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Robot physical modeling based on matlab/simulink

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Robot physical modeling based on matlab/simulink

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ABSTRACT: Robots play an irreplaceable role in the manufacturing industry. The use of machines instead of humans‘activing.It is a long-term development trend, but it is difficult to realize the research of real robots, and the data that the robot can collect is less. In response to the above problems, this article mainly proposes a method of physical modeling using matlab/simulink. This method can realize research without robots, and can obtain more robot-related data. This method includes robot physical modeling, importing into simulink and packaging in simulink. This article is mainly aimed at IRB6700 robot to complete the simulation platform construction.

1.Introduction

ABB's IRB6700 robot is an industrial robot that can engage in welding (including cutting and spraying). According to the definition of the International Organization for Standardization (ISO) industrial robot terminology standard welding robot, an industrial robot is a multi-purpose, reprogrammable automatic control manipulator (Manipulator), with three or more programmable axes, with producting activing, it has the advantages of high efficiency, stable product quality, low labor cost, and good operating environment.[1]This article builds the robot simulation operation process as follows: 1. Robot structure analysis. Including the setting of each link, the production of joints and the establishment of the relative coordinate system of each joint. 2. Establishment of simulation model: Use solidworks to complete the robot assembly, import and use matlab/Simulink to build the robot simulation model. Since the intermediate file format is an urdf file, the model needs to be modified before importing into matlab. 3. Establish sensors for the position, velocity and acceleration of each joint, and moment of inertia. 4. Motion simulation and data processing: output and collect the motion parameter curves of each joint and verify the correctness of the simulation model.

2.Robot 3D modeling creation

2.1 IRB6700 robot assembly

The assembly process of the robot mainly needs solidworks to complete. First, you need to download the step file of the IRB6700-235 robot part on the ABB robot official website, and import the setp file into solidworks.[2] After the import is completed, you need to assemble each part. Note that when importing the part base When the ground origin coordinates need to coincide with the space coordinate system. After the import is complete, you first need to make reference coordinates on each part so that you can use these reference coordinates to complete the robot assembly.[3]

Use the established coordinate system to assemble each part. First select the part to be equipped, click Mate, and in the fit selection, click the center line of the base to coincide with the center line of the ground under one axis, that is, the line coincides with the line, and continue Add that the upper surface of the base coincides with the ground under one axis, that is, the surface matches the surface. Follow the same method as above to complete the assembly of the six-axis robot.[4]

Complete the assembly in solidworks and set the material properties of each component. The main body of the IRB6700 is made of aluminum alloy. After the assembly is completed, the model built is 3% different from the actual mass of the IRB6700 at 1205kg. It can be approximated that the built physical model meets the actual situation. After parameter setting, it is as shown in the figure.

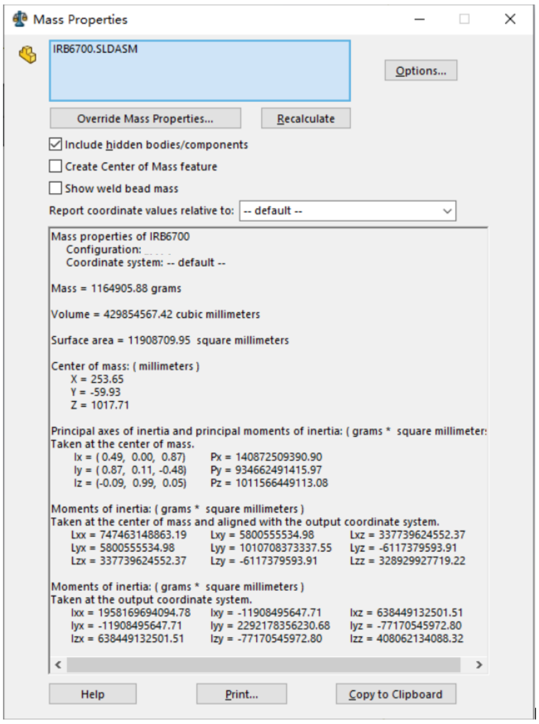

Figure 1. Robot parameters

2.2 Export the urdf file and modify it

After the assembly is completed, the coordinate system in the reference geometry needs to be set at each joint. This coordinate system is used to determine the rotation axis and the reference coordinate system in the process of exporting the urdf file. Download and install the sw2urdf plug-in on the solidworks official website to export the assembled IRB6700-235 robot model to an urdf file. During the export process, set the limit axis value and speed with reference to the robot official website data.[5]

