Virtual simulation of palletizing training for industrial robots

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ABSTRACT

With the continuous development of the present era, science and technology has also been promoted to a certain extent. Traditional manual welding can’t meet the needs of production and life. The production of automatic welding became a major mode of production. Robots are also coming into people's lives. This is very important to our life and production. In the process of Robot welding, if we do not master the following issues such as welding torch attitude, robot position path planning and control, automatic adjustment of digital welding machine parameters, robot and welding machine communication, etc. , it is easy to appear all kinds of welding defects. Therefore, this paper designs a new training virtual simulation system based on welding robot. System Design based on Unity 3D software. It can better learn and control the welding robot.

CCS Concepts

• Applied computing → Computer-assisted instruction

KEYWORDS

Industrial Robot; Virtual Reality; 3DS MAX; Unity3D; SolidWorks

1 Introduction

Because the welding robot in the work, needs the very high security and the operation accuracy, therefore, now on the market most welding robot's control is through the off-line programming way, first passes the verification work procedure, then the correct working procedure is imported into the controller of the welding robot to control the welding robot to complete the welding work. However, this method greatly limits the efficiency of the welding robot because the operation efficiency is low and the edited program can not be changed in the controller of the robot, welding robot can only complete the set work, difficult to complete complex and multi-dimensional work. If we want to improve the flexibility of welding robot, we need to set up an observation room, real-time monitor the state of welding robot, and control the welding robot. At this time, it is necessary to develop a movement system for welding robot training to improve the efficiency of welding robot training. And the virtual simulation system can build a completely the same environment as the reality, saving manpower and material resources, so, this subject to develop a welding robot-based training virtual simulation system. "industrial robot installation and training" is a practical course, and welding robot training is one of the training subjects. For a long time, the setting of this practical course is restricted by a series of factors, such as fund, site and so on. Virtual reality technology can effectively provide advanced experimental environment and simulation means for welding robot training. The application of virtual reality technology in classroom teaching and the development of virtual reality simulation training system are of great significance to the successful implementation of welding robot training. It effectively solves the problems of equipment location, quantity, model limitation and low training efficiency in welding robot training. According to the reality of this teaching condition and the actual situation of undergraduate students, this paper chooses the experiment of welding robot training to design the virtual reality simulation training system. In this paper, three-dimensional modeling and two-dimensional drawing of the selected welding robot training are carried out by using SolidWorks software, and its main characteristics are analyzed[1-9].

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2 The overall scheme design of the system

Unity 3D has five views of games, scenes, inspections, projects, and levels for developing virtual environments. These five virtual views can be edited in three programming languages, UnityScript, c # , and Boo, but in use, Boo is more complex and difficult to use, so only in the remaining two options. UNITYSCRIPT is a variant of the Java language, and because of its lack of flexibility, it is generally used only for Web scripting, which is not the language of choice for some programmers. The c # language borrows from the Java programming language and combines the syntax of the C + + language on this basis, so most programming languages now choose c # , the language can also do most of the work needed to write software today. This article uses c # language which can have the higher flexibility as the writing language. Unity 3D has MonoDevelop built in to provide a compiled environment for scripts, but this feature is not very efficient to write, so we chose Microsoft Visual Studio 2012 as the environment for scripts to improve the efficiency of development. Solidworks is used to build the model of the welding robot, and 3DMAX is used to render the model. Solidworks is the mainstream modeling software. 3DMAX is a software designed by AUTODESK FOR 3D modeling, rendering and animation. First, the model is built by Solidworks, then imported into 3DMAX for rendering, and finally used by Unity 3D for virtual simulation design and development[10-22].

