

Simulation and Implementation of Virtual Lab Circuit Based on Unity3d and 3dmax

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Abstract: In view of the poor interoperability of traditional laboratories, the inability to share experimental data, and the inability to conduct remote scientific research cooperation, an advanced interactive method, Virtual Reality Technology (VR), is used to construct virtual devices, electronic components and experiments through in-depth exploration of virtual reality technology. The virtual environment of the room presents the operation process of the whole experiment in a realistic three-dimensional perspective. Combining the real circuit welding experiment scene to make realistic circuit simulation effects, the virtual simulation laboratory of electronic circuit is realized. In experiment the computer graphics technology and stereoscopic display technology is used to apply its real immersive, interactive and conceived features to the teaching field to provide users with immersive virtual reality experience. The experimental results are far superior to the traditional room experiments.

1. Introduction

The virtual lab presents the real-world features in a 3D form through a computer, giving people an immersive feel. Researchers share equipment and data in different experiments in the virtual laboratory, and can improve the type of experiment and the experimental results at any time [1]. China's VR technology research started late, but in many schools, the application of virtual reality technology has received more and more attention. At present, many colleges and universities are actively creating virtual laboratories under the continuous reform of education mode, and using advanced technology to innovate and assist scientific research in teaching mode.

Electronic circuit simulation is an engineering method that uses mathematical models to simulate the true behavior of electronic circuits. It mainly understands simulation as a practical process of comparing and simulating reality through some means and methods, and then to understand the real process of things happening. Electronic circuit simulation builds mathematical models based on objective systems, and on the basis of explore and practice to show the essential changes that occur in real things [2]. The main basic unit of electronic circuit simulation is generally composed of component library, instrument library, mathematical model and experimental platform [3]. At present, electronic circuit simulation is usually a two-dimensional experiment, but the two-dimensional experiment cannot directly and effectively demonstrate the authenticity and interactivity of the experiment, and the realization of the three-dimensional virtual laboratory can make the experiment more based on the two-dimensional electrical simulation software. The realistic scenes makes students remember more deeply [4]. The 3D experimental process is more complicated. It is necessary to write the logic control of various 3D virtual instruments. The illumination model is designed to calculate the properties of the light source, material and texture, the environmental effects of the scenes are set to achieve the same experimental effect in reality [5]. As a high-level language, C# is usually used in various systems and virtual reality development. Therefore, we use the C# programming language to logically write virtual components to achieve the desired dynamic

effects. From the current market and various virtual reality laboratories, the immersion of electrical simulation in the three-dimensional environment and the very strong user interaction experience achieve far more profound effects than that of environment.

In this paper virtual equipment, electronic components and virtual laboratory environment are builded through VR technology to presents the whole experimental operation process in a realistic three-dimensional perspective, and produces realistic circuit simulation effects in combination with real circuit welding experimental scenarios. This consists of three parts: 1. the establishment of electronic device model. 2. Laboratory environment modeling. 3. Using unity3D for component function editing, developing the model independently with the VS script compiler to demonstrate the experimental results.

2. Component model

In the early stage of model establishment, we need to follow the basic principles of simplistic modeling and how to model the logical level. The laboratory required models are modeled separately by different software. In order to ensure the effectiveness of the experimental results, professional modeling software is used.

2.1 Altium Designer Model

After a preliminary understanding of Altium Designer's software architecture and file types, and the main structure of its internal structure, it has the following two functions for PCB model production.

Schematic design system. It mainly includes two parts: the schematic editor and the schematic model library editor which draw the circuit schematic and prepare for the development of the PCB.

Printed circuit board design system. It mainly consists of a PCB diagram editor and a package model library editor for drawing PCB schematics and storing various files generated therein.

To set the grid in the PCB board, complex and fine parameter design are required, pay attention to the minimum spacing and line width between the two lines, and pay attention to the setting of pad size. The size of the pad determines whether true component insertion can be done in a virtual development environment. Finally, the components are placed in the relevant position by manual dragging, and the wires are manually wired to complete the connection. The running design rules are used to check and verify that the circuit boards are correctly wired. The schematic design of Altium Designer is shown in figure 1.

