ALGORITHMIZATION AND MODELING OF TRAJECTORY PROBLEMS FOR MECHOTRONIC SYSTEMS ON THE MECHANISMS OF PARALLEL KINEMATICS

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Mechatronic systems find a big application in different technical spheres, including instrument producing, electronic machine producing and also in radar and navigation systems, where high resolution by positioning of linear and angular coordinate displacements is require [1]. Wherein the problem of controlling was formulated as the problem of creating a controlled multi-coordinate motion with a given law of velocity on the trajectory and ultimately was reduced to finding the control coefficients of the differential system:

$$\begin{aligned} \dot{x} &= u_{11}(t)x + u_{12}(t)y + u_{13}(t)z, \\ \dot{y} &= u_{21}(t)x + u_{22}(t)y + u_{23}(t)z, \\ \dot{z} &= u_{31}(t)x + u_{32}(t)y + u_{33}(t)z, \end{aligned} \tag{1}$$

describing the state space of a multi-axis system with speed.

Since the system (1) satisfies the existence and uniqueness theorem and has an identically zero solution, none of its phase curves l can pass through the origin, that is, the coordinate condition must be satisfied:

$$X^2 + Y^2(t) + Z^2(t) \neq 0, \quad \forall t, \tag{2}$$

where $X(t)$, $Y(t)$, $Z(t)$ – functions, specifying the law of motion points.

If not impose any additional restrictions on the matrix of coefficients of system (2) in advance, for any curve l not passing through the origin, we can determine the coefficients $u_{ij}(t)$, $i, j = 1, 2, 3$, of system (2) immediately and in general form, so that l it is its phase curve. Indeed, given the expression (2) and denoting

$$D = X^2(t) + Y^2(t) + Z^2(t),$$

finally get:

$$\begin{aligned} u_{11}(t) &= \frac{X(t)\dot{X}(t)}{D}, \quad u_{12}(t) = \frac{Y(t)\dot{X}(t)}{D}, \quad u_{13}(t) = \frac{Z(t)\dot{X}(t)}{D}, \\ u_{21}(t) &= \frac{X(t)\dot{Y}(t)}{D}, \quad u_{22}(t) = \frac{Y(t)\dot{Y}(t)}{D}, \quad u_{23}(t) = \frac{Z(t)\dot{Y}(t)}{D}, \\ u_{31}(t) &= \frac{X(t)\dot{Z}(t)}{D}, \quad u_{32}(t) = \frac{Y(t)\dot{Z}(t)}{D}, \quad u_{33}(t) = \frac{Z(t)\dot{Z}(t)}{D}, \end{aligned} \tag{3}$$

where vector-function $[X(t), Y(t), Z(t)]^{\text{т}}$ will be the solution of the system (1).

Thus, we have obtained control functions in the form of coefficients $u_{ij}(t)$ for the implementation of which the control system ensures spatial motion with a given speed law.

The control system of a multi-axis mechatronic system with a multi-axis drive consists of the required number of single-axis electromagnetic modules of linear and rotary types. It integrates all autonomously controlled electromagnetic motion modules with a special controller with a top level control from a personal computer into one control system. In this case, to simulate the control system for the drive of the mechatronic displacement system, it is sufficient to create a mathematical and computer model of control of one of the independent modules.

Based on this algorithm, a software module was developed in the MATLAB environment using Simulink tools for coordinate control systems in three-dimensional space of mechatronic systems on reconfigurable mechanisms of parallel kinematics.

References

1. Karpovich S. E., Kuzniatsou V. U. et. all. *Systems of multi-coordinate displacements on the mechanisms of parallel kinematics*. Minsk: Bestprint, 2017.