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Main Characteristics and Space Structure of a Moving Industrial Robot

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Annotation: The article describes a number of characteristics of the industrial robot (IR) in the implementation of spatial manipulation operations, namely, the robot's working space, work area, geometric characteristics, coordinate system, the degree of mobility in the process. An IR with six or more links is a complex technical system. Therefore, according to the real construction of the IR, six or fewer links are involved in the technological process. The smaller the number of links, the simpler the control of the robot.

Keywords: Industrial robot, grip device, space, coordinate system, kinematic chain, kinematic pair, positional accuracy

INTRODUCTION

Whether the IR is complex in the technological process or a simple spatial manipulation operation, a number of its characteristics are involved in the process.

The main characteristics of IR are:

The working space of a robot is the space that can be located in the movement of the robot’s actuator.

The working area of the robot is the space in which the robot’s holding device can be located in motion.

The geometric characteristics of the robot's work area are the size of the robot's work area, the cut surface, the linear, angular dimensions, or a set of them.

The basic coordinate system of the robot is a coordinate system with respect to the geometric characteristics of the working area of the robot.

The number of robotic drive levels is the set of the number of free levels of the kinematic chain of the robot’s actuator relative to the base coordinates and the number of free levels of the moving device.

The degree of mobility of a robot between positions is the degree of mobility of a robot using the movement of a robot or the path it traverses using a moving device.

The portable mobility level of the actuator of the IR is the level of mobility of the robotic actuator using the displacement of the gripping device.

The degree of mobility of the actuator in targeting is the degree of mobility of the robotic actuator using the grasp of the target device.

METHODOLOGY

An IR with six or more links is a complex technical system. Therefore, according to the real construction of the IR, six or fewer links are involved in the technological process. The smaller the number of links, the simpler the

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control of the robot. In a very simple IR, the number of links is up to three. Given the complexity of the IR movement, it can be divided into the following types:

- global - the base is specific to moving robots, the movement of the robot base increases the range of motion;
- regional - typical of transport robots, the movement of the links ensures the continuous movement of the material point in the grip device;
- local - the robot restricts the movement of the links, directs the grip device to increase positional accuracy, ie to get the target correctly.

Let us determine the mobility, maneuverability, service angle of the IR in the example of a three-link robot. The appearance of the robot is shown in Figure 1 [106].

Compounds are capital letters of the Latin alphabet A, V, S, and so on. determined by The kinematic pair is 0/1, 1/2, and so on. is shown in the view.

The mobility of the IR is equal to the number of generalized coordinates of the variable that determine the position of the interceptor in space [106]:

$$W = 6n - \sum_{i-1}^{5} (6-i) \cdot p_i \,.$$

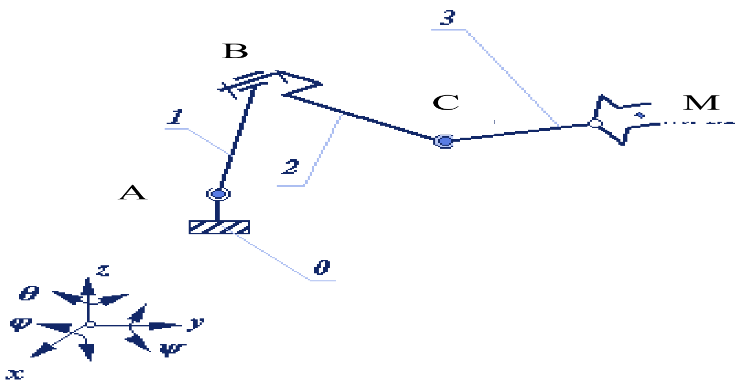

Figure 1. An overview of the three-link IR.

The maneuverability of the IR in the case of a fixed gripping M device is as follows:

$$M = W - 6.$$

MAIN PART

The concept of service angle is introduced in increasing the positional accuracy of the movement of the IR. The service is considered in three-dimensional space, and the number of free levels can be 6, 7 and more. This is because it is necessary not only to lower the gripping device to a given point, but also to direct it to the desired point. The service angle is determined as follows:

$$\psi = \frac{f_A}{l_A} \,,$$

where f_A – is the spherical surface of the last link holding device.

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the length of the holding device is l_A –.

The relative magnitude is $k_\psi = \dfrac{\psi}{4\pi}$ called the service ratio.

The number of mobility of a three-link IR

$$W = 6 \cdot 3 - (3 \cdot 2 + 5 \cdot 1) = 18 - 11 = 7.$$

Maneuverability $M = 7 - 6 = 1.$

Suppose the lengths of l_1, l_2, l_3 –the links are $l_1 \geq l_2 + l_3,\ \ l_2 \geq l_3$ to be comfortable. Let the holding device stand at a *x* point in space.

The maximum distance of the base relative $|x|_{\max} = l_1 + l_2 + l_3$. to the base coordinate system

The minimum distance is $|x|_{\min} = l_1 - l_2 - l_3.$

It is known that there will be a $0 \leq k_\psi \leq 1$ service ratio. To determine the full service area, the following work is performed:

when the zone: $k\psi = 1$

The first zone $l_1 + l_2 - l_3 \geq |x| \geq l_1 - l_2 + l_3.$

The second zone $l_1 + l_2 + l_3 \geq |x| \geq l_1 + l_2 - l_3.$

A comparison for him $l_3^2 + |x|^2 - (l_1 + l_2)^2 = 2|x| l_3 \cos\psi.$

The last zone $l_1 - l_2 + l_3 \geq |x| \geq l_1 - l_2 - l_3.$

A comparison for this zone $l_3^2 + |x|^2 - (l_1 - l_2)^2 = -2|x| l_3 \cos\psi.$

$$f_A = 2\pi l_3^2 (1 - \cos\psi).$$

Service ratio for the second zone $k_\psi = \dfrac{(l_1 + l_2)^2 - (|x| - l_3)^2}{4|x| l_3}.$

Service ratio for the last zone $k_\psi = \dfrac{(|x| + l_3)^2 - (l_1 - l_2)^2}{4|x| l_3}.$

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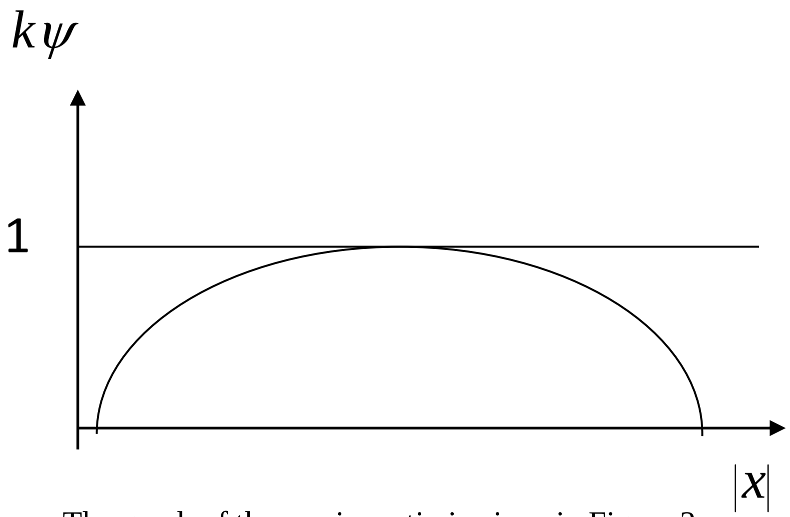

The graph of the service ratio is given in Figure 2.

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