate 3D solid graphics generation program, which provides the basis for cross platform application of electrical equipment graphics library.

## 4 Establishment of virtual assembly system for power equipment

After the digital modeling of power equipment parts and the establishment of three-dimensional power equipment model library, we set up a three-dimensional virtual assembly system of power equipment [4]. The three-dimensional power equipment virtual assembly system can provide a visual virtual world to the user, like in the real world, users can use the 3D virtual assembly simulation system of power equipment disassembly and the operation of the power equipment, users more immersion.

Vizard integrates the integrated development environment (IDE) and the advanced graphics library into the Python programming language. The integrated development environment greatly simplifies the workload of maintaining the data material, and provides a tool for real-time preview, scene debugging and script debugging. Encountered in the Vizard graphics and hardware interface related issues can be handled through the Python script code. The most important is the Vizard supports almost all current virtual reality equipment: including motion tracker, 3D stereoscopic display, helmet display and many other external input devices, will enable us to achieve wearable devices for interactive access to a deeper level of power equipment virtual assembly system.

*4.1 The power equipment model is loaded into Vizard and set up the virtual assembly system of 3D power equipment*

The 3D model of power equipment power equipment is loaded into the virtual assembly system modeling well before the 3D model for power equipment only from modeling software export to OSGB file format will be recognized by the Vizard loading.The OSGB file format is the default Vizard for storing scenes and characters and the object information such as file format, but not with OSGB modeling software file format to file format, so it is necessary to install the plug-in OSGexplorer.exe file.

First install the plug-in OSGexplorer.exe file, so in the 3DS MAX export file format options in the OSGB file format ; Then in the 3DS MAX to model a good three-dimensional virtual scene to OSGB file format storage output, at the same time, when the output is available in the OSGB file format, you need to pay attention to the settings of some parameters and attributes to ensure that Vizard can identify all the information derived; Finally, we can use Python programming language to load the corresponding OSGB file. Figure 2 shows the Vizard flow chart of the electrical equipment model:

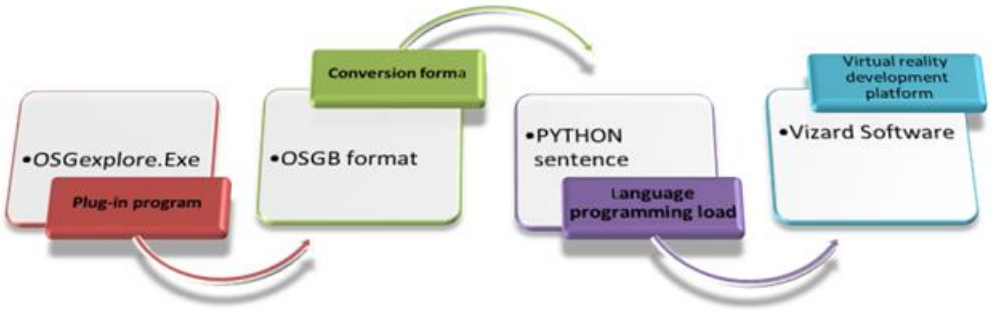


Fig. 2 Vizard flow chart of power equipment model loading

*4.2 Script design based on Vizard*

Types of power equipment in the power equipment is variety.After the establishment of basic model, We can use the Vizard software to edit and modify the model second times. Figure 3 is the flow chart of Vizard script design:

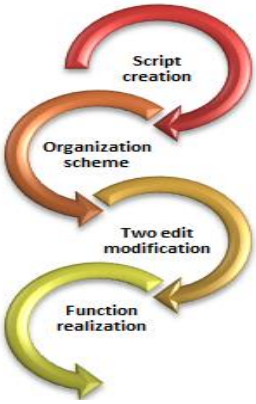


Figure 3 Vizard script design flow chart

**5 Multi channel interaction of vision, hearing and touch for 3D power equipment virtual assembly system based on wearable device**

A perfect virtual reality system can give a strong impact on the visual, in the three-dimensional virtual reality system, the sound is also a necessary complement to the image. If the use of three-dimensional

power equipment of virtual assembly system and can timely play the right sound can make observers feel the visual impact while also immersed in the realistic sound atmosphere. Haptic applications in virtual reality can increase the amount of information transmitted to the human brain: hard and soft, cold and warm, thick and thin, as well as the shape of the object, etc.. Haptic feedback can be used to establish the relationship between the human and the virtual simulation environment, and provide the user with haptic information.