3 Assembly design of welding robot based on Unity 3D

3.1 Scene Design of the system

The goal of the virtual simulation system of welding robot training is to build a welding robot which is the same as the real one in the virtual reality software (Unity 3D as an example) , and to train the welding robot visually. In order to successfully complete the training of welding robot virtual simulation design, must be able to master and use Unity 3D software skillfully. The core of the Unity 3D software is to visualize abstract objects and separate them layer by layer. The Unity 3D software has a number of components that can be divided into basic components and scripting components depending on their composition. Among them, the basic components are necessary for Unity 3d to run normally and stably, while the script components are logic controlled and adjust the basic components by controlling the code. The welding robot training virtual simulation system designed and developed in this paper is a relatively complex system. Therefore, before developing the virtual simulation software, we first understand the components of the simulation system, to improve efficiency in designing simulation systems. By understanding the components involved, we can reduce the repetition of components, improve the system's extensibility, and add new functions to the system. The welding robot training virtual simulation system constructed in this paper contains many objects, which need to list to improve the relationship between the components.

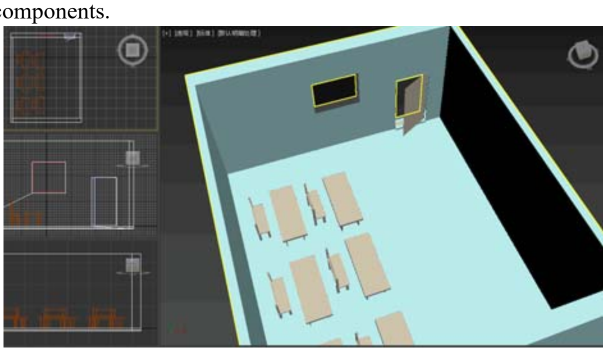

Fig. 1 Simplified classroom diagram

3.2 Modeling of welding robot

This article uses SolidWorks to model the robot, as shown in figure 2. After building the model, we need to export the file to the Unity3D software, but the format of the export file can not be directly imported into Unity3D, so we need to import the file into 3DS Max to convert the format, it usually goes through the following process.

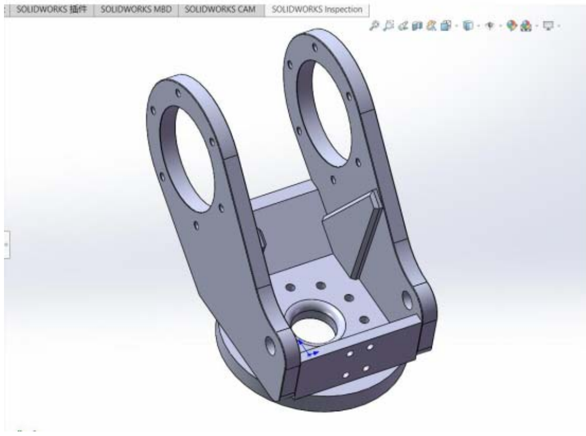

Fig. 2 Modeling of the driving arm base based on Solidworks

In this paper, the model tree is constructed with Unity 3D, which is used to display the welding robot and adjust it carefully. The correct parent-child relationship is established between the six joints of the welding robot, this enables movement between the joints so that the end effector reaches the indicated location. The process of building a welding robot virtual scene from the above analysis is shown in Fig. 3.

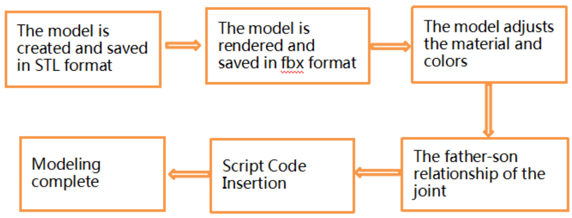

Fig. 3 Welding robot modeling process

The following welding robot with six degrees of freedom as an example to complete the welding robot joints modeling method, first welding robot base center as the origin, using SolidWorks to build the welding robot model and save it as STL format, as shown in Fig.4, import the built model into 3DMAX for rendering, there is no need to change the coordinate system direction, after rendering, export and save to FBX format, because 3DMAX and Unity 3d have good compatibility, the resulting FBX file can be directly identified by Unity 3D, and then colored and adjusted by the Unity 3D squadron model.

