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MATHEMATICAL MODEL OF CHECKING THE BEHAVIOR OF AN INDUSTRIAL ROBOT IN THE STRUCTURE OF A TECHNOLOGICAL MODULE FOR STAGNATION

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Abstract; this article provides scientific research on the participation in the mathematical model of checking industrial robotics for stagnation in the structure of the technological module, as well as the parameters of the control function

Keywords; technological module, trajectory, praragraph, coordinate, Cartesian coordinate, adaptive control, movement trajectory

There are only one criteria for checking the stagnation of autonomous controlled systems, the following conclusion can be drawn on their application by analyzing them:

Stagnation is a property of movement that has a qualitative character, and not in the form of quantity. Therefore, in the criterion of stagnation in the meaning of Lyapunov, it is necessary to choose a small amount in such a way that the trajectory line with the deviation of the movement should not go out of the circle.

The criterion of stagnation in the meaning of Lyapunov is expressed in mathematical language as follow

Optional $\varepsilon > 0$ for such $\eta = \eta(\varepsilon)$ become available, $t = t_0 \left\| y_0 - y_0^{'} \right\| < \eta(\varepsilon)$ all for inequality $t > t_0$ for $\left\| y - y^{'} \right\| < \varepsilon$ According to the President of the Republic of Tajikistan Emomali Rahmon, during the meeting the parties expressed satisfaction with the development of cooperation between Tajikistan and China.

Hurwitz value turgunlik Mezon characteristic of tenglama darajasi 4 $(n < 4)$ it is desirable to apply without top.

The stagnation criterion in the sense of Raus gives a quick answer in a given number of coefficients.Characteristic equation level from 4 $(n > 4)$ it is desirable to apply with high.

The criterion of stagnation in the meaning of Lenara-Shiparo is very close to the criterion of stagnation in the meaning of Raus. Characteristic equation level from 5 $(n > 5)$ it is desirable to apply with high.

The criterion of stagnation in the meaning of Mikhailov is appropriate to apply when determining the necessary change in the structure of the system, when researching complex multi-contour systems.

The frequency criterion of stagnation has a simple geometric interpretation and allows you to check high-order systems for stagnation.

The stagnation criterion in the meaning of the Naykvist is useful in the research of complex systems. This criterion can be used in the analysis of systems represented by analytical functions, when all or partial characteristics of individual elements of the system are given with reference to the experiment.

Structural stagnation. If some values of the system parameters are stagnant, then it will be structurally stagnant.

The issue of structural stagnation occurs when additional zveno is introduced.

In the implementation of complex spatial opera by an industrial robot, the transition from one point to another can be controlled multivariate. Each of the trajectories drawn from its motion characterizes a separate system of differential equations

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In the structure of the technological module, the control of industrial robots is multivariate and complex, especially this can be clearly seen in the control of robots with a zvenolar number higher than three . Checking a suitable controllable system solution for stagnation creates a real challenge.

Positioning precision is one of the important characteristics of an industrial robot. It determines the possibility of using an industrial robot to carry out the technological process. In practice, an industrial robot does not stop at a given or planned point in the implementation of a technological operation, but stops around this point. This deviation of the capture device of an industrial robot is called positional error or positional deviation.

As you know, enough work has been done to improve the accuracy of robotic positioning. The functional-parametric compatibility model with the components of the module in the correct Organization of the work of an industrial robot in the structure of the technological module cannot provide the positional accuracy of the robot. When an industrial robot moves with a detail, a deviation is observed in relation to the trajectory in an ideal position. This deviation represents an ellipsoid in space.When we realize that industrial robots act between two points within a technological module, it goes from one point to another to look different, that is, it can be controlled differently. In the specified time situation, the total number of industrial robots working arm motion trajectory is equal to :

$$N_{\Pi C} = \prod_{j=1}^{N} n_j \left(N! + \sum_{k=1}^{N} C_N^k (N-k+1)! \right.$$

In general, in the conditions of technological preparation of production, the technological module contains the following view of the control of the behavior of industrial robots:

Programmatic control of industrial robots by speed, acceleration and force in Descartes coordinate system.

