Simulation of six-joint robot based on CoDeSys

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ABSTRACT

Along with the wide use of robots in recent years, research on control methods for complex machines and robots developed rapidly. A new method of modeling and simulation of robot based on CoDeSys is proposed in this paper. The paper introduces a graphical software application based on CoDeSys, designed for an open platform to work on six degree of freedom robotics. The complete simulation environment was built by preparing PC software, communicating by PLC technology, setting various parameters of CoDeSys software and programming PLC control system. Furthermore, a full state feedback controller is designed for real-time monitoring of electricity and the operating of the robot.

KEYWORDS

robotics simulation, OPC, CoDeSys

INTRODUCTION

People recognized early the research and application in robot simulation system is important and carried out research work in this area since the 1970s. Simulation technology was initially mainly used in the military field. The 1950s and 1960s, simulation technology began to be used to develop intercontinental ballistic missiles, the Apollo moon program, and other aspects of nuclear power plant operation. Since the 1980s, the development of computer simulation technology by means of technology begins to enter the new era of computer simulation, computer simulation technology began large-scale used in instrumentation, virtual manufacturing, electronic product design, simulation training, other people's production, and all aspects of life.

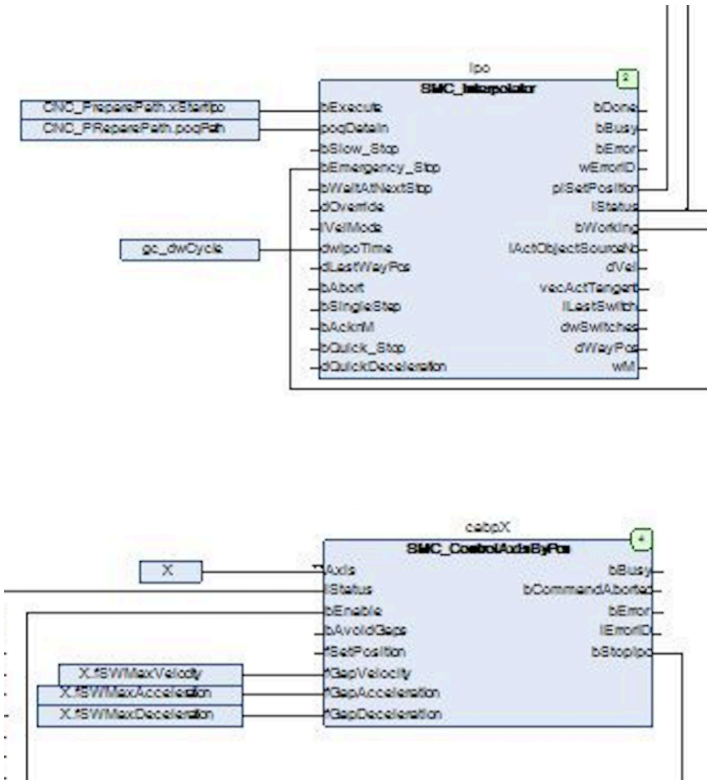
Simulation software is not only dedicated to simulate robot behavior, but also is useful for design, analysis and validation of techniques as collision detection, motion planning, sensor modeling, evaluation of control architectures and so on.

In robot simulation area, the CoDeSys which is a useful and general tool in many fields of robotics has created a controllable robot model, such as manipulator programming, simulating the trajectory of the robot, distance computation， collision detection, motion planning and so on.

About CoDeSys

CoDeSys is a powerful PLC software programming tools with complete development environment (an abbreviation for Controlled Development System), Since the 1980s, the development of computer simulation technology by means of technology begins to enter the new era of computer simulation, computer simulation technology began

large-scale used in instrumentation, virtual manufacturing, electronic product design, simulation training, other people's production and all aspects of life. PLC manufacturers are using CoDeSys platform to develop their own programming software, such as ABB Bachmann, IFM, EPEC.



figure：part of CoDeSys

ABOUT OPC

In this research, the OP interface written in C# combined with CoDeSys, the method used in this paper is OPC communication. OPC stands for Object Linking and Embedding (OLE) for Process Control, it appears as a Windows-based applications and on-site process control applications to establish a bridge. In the past, in order to access the data field devices, each application software developers need to write specific interface functions. Since many types of field devices, and continue to upgrade products to users and software developers often tremendous workload. Typically this does not meet the actual needs of their work, systems integrators and developers have an urgent need for a high efficiency, reliability, openness, interoperability, Plug and Play device drivers. In this case, OPC standard came into being. OPC standard to Microsoft's OLE technology, its development by providing a standard set of OLE / COM complete interface technology used in the OPC is OLE 2 technology, OLE standard allows for the exchange of documents between multiple computer, graphics and other objects.