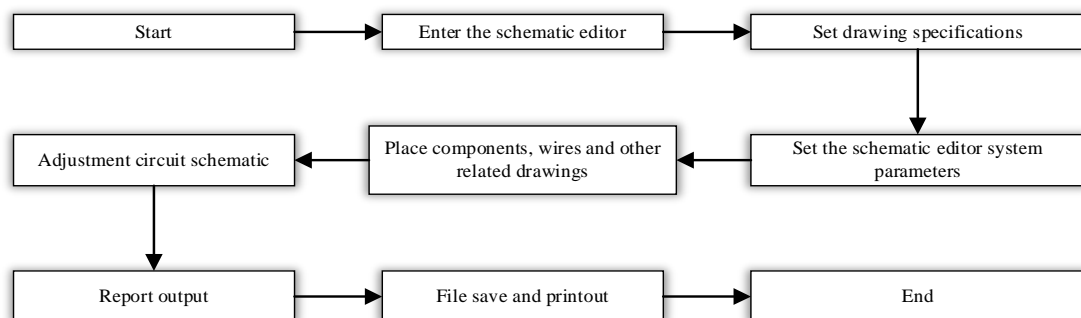


Figure 1. Circuit schematic design flow.

2.2 SolidWorks Model

The virtual laboratory circuit simulation model is built with SolidWorks as the main modeling software. The 3D model of the electronic device is mainly drawn by SolidWorks software. There are two main designs: component design and assembly design. The component design is the basic design for the entire mechanical model design. The other assembly design is to generate the model and then assemble the model. When we are designing a product, SolidWorks will provide us with the following two design options:

The top-down design method, which understand its overall realization function from the backbone to the leaf's step-by-step thinking and the main body of the electrical model in order to better plan the functional modules involved in the location, takes into account the overall function of the model and effectively avoids excessive development of the model.

The bottom-up design method starts with the design of the individual parts of the overall model, and assembles and assembles according to the functions between the parts to complete the specific functions of the model. This kind of thinking makes the parts making process independent of each other, without too much consideration of the binding relationship between the part and the whole, and is suitable for the size and model design of the single function part.

3. Laboratory environment model

The creation of the experimental scene and the experimental main interface geometry is an important basis for the experimental virtual environment and real-time virtual roaming. In order to create an immersive feeling for the user, in addition to the device shape in the main experiment, it needs to be rendered by 3dmax software to create a real effect. Experimental environment model is shown in Fig. 2.

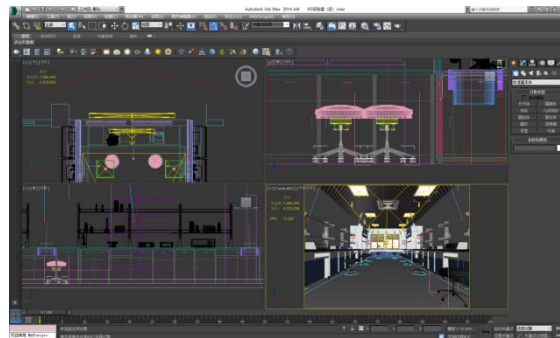


Figure 2. Laboratory environment.

The virtual laboratory circuit simulation designed in this paper is from the whole to the part. In order to improve the enthusiasm for learning, some environmental effects that stimulate the curiosity of learning are added. The virtual laboratory circuit simulation system is designed to present the charm of the electrical experiment. Every user's eyes. The key to exploring the core of the entire virtual lab is interactive design. So at the beginning of the virtual lab design, we use the real lab as a template to experience the steps into the experimental interface from the outside to the environment, from the environment to the platform, from the platform. These interactions are scripts that correspond to the static model by logical thinking, so that they reflect the corresponding changes and realize the interconnection of each module. This should fully consider the sequence and logic of each script execution.

4. Experimental effect

4.1 A. Virtual simulation environment planning

The static model building of the electronic circuit virtual simulation laboratory is a delicate and labor-intensive work, and each time the optimization and the attempt to achieve the realistic three-dimensional effect of the virtual laboratory. Environmental modeling and construction can provide students with a stimulating three-dimensional sense. First of all, according to the basic impression of the laboratory, each experimental equipment and table and chair should be placed just right. Laboratory environment interface is show in Fig. 3.

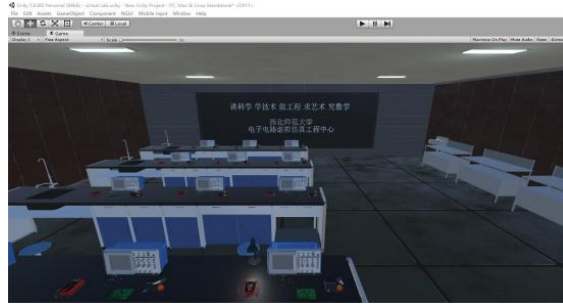


Figure 3. Laboratory environment interface.