Table 1. Rotation parameters of each axis of the robot

Axis	Type of motion	Range of movement-IRB 6700	Range of movement-IRB 6700Inv
Axis1	Rotation motion	$\pm 170° or \pm 220°$	$\pm 170°$
Axis2	Arm motion	$-65°/+85°$	$\pm 65°$
Axis3	Arm motion	$-180°/+70°$	$-180°/+70°$
Axis4	Wrist motion	$\pm 300°$	$\pm 300°$
Axis5	Bend motion	$\pm 360°$	$\pm 130°$
Axis6	Turn motion	$\pm 360°$	$\pm 360°$
		$\pm 93.7 revolution$	$\pm 93.7 revolution$

After completing the plug-in installation, restart solidworks to display the SW2URDF function in the plug-in, select Export as URDF.[6] To set in the pop-up dialog box, you first need to select the base coordinates, add the base parts, and click Load Configuration to add the next level link is the previously built reference coordinate system, and the joint activity type is set to rotate and the parts of the next level link are added, and the joint name of the next level is set, and the rotation is set Refer to the coordinate system and the rotation reference axis, select the joint motion mode as rotation, and the part section dog, and complete the addition of parts at each level as shown in the figure.

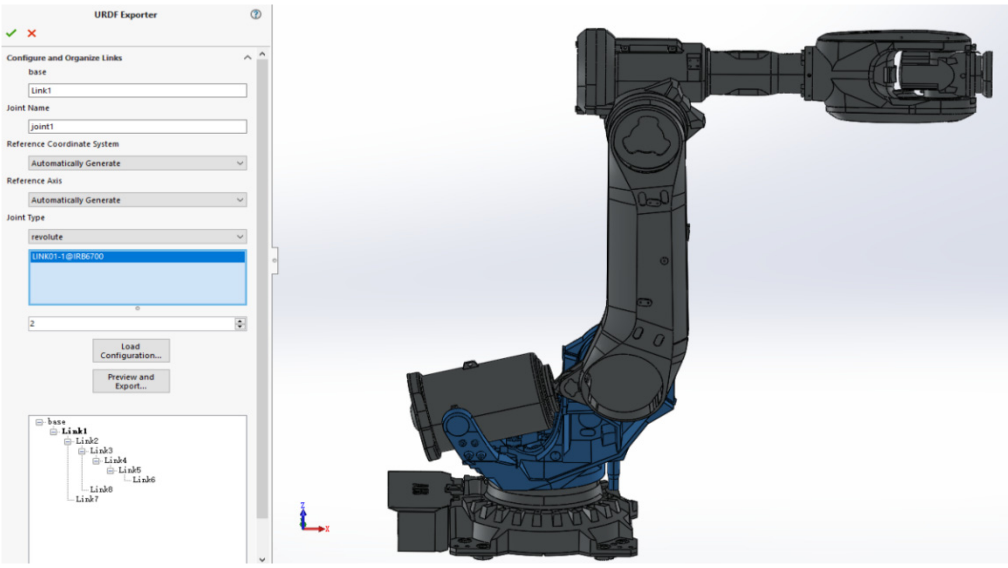

Figure 2. Complete urdf file configuration

After completing the above configuration, click the Preview and Export URDF button to export the urdf file, which corresponds to the IRB6700-235 robot axis rotation parameter table. Set the rotation parameters of each axis of the robot. When setting the rotation parameters, you need to convert the angle system to the radian system, as shown in the figure show.

