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TOUCH SUBORDINATES MANAGEMENT OF INDUSTRIAL ROBOTS IMPROVING THE POSITIONAL ACCURACY OF THE MATHEMATICAL MODEL

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ABSTRACT

In this paper were discussed the development of mathematical models and algorithms of optimal control of the functioning of industrial robots on the moving base to ensure the accuracy of the trajectory and positioning. Obtained equation of the operation of the industrial robot on a mobile base to perform complex spatial operations and on its basis the mathematical model of optimal control.

KEYWORDS: Industrial Robots, Motion Model, System of Optimal Control, Algorithm

INTRODUCTION

The motion model and control of industrial robots are usually developed based on two components of the system: the base and the actuator of industrial robots. Accordingly, the control system of industrial robots also consists of two parts. For base, the office will direct, and for actuator control with feedback. The analysis of researches shows that there are some drawbacks of the actuators controlled by the feedback system.

- When the movement of the robot together with the detail of the existing models of the force of gravity of the part is only taken into account when calculating the last link – exciting element, and the calculation of the remaining intermediate links, this factor is not taken into account.
- Nonlinearity effects produced by the movement of industrial robots to power factors connections is not taken into account, the movement of the intermediate links are described by differential equations of the second order, as shown by the analysis of the literature with constant coefficients. According to practice, these differential equations should take into account the variability of the coefficients.
- The primary error motion of industrial robots on the moving base is determined using the logical tree of possibilities (LTP) and statistical tests. LTP is the short and simple way, which ensures positional accuracy of the robot on the basis of laws of distribution of discrete primary errors. But this method has its drawbacks. In this model is not clear and the decision is based on knowledge and insights of the person who makes the decision. During a manipulation, not all parameters are taken into account, and the logical movement of parts is represented in the tree-like form. LTP is more consistent with the units which make consistent motion. It does not apply to units performing the movement at the same time.
- The main goal pursued by attracting robots to the production process is accurate and fast execution of all operations process and timely provide customers with quality product or semi-finished product. This is especially noticeable, for example, in the machining processes in mechanical engineering. When compiling the motion

equations of the robot into account external forces, but internal forces are neglected. For example, when the movement of the robot with the detail necessary to consider both external and internal forces.

- Development of methods for control of investigated objects devoid of the above disadvantages is one of the urgent problems in the field of research.

STATEMENT OF THE TASK

Industrial robot impermissible criteria in the standard positional accuracy robots play an important role in the implementation of specific process or operation. Therefore, in this paragraph, the management of touch sensor, the robot motion on the issue of increasing positional accuracy in detail.

Industrial robot work zone in the form of a closed three-dimensional space, touching the device is closed as a result of movement in space is important to issue the necessary trajectory.

Is drawn inside the zone parallelepiped. Because the three-dimensional space is larger than the circulation figures parallelepipeddir.

Cylindrical coordinate system for robots working in the zone height and the radii of the inner form of concentric cylinders. This came to be drawn inside the inner cylinder, parallelepiped and the projection of the plain view of Figure 1 [1, 2].

In accordance with the right sides of the rectangle x_1 and x_2 get. The participation of the parties $f_0(x_1, x_2)$ function to be formed. As a result, $f_0(x_1, x_2)$ suspended the issue of finding the maximum of the function.

$$f_0(x_1, x_2) = x_1 x_2 \to \max$$

Figure 1 $f_1(x_1, x_2) = 0$ should be.

$$f_1(x_1, x_2) = (r + x_1)^2 + \left(\frac{x_2}{2}\right)^2 - R^2 = 0$$

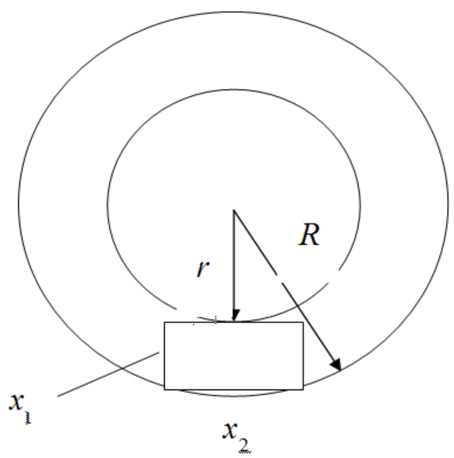

Figure 1: Concentric Cylinders and the Interior Parallelepipedning Plane

Projection

Lagranj factors such practices.

$$L(x_1, x_2, \lambda) = x_1 x_2 + \lambda\left[(r + x_1)^2 + \frac{x_2^2}{4} - R^2\right]$$

Extreme necessary conditions

$$\begin{cases} \dfrac{\partial L}{\partial x_1} = 0 \\ \dfrac{\partial L}{\partial x_2} = 0 \\ \dfrac{\partial L}{\partial \lambda} = 0 \end{cases}$$

As a result, the following system of equations is formed.

$$\begin{cases} x_2 + 2\lambda(r + x_1) = 0 \\ x_1 + \dfrac{x_2}{2}\lambda = 0 \\ (r + x_1)^2 + \left(\dfrac{x_2}{2}\right)^2 - R^2 = 0 \end{cases}$$

This equation system s the unknowns will $x_3 = H$ be found. Spherical coordinate system for mobile robots is the radius of the base of the zone in view of the cylinder and sphere radius drank deeply figure. Cferik and angular coordinate system moving robots work zone analysis showed that the shape of the geometric point of view, the size of the space, draw concentric sphere figura that this parallelepiped. (Figure 2).

Parallelepiped active x_1, x_2, x_3 get.

