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# SELECTED ENGINEERING PROBLEMS

NUMBER 6

INSTITUTE OF ENGINEERING PROCESSES AUTOMATION  
AND INTEGRATED MANUFACTURING SYSTEMS

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## MODELING AND SIMULATION OF INDUSTRIAL ROBOT ON RAIL TRACK

**Abstract:** Industrial robots are used for many tasks, mainly for material handling and welding. The use of additional axis for example rail track allows increase the robot workspace and make the manufacturing of large-size elements possible. The problem is to identify the correct parameters of axis motion. An example of modelling and simulation of robot on a rail track in Roboguide is presented. The obtained model can be used for off-line programming of robot work.

### 1. Introduction

Classic industrial robots are characterized by a relatively large arm range and a large working space. Unless in the case of small items manufacturing such coverage usually is sufficient, but in the case of large-size items with a very large external dimensions, the range of a single robot turns out to be insufficient. Possible solutions of the problem include the use of several stationary robots working side by side. However this solution is difficult and costly. It is also possible to use the rail track, which allows for the movement of the robot or the material along extra axis and additional positioning elements forming extra rotary axes controlled by the robot [6]. Such a solution allows to significantly enlarge the workspace of the robot and to increase the opportunities for the application of industrial robots. As examples, one robot can weld long elements of heavy machinery arms, painting conveyor elements or tending the machine lines [7].

### 1. Robot parameters

The primary parameter describing the robot is the number of axes, reflecting possibility of robot movements. Namely, the two axes are required if the robot can reach any point in the plane. To reach any point in 3D space robot need 3 axes. Robot can maneuver the X-Y-Z axes, however, it cannot tilt or turn. When you increase the number of axes on a robot, you can access more space than with a robot that has a lower number of axes [1].

In order to get an orientation of the final part the robot arm has additional 3 wrist axes. At a minimum, a 6- axis robot is fully free: it can travel through X-Y-Z axes and turn around each axis. The next parameter marked by industrial robot is the number of degrees of freedom

(DoF). It is usually equal to the number of axes of the robot because it talks about a unique determination of the robot system in the space defined by the amount of variables. Workspace is also one of the parameters that describe the range of motion of the robot in space [4]. Adding external axis changes the robot workspace and makes more tasks possible. The Figure 1 shows robot from our laboratory - Fanuc Arc Mate 100iC on rail track.

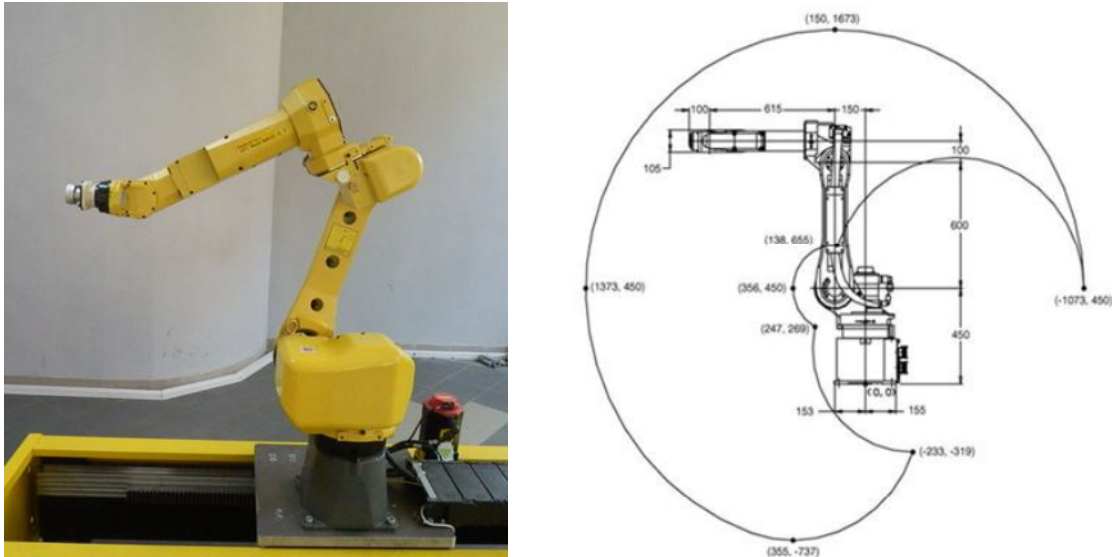


Fig. 1. Fanuc Arc Mate 100iC Robot on rail track and its working space [2]

In order to make off-line programming possible the modelling of robot cell is required [5]. We are using Roboguide software dedicated for Fanuc robots [3].

## 2. Rail track modelling

A robot can have multiple additional extended joints. Auxiliary axes define a set of motors and axes that are combined to accomplish a motion task. The additional axes definitions are created by setup menu at controlled start for the virtual robot.

Robots additional axes can have different configurations [2]:

- Integrated axis: the robot world coordinate system is on the aux axis. The position on the rail (linear) or on the arm (rotary) is added to the robot position.
- Extended axis: the robot world coordinate system is at the robot base. The aux axis device is a joint value and does not participate in defining the robot tool center point location. The position on the rail (linear) or on the arm (rotary) is not added to the robot position.

The procedures for rail track definition as integrated axis of robot are described in Robot Operator's Manual and Roboguide Manual [2, 3]. By the workcell creation stage the Extended Axis Control (J518) tool must be loaded. In Roboguide virtual environment there is also virtual robot and virtual controller (teach pendant) with exactly the same functions as real robot controller and some software tools for modeling and programming of robot cell. The rail track is linked into motion Group1 as extended axis 7. The rail track parameters are included in the table 1.