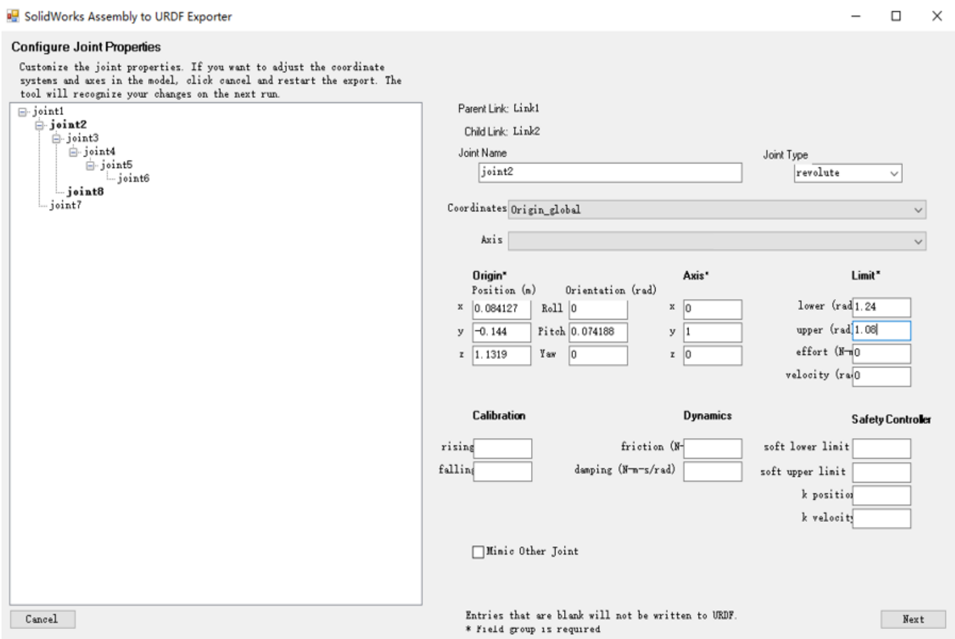

Figure 3. Set rotation limit

3.Build the model in simulink

3.1 Import urdf file into simulink

We need to import the model containing the physical parameters of the IRB6700 robot into simulink. First, we need to download the corresponding version of simscape Multibody from the matlab official website, add the path to matlab, and complete the installation.After the plug-in is installed, the exported URDF file Adjust the price to the matlab path, use the smimport() command in the command window to import the model into simulink.

3.2 Encapsulate the simulink model

This robot model mainly has a driving module, an execution module and a data acquisition module. The driving mode of the driving module is mainly driven by the rotation angle of the six axes. The angle data is intercepted in units of 0.1 seconds. The intercepted data is very close and can be approximated. The authenticity of the data is reliable, and compared to the design of the motor drive, it can achieve simple and accurate results. The input module is shown in the figure.

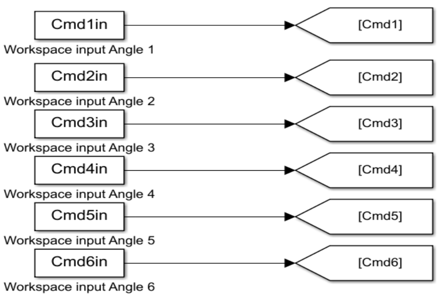

Figure 4. Corner drive module

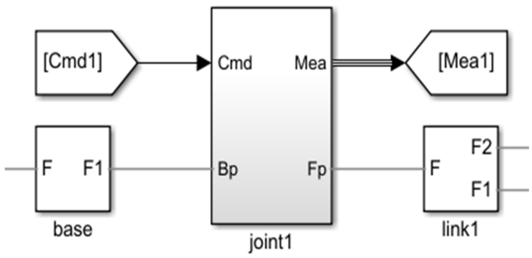

Figure 5.Package execution module

After encapsulating the input module, we need to encapsulate the execution module of the imported IRB6700 robot, as shown in the figure is the execution module, Cmd1 is the input angle of the input drive module, base is the robot base, link1 is the arm of the robot 1, and Mean1 Represents the output data of the robot.

The execution module mainly encapsulates the joint connection, which contains corner drive, joints and output data. As shown in the figure, the inside of the encapsulated execution module, joint is each axis of the robot, and m represents a set of output data, which contains each The axis speed signal, position signal, torque signal, etc., cmd corresponding to cp is the input angle data drive, p corresponding to Mea is the data output.

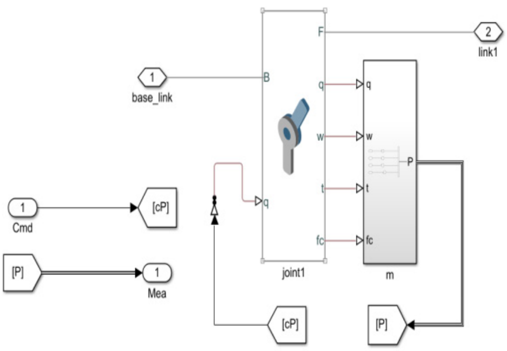

Figure 6. Inside the execution module

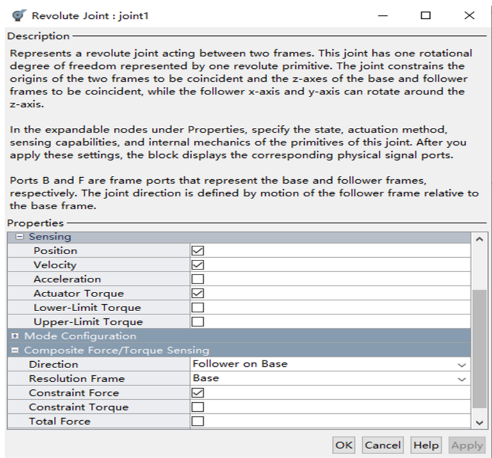

Figure 7. Joint output data type

After completing the joint encapsulation, research on the joint output data. Double-click to open the joint control. The joint control can output a variety of data.