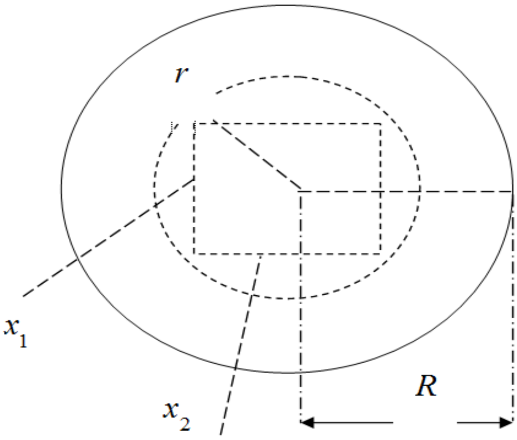

Figure 2: Draw Concentric Spheres, and Parallelepipedning Plane Projection

The issue is to find a $f_0(x_1, x_2, x_3)$ function to achieve the maximum x_1, x_2, x_3 respectively.

$$f_0(x_1, x_2, x_3) = x_1 x_2 x_3 \rightarrow \max$$

At the same time, $f_1(x_1, x_2, x_3) = 0$ you need to know.

$$f_1(x_1, x_2, x_3) = (r + x_3)^2 + \left(\frac{x_1}{2}\right)^2 + \left(\frac{x_2}{2}\right)^2 - R^2 = 0$$

Lagranj function.

$$L(x_1, x_2, \lambda) = x_1 x_2 x_3 + \lambda\left[(r + x_3)^2 + \left(\frac{x_1}{2}\right)^2 + \left(\frac{x}{2}\right)^2 - R^2\right]$$

Extreme necessary conditions

$$\begin{cases} \dfrac{\partial L}{\partial x_1} = 0 \\ \dfrac{\partial L}{\partial x_2} = 0 \\ \dfrac{\partial L}{\partial x_3} = 0 \\ \dfrac{\partial L}{\partial \lambda} = 0 \end{cases}$$

As a result, the following system of equations is formed.

$$\begin{cases} x_2 x_3 + \lambda x_1 = 0 \\ x_1 x_3 + \lambda x_2 = 0 \\ x_1 x_2 + 2\lambda(r + x_3) = 0 \\ (r + x_3)^2 + \left(\frac{x_1}{2}\right)^2 + \left(\frac{x_2}{2}\right)^2 - R^2 = 0 \end{cases}$$

This equation system the x_1, x_2, x_3 unknowns found.

Recognized by the sensor, the robot after the capture device can determine where parallelepipedning standing.

[1] parallelepipedning nine points, each point draw a small parallelepipedlar. Industrial robot motion trajectory study of the decline of the trajectory that transition into a nine point names in the chain of use [62]. Hamilton chain ordinary chain, once a nine point of the broken line trajectory. The participation of a large parallelepiped can make lots of chains of Hamilton. Therefore, it must be named Hamilton chains in the chain tanlansinki, the minimum length.

In this case, the accounting books after the chain length of at least equal to the following:

$$L = 4x_3 + 3x_1 + \sqrt{\frac{x_3^2}{4} + x_1^2}$$

This approach has the following advantages:

- In the form of a sensor, the robot is the main zone is formed;
- Graph theory through the use of a closed three-dimensional space, trying to touch the robot trajectory is formed;
- Parallelepiped aspects of determining the length of the sensor, the robot does not need to express the full kinematics analytical response.

TOUCH CONTROL FOR INDUSTRIAL ROBOTS ALGORITHM FOR DETERMINING THE POSITIONAL

Touch control sensor on the robot positional accuracy issues are resolved as follows: the appearance of a spherical coordinate system for the robot motion sensor zone radius of the base of the cylinder, the sphere radius of the inner figure, and the height of the cylindrical space objects on the basis of the drawing and they find out the benefits of parallelepiped The third point mentioned in chapter nine times through the issue of selection of names in the broken lines in the minimum uzunlikdagisini algorithm developed. Algorithm block sequence diagram in Figure 3.

- the beginning.
- The first information to verify the sensitivity of the sensor, the robot: the robot sensor mechanism acting insecure spent during the first point to the second point of time (t_0, T), Directions parallelepipedning x_1, x_2, x_3, that characterizes the work zone cylinder radius r, R, the height of the cylinder, the lengths of sensor robot insecure $l_i, i = \overline{1, N}$ multilink in $t = t_0$ the speed and location coordinates.
- The objective function

  $$f_0(x_1, x_2, x_3) = x_1 x_2 x_3 \rightarrow \max \;\; f_1(x_1, x_2, x_3) = (r + x_3)^2 + \left(\frac{x_1}{2}\right)^2 + \left(\frac{x_2}{2}\right)^2 - R^2 = 0$$

  to create the equation.
- Lagranj function.

  $$L(x_1, x_2, \lambda) = x_1 x_2 x_3 + \lambda\left[(r + x_3)^2 + \left(\frac{x_1}{2}\right)^2 + \left(\frac{x}{2}\right)^2 - R^2\right]$$

- Lagranj Extreme conditions necessary for the function check.
- create a system of algebraic equations.

- 6-Kramer method of solving the system of equations of the block.
- found x_1, x_2, x_3 solutions to create a chain of Hamilton. $L = 4x_3 + 3x_1 + \sqrt{\frac{x_3^2}{4} + x_1^2}$.
- $\dim L \to \min$ must do, 10-otherwise block 2-unit.
- at the end.

CONCLUSIONS

Thus, as a result of the system analysis of robotic systems found that existing mathematical models and provide a high degree of performance and positional accuracy of industrial robots on a movable base. The resulting equation of the operation of the industrial robot on a mobile base to perform complex spatial operations and on its basis the mathematical model of optimal control. On the basis of theoretical and experimental results of the constructed model to ensure a local minimum of errors in the equations for the coefficients.

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