1. Adaptive control.

From management theory it is known that in order to transfer a system from one point to another to a bounded waqut, a continuous i(t) control function had to exist. The passage of a fragmentary-continuous Hamar along with the continuity of the management function in Aekin technical systems was considered in the previous praragraph. Since when transferring industrial robots from one point to another, each zveno has to be controlled, the subtraction of the function relative to the time of the cosy slope. In the management of industrial robots in the structure of the technological module $u(t) = (u_1(t), u_2(t), \dots, u_n(t))$ the parameters of the management function are involved. Here,$u_i(t)$ $i-3$venoni exhaust control function.The control function is borderline from above, that is, it is $\varepsilon > 0$available, $|u_i| \le \varepsilon < \infty$ $(i = \overline{1,n})$, Taking the number of industrial robots in operation as n, every zveno is worth $E_i (i = \overline{1,n})$ −yaar biyaan was marked. While some of the industrial robots are run by paramel, some are run by a ketechnological module. This makes it clear that the coordinate system underlying the study of the behavior of his working hand is not enough. Therefore, a zvenoni-compatible coordinate system in every movement is filled by biyaan. Their spaces that involve action

$H_1, H_2, \dots, H_n$let. $H_1, H_2, \dots, H_n$

one of the bi ethan $H_i \ne H_j, \quad i \ne j (i, j = \overline{1,n})$.

In the structure of the technological module, the control of industrial robots is multivariate and complex, especially the control of robots whose zvenos number is higher than three, which can be clearly seen Checking the solution of a suitable controllable system to a stable one creates a problem. Therefore, it is possible to divide industrial robots from the AVV into those parts that satisfy and do not satisfy the stability of the solution. Tengamani when checking the solution for stagnation$z(t) = \Lambda(t) z(t)$the solution to the nomination, taking autonomous viewshaa $z_0(t)$the difference between the optional z(t) solution of the Biyan equation is that an infinitely small amount must be tilted.$z(t) - z_0(t)$ spinning too $\frac{d}{dt}[z(t) - z_0(t)] = A(t)[(z(t) - z_0(t)]$there must be a tengyaamani solution .If the Arap is z(t)=0, it is sufficient to check that the xolaaa z_0 (t) trivial solution is stable. This approach is convenient only when the industrial robots zvenos are all operated by a ketechnological module a-ket or paramee. If arayaash looks, it will cause some difficulties due to the fact that the control function is a subtracted fuknsia. It is better to resort to an approach to the khomaa regime stagnation.

By taking each of the above phases as invariant phases, the following can be checked based on the condition of structural stagnation [84]:

1). $H_i = H_i^1 \oplus H_i^2 \quad i = (\overline{1,n})$ part Space

(3.16)invariant part space for a condition-satisfying solution of the Equinox system (3.17;

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2). H_1invariant partfazo to $\rho < 1$if the number exists, $\| Ax \| \leq \rho \| x \|, \forall x \in H_i^1$and $\| Ay \| \leq \rho^{-1} \mid y \|, \forall y \in H_i^2$if the conditions are met.

In order to check the solution for stagnation, stagnation in another modem will remain a characteristic sonyaar. A specific sonyaar cannot always be found from a structured characteristic equation, Sometimes it corresponds to an approximate calculation. This can lead to an error in giving industrial robots a trajectory of movement. Therefore, in order to check the stability of the solution, let's show that another model is equivalent to the masayaan, Ayapunov model. The ayapunov modeliaa solution becomes stagnant, when the difference between the two solutions is in the initial timeare,.$t = t_0$At any$\delta > 0$if smaller than, $t \geq t_0 \varepsilon > 0$it had to be small. That is, if we say that the solution φ(t), then it is xamaa the second solution ψ(t), and |φ(t_0)-ψ(t_0)|<δ,|φ(t)-ψ(t)|<ε if the conditions are met, then the solution φ(t) will be stagnant.

Since the second solution is optional ψ(t)≡0 to say trivial solution, it follows that xolaa φφ (t)<ε. This results in the fact that at every moment of time, the out-of-the-box technology module is given. That is, those giving soxa φ(t) will be invariant for the solution. if we say ε from an arbitrary small quantity ε=ρ, then the second condition xam is fulfilled.

