

Study on Six Degrees of Freedom Arc Welding Robot Trajectory Based on SolidWorks

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Abstract: Three- dimensional (3D) saddle shape model is built by using SolidWorks software in this paper. Then import the saddle model into a robot off- line programming system. Finally, the simulation study of the SIASUN robot off- line programming system can be used after collecting the saddle model and saving the recognized data type of the robot. Singularities can appear during the period of simulation study. These singularities can disappear after continually adapting the data of saddle model and finally run the predefined program. The robot can be seen moving based on the predefined route within the simulation software interface.

Introduction

In modern society, with the development of industrialization, control of automation and intelligent have become the trend of development. But most robots in domestic factories mostly using teach programming, and rarely using off-line programming, thus limiting the increase speed in the level of domestic industrial automation. Especially in complex curve design, this paper is going to investigate the saddle shaped curve as an example. This paper would mainly application of SolidWorks software for saddle shaped to establish a three-dimensional (3D) model, and combining SIASUN robot off- line programming system, and do some research on the methods which focus on the complex off- line programming of saddle shaped seam trajectory.

Modelling of Saddle Shape

Due to its powerful system of Solidworks software and its multiple assemblies, we choose it as a 3D mapping software. The reasons for Selecting Software Solidworks to design 3D saddle trajectory for its simple to application, convenient to operate and easy to learn.

Selection of test parameters: main pipe diameter is 220mm, length is 380 mm, and the thickness is 5mm. Branch diameter is 120mm, length is 190mm. Open SolidWorks software [1] after selecting the parameters well. The drawing steps are as follows:

Step 1: Create a new file, and click the new sketch icon then, make the XY coordinate as the datum;

Step 2: Click the circle icon command which is used to draw a round and then draw a round with the diameter of 220mm; click the same command to draw another round with diameter of 219.8mm. Then click characteristic command, and design the length as 380mm while choosing stretch command which is in the characteristic command; click OK;

Step 3: Build a new sketch, the basic plane should based on XY coordinate, then click OK;

Step 4: Click the circle command and draw out a round with the diameter of 120mm again after seizing the center point on the main pipe and click circular command again to draw a round with the diameter of 119.8mm. Then click characteristic command, and design the length as 300mm while choosing stretch command which is in the characteristic command. Its graphics 1 can be seen in the following figure 1;

Step 5: Save files in *.STL format.

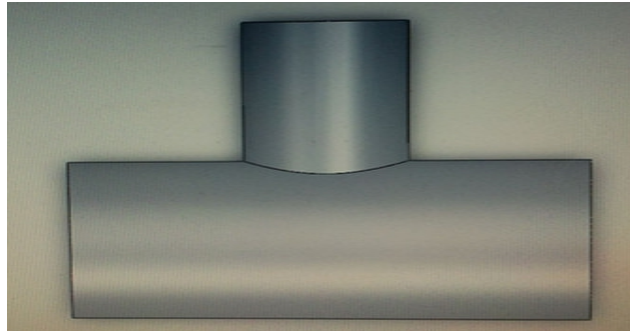


Fig. 1. Diagram of saddle model

Setting of Robot Coordinate System

Setting of Tool Coordinate System

A saddle shaped track will be welded this time. First of all, a welding gun should be mounted on the robot wrist. Due to the origin point of the coordinate system of the robot work- piece should be located in the end of welding gun but not on the wrist of the robot, therefore, the tool coordinates system is need to be demarcated, so as to the end effector on the robot can move based on calibration tool coordinate system and can make sure its accuracy and precision. Five points calibration method can be used on the calibration of tool coordinate system. The steps are as follows:

Step 1: Putting the tools on the operating platform and ting them well. Turning on the robot and using the teach box to fix the underlying with the method of five points calibration method;

Step 2: Using the teach box to adjust the robot's posture^[2]; making the robot go to the standard fixed point and then taking as the first point. Adjusting robot posture again and setting the different point as the second one. Then setting the third point, the fourth point, the fifth point, and then end and exit;

Step 3: Recording the defined tool coordinate system. Its coordinate values are shown in Figure 2.