ABOUT SIX DOF ROBOT MODEL

For six joints robots, it has six rotational axes and 6 degrees of freedom (DoF). Robot wrists at the intersection of the three axes which is at one point. (Fig 1)

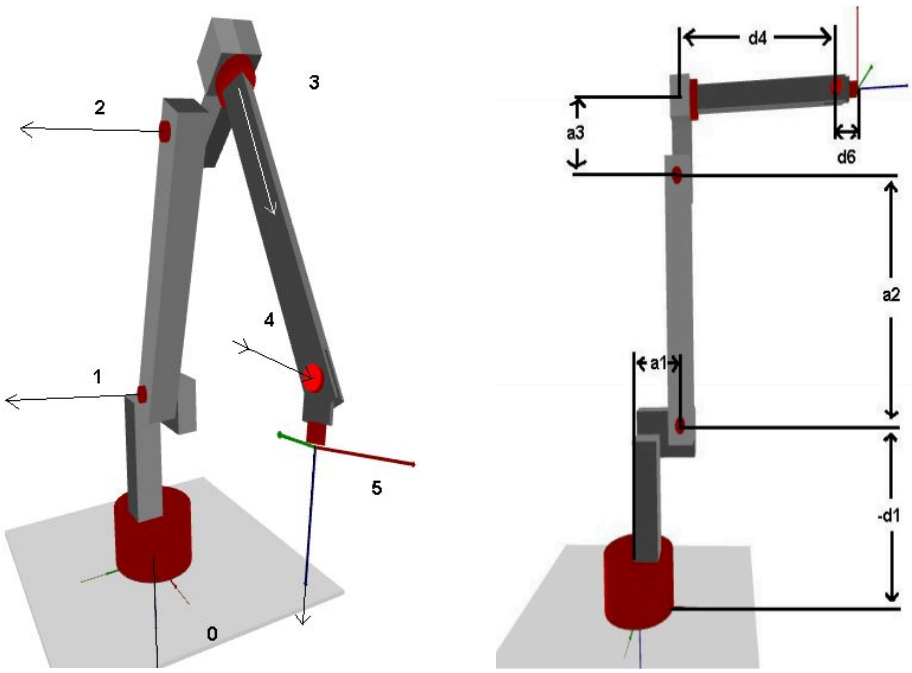


Fig 1: six joints robot model

The direction of rotation indicated by the black arrow. The arrows is along the axial direction. Rotation mode is carried out in accordance with the right-hand rule. For example, when the axis 0 rotated forward, the robot rotated clockwise if you looked down from top.

Axis has the following range limits:

Axis 0,1,3 and 4: [-180°, 180°]

Axis 2: [-90°, 180°]

Axis 5:no limitation，the range of the axes may more than 360°

DH joint parameters as shown in Table 1:

	Joint migration	Connection offset	Connection length	Connection angel
1	0	d1	a_1	-90
2	90	0	a_2	0
3	0	0	a_3	90
4	0	d4	0	90
5	0	0	0	-90
6	0	d6	0	0

Use X,Y and Z system to control the center of the tool, the dimensions and parameters of X,Y and Z are the same as a_i and d_i. the direction in degree is controlled by the A(deflection), B (pitch), and C (reversal).

Based PC in a 3D model and six-joint robot model given in CoDeSys software. The motion of each joint of the robot need to be driven by G code. The input angle of each joint can be obtained by the use of robot kinematics and inverse solution

equations in Robotics. CoDeSys platform integrates a six-joint robot motion equations both in Positive Solutions and Inverse Solution module.

ABOUT PC INTERFACE

PC software is programmed using C # language, the software is VS2010.

