Virtual simulation of zero-point alignment for industrial robots

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Abstract: Zero-position regulation training is a compulsory course for industrial robot training. Generally, the zero-point regulation of industrial robots was completed by beginners through the actual equipment. However, the training based on practical equipment was restricted by training venues, training scale, and equipment reliability. It can’t satisfy the requirements of actual training. A wider training environment of robots was provided by the technology of virtual simulation in this paper. And the problems of complex equipment and expensive price in the practical process can be solved effectively. Virtual simulation of zero alignment of Kuka industrial robot is an important subject. The performance of trajectory planning and kinematics were studied. And the accuracy was verified in the paper. This paper gives A brief description of zero alignment were assumed by the paper. A three-dimensional model of Kuka industrial robot was built by SolidWorks, 3DMax and other three-dimensional software Its main characteristics were analysed based on the 3D model. And the zero alignment of Kuka industrial robot was simulated by the virtual reality software. In addition, the virtual simulation environment and the main function of the system were constructed. The project was debugged at last.

1. Introduction

The zero position of the robot is the initial position of the manipulation model of the robot. When the zero position is incorrect, the robot cannot move correctly. The process of setting the position of the motor (code disc value) to zero code disc value is zero correction. Re-zeroing is to change the calculation benchmark of the software, which results in the change of the actual location of the homework that has been taught. Zero position of industrial robots is usually set up when they leave the factory. Normally, zero correction is not necessary. Zero must be recalibrated when special circumstances arise. Therefore, zero-position regulation training is a compulsory course for industrial robot training. Generally, beginners use actual equipment training to complete zero-point regulation of industrial robots. However, such practical equipment training is often restricted by training venues, training scale, and equipment reliability. This will not meet the actual training needs[1-2].

In this paper, virtual simulation can provide a training environment for robots to a large extent. It can effectively solve the problems of complex equipment and expensive price in the practical process. Virtual simulation of zero alignment of Kuka industrial robot is an important subject. This paper studies its performance on the basis of trajectory planning and kinematics, and further verifies its accuracy. This paper gives a brief description of zero alignment, then uses SolidWorks, 3dsmax and other three-dimensional software to build the three-dimensional model of Kuka industrial robot, and analyses its main characteristics, then uses virtual reality software to simulate the zero alignment of
Kuka industrial robot. And the construction of virtual simulation environment, the completion of the main function of the system, project debugging.[3-5].

2. Basic Principle of Robot Zero Point Normalization

2.1. Zero calibration

General machines, including measuring instruments, have their own zeros. Only when zeros are determined can they work effectively. So does the Kuka robot. Only when zeros are calibrated can it work more efficiently and accurately. If the axis of the robot is not zero, it will greatly affect the operation. Failures that may occur may include:

1) Unprogrammable operation
2) Cannot perform Cartesian manual operation
3) Software Limit Switch Closed

In order to make the robot run normally, zero calibration is needed when the following situations are encountered:

1) Testing the performance of robots
2) After maintenance of some parts
3) When the axle of the robot is not moving
4) After maintenance, the stop gear was collided at a relatively high speed, with a limit of more than 250mm/s.

How to do zero calibration?

Firstly, when calibrating the robot, it is necessary to adjust the axes of the robot to a certain position, which is called mechanical zero. This position represents the corresponding relationship between the axes and the angles. Usually indicated by the measuring slot, that is, the position before zero.

When the position of zero point is located by electronic controller, it needs to reach a standard. The probe reaches the deepest part of the measuring slot, and the axis needs to keep moving all the time[6].

Fig. 1 below:

Notable things here are
1) Find the mechanical zeros from left to right (positive and negative) as shown in the Fig.
2) The correction process should be constant temperature to avoid the error caused by thermal expansion and contraction.

What are the ways of zero calibration?
According to accuracy standards and load specifications
1) Standard Zero Calibration (Low)
2) Zero Point Calibration (High)
It is worth noting that the first zero point calibration must be that there is no tool and no load on the robot. When using the Kuka robot, debugging and checking should be carried out. When the above problems arise, checking and correcting should be carried out, and the zeros should be re-calibrated to ensure the normal operation of the machine.

So the zero position regulation is very important for the good operation of the robot.

2.2. Modeling of Industrial Robots

The following is the three-dimensional modeling of industrial robots based on SolidWorks.

![Fig. 2 Modeling of Robot](image1)

The following is the 3D modeling of 3DMAX.

