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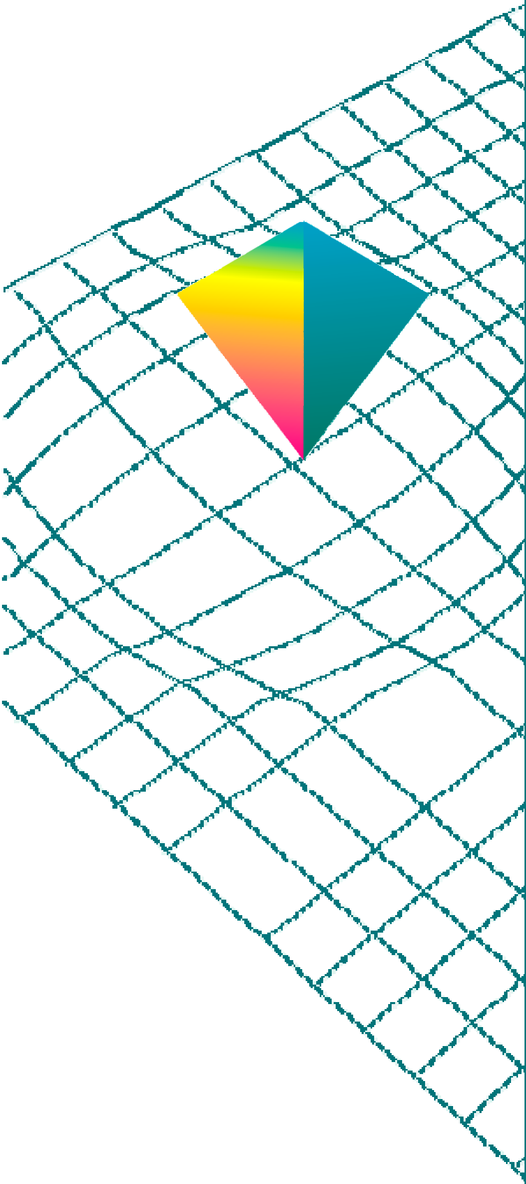

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50. Internationales Wissenschaftliches Kolloquium
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The Dynamics of the Microrobot with Three Fulcrums on the Planar Surface

ABSTRACT

Microrobots achiveved wide distribution in many fields of technics. There is well known area of application of the microrobot for the transportation of the instruments and devices within the channels of small diameter. Piezo drive is one of the most efficient. The design of microrobot is developed by us, which implies three fulcrums. Moreower, one of the legs is formed by the "tail" of the robot. The theoretical basis of the structure is considered in the work presented.

THE FORMALISM

The structure is considered that has three fulcrums on the planar surface, which moves by excitation of high frequency (ultrasonic) oscillations in the fulcrums. In contrast to the existing designs of microrobots with four, six fulcrums the robot considered in this work has tree fulcrums. Moreover the third fulcrum is formed by the “tail” of the robot. Thus the basing of the whole structure on the planar surfaces can be maintained more effectively. The robot’s “legs” motion during operation can be represented as the complex ultrasonic oscillations. The motion control is implemented on the base of frequency modulation of the waves in the fulcrums providing high flexibility of the control. Fig. 1 shows the scheme of the microrobot.

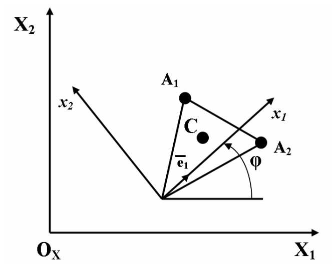

Fig.1

Here, the absolute coordinate system $X_1O_xX_2$ and the mobile system X_1OX_2 related to point O presented. Let the angle φ be the course angle of the robot. C – mass centre of the robot. The next relations are equitable: $A_1A_2=2l$, $OA_1=OA_2=l_1$.

The velocity of the movement of the point A_α, $\alpha = 1,2$ can be written as:

$$\overline{V}^{(\alpha)} = \left(V_0 + l\omega_i^{(\alpha)}\right)\overline{e_1} \tag{1}$$

where $\omega_i^{(\alpha)}$ – axial angular velocities of points A_1, A_2.

Equation (1) corresponds to the case when points A_1, A_2 rotate in plane // $\overline{e_1}$, which provides maximal velocity of the forward movement. On the base of the laws of impulse and moment of impulse variation mechanics the equations of the body dynamics can be written as follows:

$$\frac{d\overline{P}_0}{dt} = -\sum_{i=1}^{2}\left(F_i^{(1)} + F_i^{(2)}\right) \tag{2}$$

$$\frac{d\overline{K}_0}{dt} = -\sum_{i,\alpha}\left[\overline{R}_i^{(\alpha)}\overline{F}_i^{(\alpha)}\right] - \sum_{i,\alpha}\overline{M}_i^{(\alpha)} \tag{3}$$

Let's consider points A_1 and A_2 are leading ones in this case and point O is passive fulcrum. However, in more common case it is possible to activate three fulcrums or excite them in pairs (elements in touch with the plane). The common equations of the microrobot dynamics can be evaluated from Eq. (1)-(3). After several conversions the system of nonlinear dynamic equations is obtained, which describes the microrobot motion under the influence of ultrasonic oscillations.

CONCLUSIONS

The formalism considered in the work allows us to solve practical problems of the microrobot design with given technical characteristics and to evaluate the laws of the motion control.

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