4.2 B. Virtual 3D roaming

Roaming reflects the first step of the interaction of the entire virtual environment. The user can freely manipulate the perspective to obtain the information in the scene. The application is suitable for his own operation and can bring the experimenter into the experimental environment and obtain the real experimental feeling. There are two ways to virtual roaming, one is manual roaming and the other is automatic roaming. The manually roaming character (first person perspective) will guide the experimenter along a fixed route to view all the information. The automatic roaming function is realized by the external plug-in in unity [6], which is mainly applied to automatic path finding and tracking AI behavior control of objects. In this paper, manual roaming is used to control the direction of the character through the right mouse button. The “W, S, A, D” keys on the keyboard control the forward, backward, left shift, and right shift of the character respectively. When you zoom in and out of the object and set these settings, we can set the upper and lower limits of the field of view according to the scope of the human eye. The main codes for the control of the characters are as follows:

```
//A member variable that controls the rotation of the camera.
Private float m_fLastMousePosX = 0.0f; //Camera X-axis variable
Private float m_fLastMousePosY = 0.0f; //Camera Y-axis variable
Private Bool m_bMouseRightKeyDown = false; //the initial state of the mouse
The event response in roaming will be completed in update
// determine the rotation
If (Input.GetMouseButtonDown (1)){ //The right mouse button has just been pressed
If (m_bMouseRightKeyDown == false) {
m_bMouseRightKeyDown = true; //Initial state change
Vector3 kMousePos = Input.mousePosition; //The camera position is assigned to the variable
m_fLastMousePosX = kMousePos.x; // camera X-axis variable instant position
m_fLastMousePosY = kMousePos.y ;} // camera Y-axis variable instant position
}
Else if (Input.GetMouseButtonUp (1)) { //The right mouse button has just been lifted
Else if (Input.GetMouseButton (1)) //The right mouse button is in the pressed state
```

The final part of the experiment is to let the experimenter get the final result after the experiment, Therefore the output phenomenon is the key factor for the success of the virtual laboratory circuit simulation. This is the most important part. The user should really experience the joy brought by the experimental effect. The unity3D platform presents a rich and interesting virtual simulation lab by adding powerful features such as physics engine and particle effects, as well as lighting. So far, the opening of the laboratory show is basically over. Operation interface and output effect interface of small night light experiment is shown in Fig. 4.

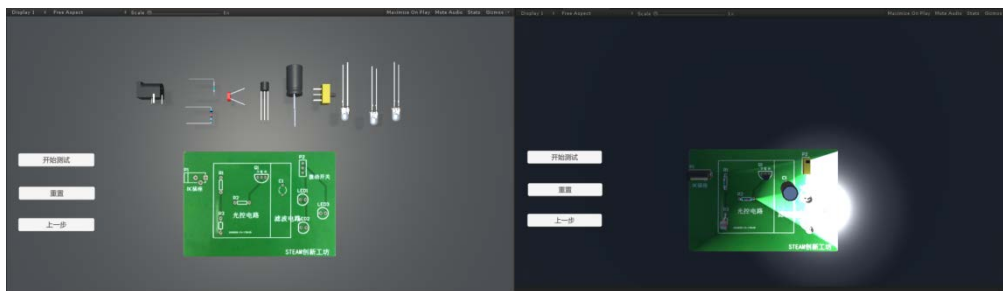


Figure 4. Show results

5. Summary and outlook

In this paper, the virtual reality technology is used to develop a circuit simulation virtual laboratory system to realize the circuit simulation process for 3D virtual experiment. This system guides users into the electric world in the form of three-dimensional experience for users who are not aware of electronic circuits. Altium Designer, Solidworks and 3dmax modeling professional tools are used to provide the basic model of the three-dimensional world and integrate various technical methods. The real world is an example to build a basic static model for mapping and baking. Through the development of the Unity3D virtual reality development engine, each model in the scene is hung in the corresponding control script to realize the interaction process of the user in the virtual scene. In this article, despite the implementation of the new virtual reality education system, the real virtual reality also needs to use VR equipment, which can allow users to get rid of the constraints of the mouse and keyboard, so that the entire virtual laboratory is presented.

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