Cable (measuring wire) connects calibration box (same label can be connected) to connect robot junction box X32 interface, and connects EMD. Screwdriver (screw down the protective cover on the measuring cylinder). EMD (Electronic Controller) is connected to the measuring cylinder (different models of SEMD, MEMD are selected according to the size of the machine).

![Fig. 3 Detection Tool Modelling](image2)

Robot (Zero Point Regulating Simulation Object)

![Fig. 4 Industrial Robot Rendering Based on 3DMAX](image3)
Through SolidWorks and 3dsmax, the three-dimensional model is built and analysed. Finally, the model is imported into unity3d virtual reality software for simulation.

3. Zero Regulating Simulation Design Based on Unity3D

3.1. Virtual Reality Technology
In short, it is a computer-generated realistic 3D virtual environment that uses natural technology to interact with new technologies using sensor devices. Different from traditional analog technology is the combination of analog environment, visual system, simulation system, sensor equipment and real equipment ( helmet mounted display, graphic glasses, data service, stereo, digital, etc.). The 3D virtual environment generated by headphones and operators' computers is interconnected to give people a real feeling.

![Fig. 5 Zero-point Correction Simulation Based on Unity3d](image)

3.2. Unity3d and simulation
Unity3d is a kind of virtual reality software. In reality, we need to use Unity3d in game scenes such as mobile phones. It is a professional game engine. Unity3d has the following advantages and is widely used.

- **1) Powerful physical engine system.**
- **2) Efficient resource allocation, more comfortable and convenient for users to operate.**
- **3) Development and compatibility of scripts. A kind of**
- **4) It can be released across platforms, which is very convenient.**

The models built by the Three-dimensional Modelling Software Solidworks and 3dsmax are imported into the initial interface of unity3d, including the Kuka robot, screwdriver, EMD ( electronic controller ) and measuring wire. In order to make the simulation interface more beautiful, a small classroom with desks and chairs is drawn by using 3dsmax modelling software. The following is the simulation interface after changing the view angle, as shown in Fig. 5 below.

Here, because the format of SolidWorks three-dimensional model is incompatible with the import format of Unity3d, 3dsMax is selected as the intermediate software, and the model built by SolidWorks is imported into 3dsMax for model rendering, converted to FBX, and then imported into Unity3d for virtual simulation. The following is a virtual simulation by programming, as shown in Fig. 6:

The above Fig. is a program of zero-alignment of Kuka robot by visual studio software. The virtual simulation of zero-alignment of Kuka industrial robot is realized by programming. By programming the screwdriver, three buttons, grey, purple and orange, are set up to indicate that they are pressed, not pressed and scratched. To achieve the control of the screwdriver, the protective cover on the measuring cylinder of the robot is screwed down by controlling the screwdriver.
Similarly, by programming EMD (Electronic Controller), it is screwed onto the measuring cylinder, and the measuring wire is connected to EMD, and the virtual simulation of Kuka robot zero alignment is realized through the teaching device.

![Fig. 6 Zero Detection Programming Based on Unity3D](image)

The significance of this research is to simulate the virtual reality scene in Unity3d, simulate the real scene, after debugging and scene simulation is correct, then plan to put into actual production, because without simulation practice, rush into actual production, the actual situation of the actual scene may not be in line with the time, not only directly. As a result, the performance of the robot can not meet the requirements, and the working condition is low. Even later, it has to bear a series of costs for its maintenance. It's not only possible that after this maintenance, there will be other problems next time. Therefore, through the research of this subject, we can avoid the unnecessary losses caused by various problems in the later period caused by the direct role in reality. So, we can solve the problems more effectively by putting the virtual simulation into the design and production.

4. Conclusion
With the development of science and technology, industrial robots have been popularized, and the application of Kuka robots is also widespread. In this paper, the universality of industrial robots and their important roles in modern society are described. The performance of Kuka robot is also studied on the basis of kinematics and motion trajectory, and its accuracy is verified. At the same time, this paper expounds the importance of checking and correcting the zero gauge of Kuka machine when it is working. In this paper, the system model is established by using three-dimensional software such as Solidworks and 3dsmax. In this paper, virtual simulation is carried out in Unity3d to simulate the reality detection.

Now we can see that factories emerge in endlessly, the popularity of Kuka robots is increasing, and more and more robots are put into production. Therefore, it is more and more important for the normal operation of robots. It is also not negligible to simulate zero-position regulation through virtual simulation. The cost of actual production can be greatly reduced by putting into production after simulation, so simulation has a great development. Advantages and prospects.

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