Table 1. Rail track axis parameters

1 Motor= biS12/3000 40A	9. Accel time1=256
2 Gear Ratio= 32	10. Accel time2=128
3. Ext_type=Integrated Rail ext direction = Y	11 Min accel time=128
4 Joint max speed = 1600 mm/s	12 Load ratio= 3.0
5 Motion Sign= False	13 Axis amp number= 2
6 Upper limit = 1950 mm	14 axis amp type=1
7 Lower limit =0 mm	15 Brake type=1
8 Master position =0	16 servo off enable = disable

Next, the rail track creator can be used to make the model of rail track (Fig. 2).

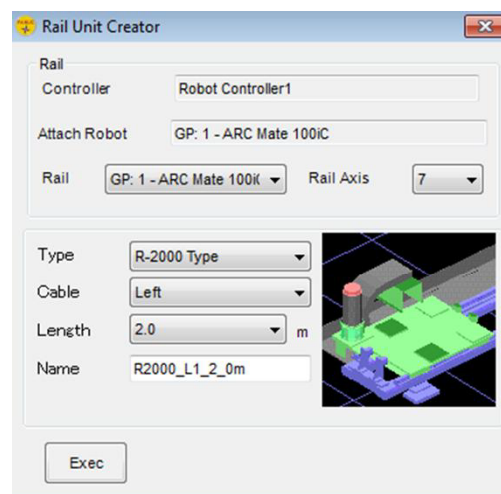


Fig. 2. Rail track creator

Predefined model of Arc Mate 100iC Robot was loaded into workcell and joined with rail track as in the Figure 3.

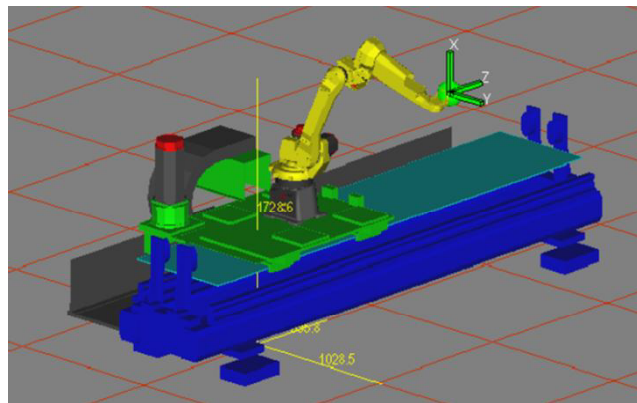


Fig. 3. Robot on rail track

Next other elements of workcell are added into model: fixture, part and tool. Complete virtual workcell for welding of large size elements (to 3 meters long) is shown on Figure 4. It makes possible the off-line programming and simulation.

### 3. Robot programing and simulation

By off-line programming, the virtual teach pendant can be used to teach the robot program in the same way as in real world. It also possible the use of programming wizard or direct input of point coordinates. Each End of Arm Tool (EoAT) can be also used to make moving to a surface simple. The example of defining a robot position with Simulation Program Editor is also presented in the Figure 4. The generation of robot path on the basis of part CAD data it also possible (CAD to PATH). Virtual simulation of robot work allows checking the program and error correction in the early stage of workcell design process.

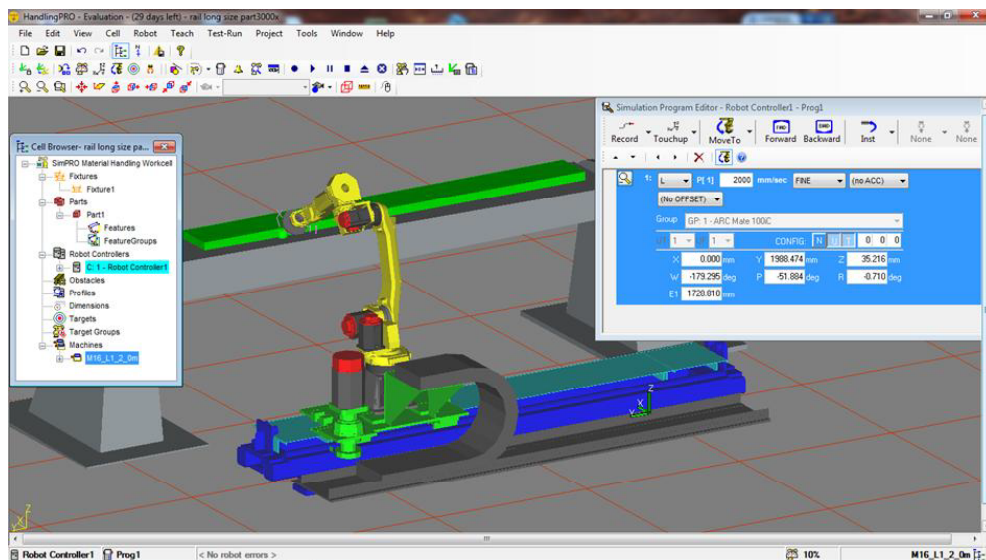


Fig. 4. Example of robot on rail track programming

### 4. Conclusion

The workcell model was used for off-line programming of robot work. Obtained program was tested in virtual environment and then loaded into real robot controller. Test of programmed robot motion on rail track was successful. Designed workcell can be used for further advanced project of real robot workcell.

### References

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