In 3DMAX, the default unit of the model is mm, the coordinate system is right-handed, and when the Unity 3D model is imported, the unit of the model is m, the opposite of which is left-handed, so, these two problems need to be solved in order to ensure that the model is imported smoothly into Unity 3d without any problems. The default unit of the model in 3DMAX is mm, but the default unit imported into Unity 3D has been changed to M. The welding robot requires a high degree of accuracy in the process of operation, therefore, the choice of the default unit is mm to better meet the design needs. However, since the minimum change is 0.001 in millimeters, it is easy to make mistakes when writing code, so when building a welding robot, the whole robot is enlarged 100 times, this will result in a lot of error reduction when writing code. The default coordinate system in Unity 3D is left-handed coordinate system, and the default coordinate system in 3DMAX is right-handed coordinate system. When importing the welding robot model, the robot coordinate system should be changed to the right-handed coordinate system, the idea is to create an empty parent joint for each of the six joints, and then adjust the parent joint's parameters to those of the corresponding joint, in the input script, the parent of these empty objects moves the corresponding joint. In this paper, the method of setting up the parent joint of the empty object to drive the child joint is used to adjust the default coordinate system. In the parent and child of an empty object, script code is used to establish the correct parent-child relationship between them.

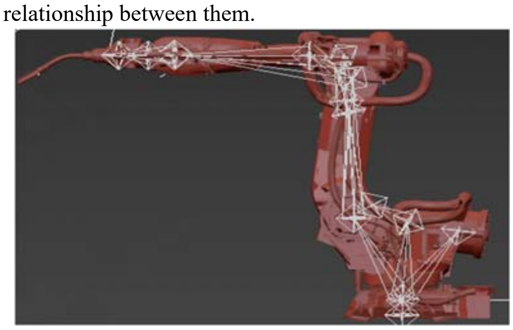

Fig.4 Welding robot rendering based on 3DMAX

3.3 Virtual scene preview

In the virtual simulation system of welding robot training, we need to pay attention to the movement and pose change of every joint in real time, so we need to preview the virtual simulation environment before training. The virtual scene preview is to observe the motion state and the change of position of the robot around the welding robot through the view angle of the main camera, to get a better view of the robot, see the script for controlling the camera shown in Fig.5. This script defines the Free Orbit Parameter, which allows you to select the rotation range of the camera around the x axis and the Y axis, the Current CameraParameter parameter is also defined, which determines the camera's Current position and center of rotation, and other parameters such as sensitivity.

Fig.5 Parameter setting

In the script above, we define two functions, Orbit and Zoom, in which Orbit is used to hold down the left mouse button to observe the state of a welding robot at a specified range of angles, another function, Zoom, indicates that a welding robot can be observed at a specified distance with a mouse wheel. The script also has two empty objects, camera OOTTF and camera ATF, in which the main camera and the built welding robot model are placed, allowing the welding robot to be moved and rotated to set its position.

3.4 construction of Virtual Reality Operation Platform

In this virtual simulation training system, the interaction between the operator and the virtual welding robot is needed to realize the training of the welding robot, this section extracts the main and typical interaction examples to introduce the interaction with the virtual scene. In order to interact with the welding robot, you first need to build its virtual operating platform. Fig. 5 is the interface for the development environment in Unity 3D. Ngui plug-ins are needed to complete the virtual interface. In the design of virtual simulation, there are many operations that need to be interacted. In order to achieve the interoperation, first, you need to import Ngui plug-ins into Unity 3d, and then open the Unity 3d interface, the NGUI's action menu appears. The Unity 3D comes with a Gui, but the NGUI uses the camera's vertical projection technology to create a Gui that is much easier to use than the one that comes with the engine, first Click on the Open the UI Wizard option in the NGUI action menu, then the UI will be created, and then the UI will be created. Then the created Ui will appear in the Hierarchy panel, to facilitate interaction with the welding robot. Fig.6 shows the UI creation interface for the Ngui, and figure 4 shows the elements in the Hierarchy panel.