We use the 3D stereo helmet to realize the 3D visual impact effect of 3D power equipment virtual assembly system. Three dimensional sound effect of 3D virtual assembly system for power equipment based on OpenAL/OSGAL. Haptic interaction of 3D power equipment virtual assembly system using data glove.

*5.1 Virtual assembly system of power equipment based on data glove haptic interaction*

In the data glove interactive system, a complete interactive behavior mainly consists of three processes: the operator sends commands to the virtual hand in a computer, is mainly realized through data glove and position tracker; virtual hand to receive orders, and according to the command to execute the corresponding operation, the operator to complete the operation; after the system through the visual channel will change the virtual environment transfer to the operator, the operator used to prompt the next action [5].

*5.2 Improved BP neural network data glove gesture recognition based on PSO algorithm*

Data glove as an input device model is widely used in human-computer interaction system in numerous data acquisition operation of the operator gloves can transfer signals to virtual computer, so that an operator can be immersed in the virtual environment created by the virtual equipment, more around the real feelings of the environment and the state. Data glove provides a natural and effective human-computer interaction tool for operators. Therefore, how to accurately identify the operator's gesture has become a hot topic in the field of intelligent control [6].

In recent years, many domestic and foreign researchers are looking for effective gesture recognition algorithm, such as the Department of computer science at the University of Michigan Cui Yuntao established a hand gesture image of a database to store a large number of different time in different locations and different proportion for gesture recognition, the computer science department of Columbia University, New York Gluckman image using the reflection mirror the calculation of the distance between the object and the camera, a gesture segmentation based on distance information, such as Wu Jiangqin of Harbin Institute of Technology proposed the hybrid method of ANN and HMM as a gesture training method for classification recognition method and reduce the increased number of parameters. These methods have achieved certain results in the aspect of gesture recognition.

But for the whole system, the real-time and accuracy of the recognition has not been well solved, so how to deal with a large number of gesture data in the shortest time is the core of the algorithm.

The traditional single BP neural network algorithm uses the trained BP neural network to carry on the fast matching of gestures, and uses the standard BP neural network model of three layers: input layer, hidden layer and output layer. The input layer is provided with 14 neurons, which means that the 14 sensors of the data glove in each gesture input process are normalized and the output layer has 5 neurons, which represent the curvature of the 5 fingers. However, the algorithm still has the following defects: it is easy to fall into local minimum, slow convergence speed and different network structure.

In order to solve the above problems, the system will first numerical sensor data glove collected are normalized to establish a universal gesture template, and then BP neural network is established for the gesture template learning toolkit, PSO algorithm is used to modify the system weights, finally in the recognition process in the continuous data stream is divided into separate fragments of static gestures by software design. We used to discretize data glove gesture data acquisition, through software programming is transformed into static gesture fragments, and general gesture template were compared through gesture recognition, greatly reduces the complexity of data processing, improve the

real-time identification algorithm. Furthermore, a new algorithm combining BP neural network and PSO algorithm is proposed to overcome the shortcomings of traditional BP neural network algorithm.

Aiming at the defects of standard BP network, this paper uses PSO algorithm to optimize BP neural network, and takes the weights and thresholds of BP neural network as the particle, and completes the training process:

$$\Delta w_{ij} = c_1 r_1 (w_{ij}(p) - w_{ij}) + c_2 r_2 (w_{ij}(g) - w_{ij}) \quad (1)$$

Among them, $w_{ij}(p)$ said the individual optimal particle value, $w_{ij}(g)$ said the global optimal values of the whole network, which use PSO algorithm to optimize the traditional algorithm, we use the data glove gesture recognition rate enhanced convergence error in this way is smaller, the accuracy of the algorithm is improved.

## 6 Epilogue

In this paper, the VR technology is used to build the three-dimensional virtual assembly system of electric power equipment, which is more prominent than the traditional power equipment assembly system in the maintenance, protection and operation of power equipment. The realization of multi channel interaction enables employees to use virtual reality helmets and equipment into the virtual scene, and then interact with a variety of electrical devices. Finally, the virtual assembly system of electric power equipment can get rid of the defects of low efficiency, low efficiency, low immersion, low reality, low dynamic and low sensory enjoyment. With the arrival of the "VR+" era, the virtual assembly technology of electric equipment based on VR technology will be developed rapidly.

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