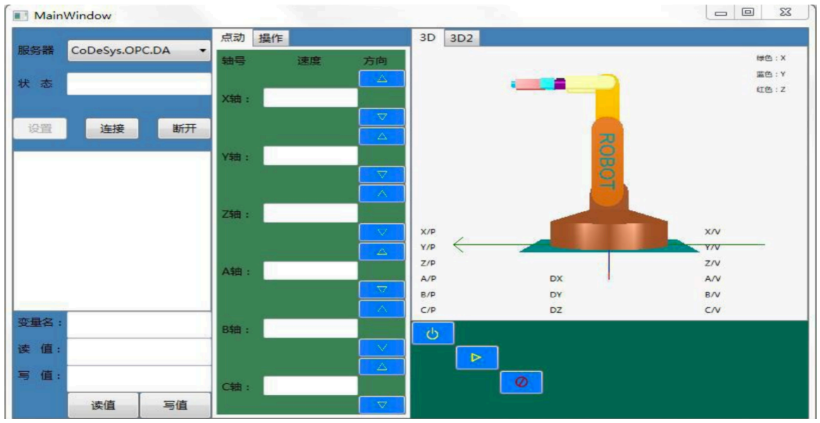


Fig 2: the PC interface

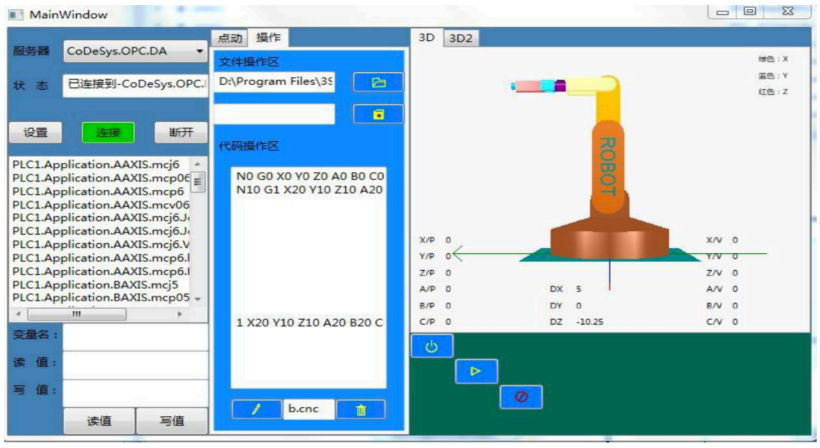


Fig 3: the result 1

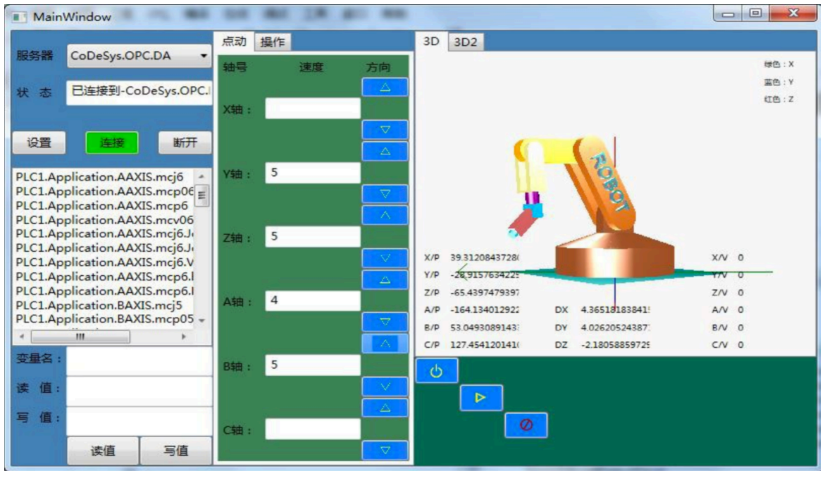


Fig 4: the result 2

CONCLUSION

By CoDeSys software and PC interface, via OPC combined with CoDeSys system, it comes to a complete closed loop, in PC, the joint model robot movement is driven by G code through OPC to passed the CoDeSys system. while the motion control system, we got the real-time status of each joint(real-time location, real-time speed, etc..). It is easy to work intuitively to understand the robot, therefore, we can determine whether the normal motion of the robot, and make the amendments or improvement.

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