The welding robot simulation area can observe the virtual welding robot in real time through the main camera. In this area, the training state of the welding robot can be observed at any angle and distance by control tools such as mouse or keyboard. The motion control area can be divided into welding robot joint control area, Welding Torch Control area, welding robot command control area and welding robot online control area. The joint control area of the welding robot can control the six joints of the welding robot through the input data of the dialog box or the direct sliding bar. This operation mode can adjust the joints of the welding robot quickly, moreover, the change of joint angle between the six joints and between the two joints can be observed conveniently and quickly. The welding torch control area can complete the welding work of the welding robot by inputting the specified welding spot through the dialog box, this control area is the core of the virtual simulation welding robot, therefore designed x, Y, Z, R X, R Y in the dialog box, exact coordinates for six positions, Rz, for the precise training of the welding robot. The welding robot on-line control area simulates the real welding robot's movement control process, through the input instruction in the dialog box, lets the welding robot move to the corresponding place through the input instruction, and the path of the movement is recorded, after the movement is completed, the welding robot can be selected to complete repeated actions, in order to complete the welding robot training.

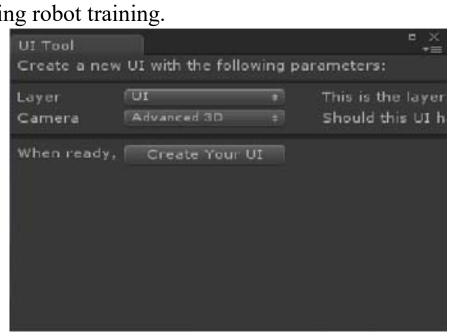

Fig.6 Creation of the user interface (UI)

3.5 Interactive implementation of the system

Through the above analysis and research, a virtual reality based robot motion simulation system is established, and then the performance test is carried out, and the off-line simulation test method is used to verify whether the virtual robot motion simulation system operates well. Joint Motion: Firstly, the joint motion of the welding robot is selected in the motion control area, and then the joint position coordinate point is input after confirming the selection, and the initial joint point p 1 and the target point p 2 are input respectively in this area, click the add button to enter the coordinates of the two pose points into the dialog box to observe the robot's movement. The welding robot will move to the designated position according to the Joint Motion Command. The final position of the welding robot is shown in Fig.7.

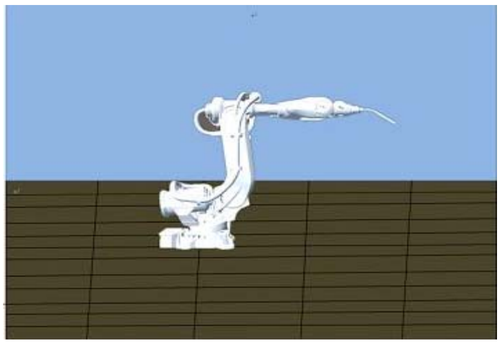

Fig.7 Position setting of welding robot

4 Summary

In this paper, a six-degree-of-freedom welding robot is taken as an example to study its virtual simulation. Developed a model based on Solidworks, Unity 3D as the engine of virtual training simulation design. The main object of this design is teachers and students of mechanical specialty in universities. It is convenient for teachers to teach about welding robot programming and operation. Because the design is all virtual part, teachers and students can operate online at the same time, teachers can guide the operation of students in real time, which is convenient for teachers to teach, and also convenient for students to absorb what the teachers teach, lay the groundwork for a career after graduation. 2. The next direction of efforts, this design is mainly for the virtual part, not the entity of the welding robot and design link up. So there is a need to use welding robot enterprises and welding robot engineers can operate too much help, so the next step is to work through communication software, design and physical welding robot links, to help companies train welding robot engineers, and the existing welding robot equipment debugging and repair.

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