Px	-4.469	Rx	0.000
Py	-13.840	Ry	0.000
Pz	442.802	Rz	0.000

Fig. 2. Chart of tool coordinate value

Setting of Work-piece Coordinate System

The work-piece coordinate system (also called programming coordinate system) is the coordinate system which is used during programming. This coordinate system is set manually. Establishing the

work-piece coordinate system is a necessary step before the robot off-line programming. Different methods can be used in different systems. Take the SIASUN robot as an example, the steps of developing the work-piece coordinate system are as follows:

Step 1: Open the design command of the work-piece coordinate system, and select one corner of the working table as the start point of work-piece coordinate system;

Step 2: Apply the teach box to adopt robot reaching the start point and this point should also be located as the origin of the work-piece coordinate system. Select one side of the work-piece as the X axis, perpendicular to the X axis as the Y axis, and Z axis should be determined by the right hand rule, then exit. The teaching points as shown in Figure 3;

Step 3: Record the well designed work-piece coordinate system, its coordinate values are shown in Figure 4.

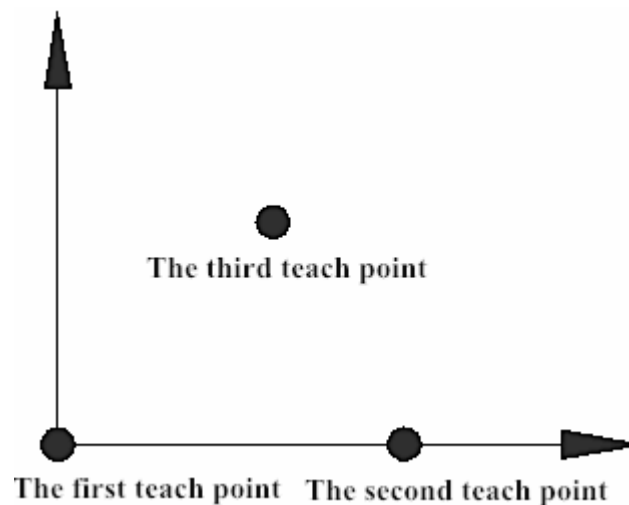


Fig. 3. Work-piece Coordinate System Calibration

Nx	0.998	Ox	-0.065	Ax	-0.015
Ny	0.065	Oy	0.998	Ay	0.012
Nz	0.014	Oz	-0.013	Az	1.000
Px	796.641	Py	-535.814	Pz	-402.971

Fig. 4. Chart of Work-piece Coordinate Value

Off-line Simulation in SR_CAM_SOFTWARE (SIASUN Robot Software)

Simulation is the application of computer on an actual robot system for simulation^[3-5]. Principle of simulation is by using interactive computer graphics technology and robot theory and forming a robot geometry in computer, then carries on the 3D display which is used to confirm the changing process of robot and working situation. In this paper, the SR CAM software can be used as an example to simulate the predesigned trajectory. The steps are as follows:

Step 1: Open the software of SR-CAM-SOFTWARE, click the open button and the saddle shaped 3D map which is mentioned above; click processing button; choose the border select button which located in the processing button; recognize the saddle shape trajectory and preservation it for

a *.txt file format;

Step 2: Build a new robot workstation and import the robot model; then set parameters of the above mentioned tool, work-piece coordinate system;

Step 3: Click on and load the core data; and the load the *.txt file into the work space of the robot;

Step 4: Configure track points, and then select all these points for a simulation run. The running status is in line with the actual requirements. The simulation results are shown in figure 5;

Step 5: Save the file at last, which can be used for network remote control application.

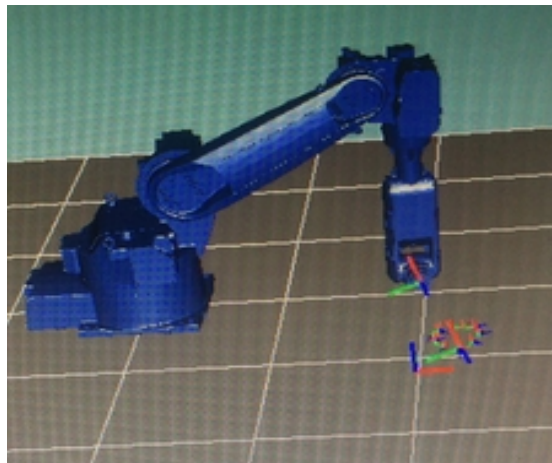


Fig. 5. Chart of Simulation Operation

Conclusions

The accurate data of saddle model trajectory can be got by drawing the 3D graphics under the help of the SolidWorks software. Such method can improve the accuracy of welding efficiency and its process, but not the teaching- programming.

Programming interface based on SR_CAM_SOFTWARE. Then introduce the well designed trajectory into virtual environment where might appear some singularities. The data of singularity should be revised so as to disappear in the end. Run the well adjust program to complete the whole virtual simulation task.

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