For the parallel mechanism of the robot piston connecting rod, cylinder and robot body, triangle equations are used to solve the kinematic relationship of the mechanism. As shown in the figure, the function is written according to the kinematic relationship of the mechanism.After the completion of the drive module and the actuator, the data output module needs to be packaged.

After completing all the configurations, the overall package model of the IRB6700 robot in simulink and the robot matlab robot human model are shown in the figure.

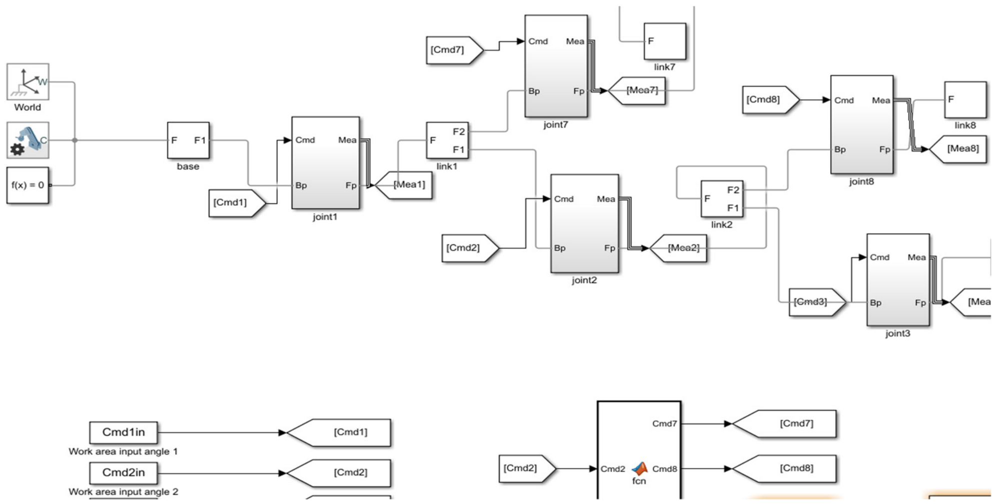

Figure 8. Simulink robot model

4.Robot movement data

Write the function to read the data in the file in the matlab script file, and set it to read in 0.1 seconds. As shown in the figure, it is part of the running data result.

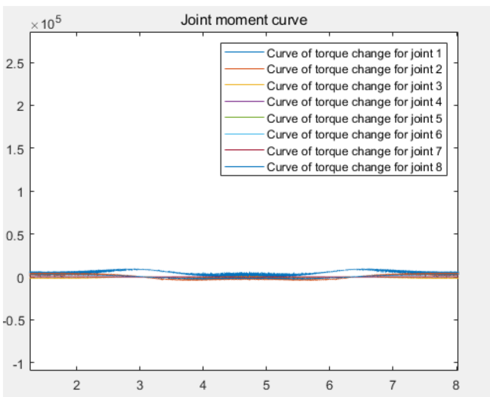

Figure 9. Partial curve of torque change of each join

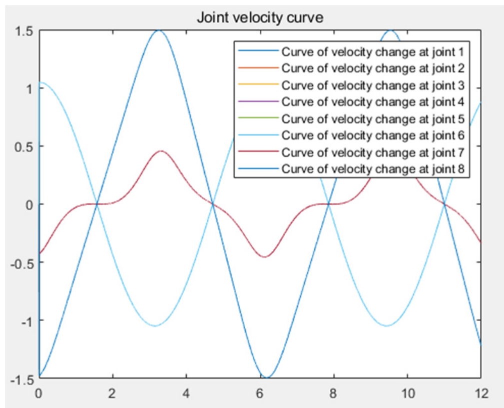

Figure 10. Partial curve of speed change of each joint

5.Conclusions

This paper realizes that the 3D model of the robot is created in solidworks, converted into a URDF file after assembly, and then the optimized model file is imported into the simulink simulation environment to complete the package and output data. Compared with the actual data of the real robot, the difference is small.This model meeting the requirements of the simulation model. The paper designs the parameters of the IRB6700-235 robot, analyzes the kinematics and dynamics of the robot, and uses the model to simulate and obtain good results.

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