So given 1) and 2) as long as the conditions are equivalent to the lyatunov model.

Based on all this, the following Lemma can be cited as a conclusion.

Lemma. Checking the system solution for stagnation (1), which represents the behavior of industrial robots, the Ayatunov model with structural stagnation is equivalent to each other.

The structural model of checking the behavior of industrial robots for stagnation can be checked with a different modelyaar from the Lipunov model. Positioning precision is one of the important characteristics of an industrial robot. It determines the possibility of using an industrial robot to carry out the technological process.

In practice, an industrial robot does not stop at a given or planned point in the implementation of a technological operation, but stops around this point. This deviation of the capture device of an industrial robot is called positional error or positional deviation.

As you know, enough work has been done to improve the accuracy of robotic positioning. The functional-parametric compatibility model with the components of the module in the correct Organization of the work of an industrial robot in the structure of the technological module cannot provide the positional accuracy of the robot. When an industrial robot moves with a detail, a deviation is observed in relation to the trajectory in an ideal position. This deviation represents an ellipsoid in space.

There are not only internal factors, but also external factors that resist the positioning accuracy of an industrial robot. For example, the main causes of deviations include technological uncertainty in the preparation of industrial robot zvenos, gaps in the connection of kinematic chains, an error in the assembly of individual nodes, uncertainty in the movement of the control system, elastic (non-slip) deformation, etc.k.

Gaps in the connection of kinematic zvenos lead to the appearance of lyuft(narrow spacing). This in turn causes not only a static, but also a dynamic error. If the kinematic chain contains only one lufts, the industrial robot will worsen its work and will lead to an increase in the positional error.

Elastic deformation occurs as a result of the elasticity of industrial robot zvenos. Elastic deformation in the movement of an industrial robot is manifested separately in dynamics, and the resulting error in each zveno leads to an increase in the error of the common executor mechanism.

To determine the positional deviation, the industrial robot will have to analyze the source of each of the above errors, which simultaneously affect the movement of the zvenos.

From management theory it is known that a continuous u(t) control function had to exist in order to move the system from one point to another at a time limited to one point. But in technical systems, the passage of fragmented-continuous points along with the continuity of the control function was considered in the previous paragraph.Stochastic control theory developed rapidly with the advent of new flying machines. Currently, a lot of work has been done on the theory of stochastic systems, and the necessary results have been obtained in them. The principles of stochastic management are used on a large scale in various branches of industry, for example, in electronics and electrical engineering, chemistry, metallurgy, mechanical engineering, flight control and other fields. Stochastic control systems are divided into two large classes: self-organizing and self-adjusting systems. Self-organized systems characterize not only the change of parameters in the process of forming a control algorithm, but also the search for the necessary regulator structure to achieve the set goal. This class of stochastic management system is currently used on a large scale in practice, as it is simple to study and analyze. Self-adjustable systems, in turn, are divided into two large classes: searcher and non-seeker. Changes in the parameters of the control device in search engines will be available as a result of the search for extremum under the quality criterion based on the search engine.

Models with expected dynamic properties in non-searchable systems are given in both transparent and non-disclosure views. 17 for the construction of stochastic control systems, the following methods are used: Lyapunov method, stochastic approximation method, target recurrent inequalities method, quadratic criterion of absolute stagnation, methods based on the identification approach, etc.k. Also, the use of Noravshan models in Noravshan management made it possible to create knowledge bases and expert systems of a new generation capable of storing and processing ambiguous information. In general, Noravshan models are an information-logical model of a system built on the basis of the theory of sets and logics. The Noravshan model is an information-logical model of a system based on Noravshan set theory and Noravshan logic. One of the characteristic signs of the complexity of building a model is the ambiguity of the structure or behavior of the original system.

In other models to check the solution for stagnation, stagnation remains dependent on specific numbers. Specific numbers cannot always be found from the structured characteristic equation, Sometimes the approximate calculation is correct. This can cause an error in giving industrial robots a trajectory of movement. Therefore, in order to check the stagnation of the solution, let's show that another model is equivalent, for example, to the Lyapunov model.

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