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SOME ASPECTS OF COMPUTER DYNAMIC GEOMETRICAL MODELING OF MILLING PROCESSES

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The method of computer dynamic geometric modeling for milling processes based on structural-parametric approach to shaping is proposed in this article. The prospective directions for further scientific research have been determined.

Keywords: computer dynamic geometric modeling, structural-parametric approach to shaping, milling.

Formulation of the problem. Currently, the scientific problem of increasing the efficiency of various industrial processes is quite relevant. Milling - this is one of the most widespread in machine building methods of cutting. Widespread introduction of computer information technology practices contributes to the productive resolution of the above tasks. This article is devoted to working out the above-mentioned questions for dynamic formation on the principles of structural-parametric approach.

Analysis of recent research and publications. The main provisions of structural-parametric geometric modeling are given in the publication [1]. The paper [2] describes the theoretical foundations of the method of poly parameterization, which can be successfully used for computer reproduction of many technological processes, in particular, rolling [3] and drilling [4]. The urgent issues now appear further expansion of the scope of practical application of relevant scientific results.

Formulating the goals of the article. To propose a new method of computer dynamic geometric modeling of milling processes on the basis of a structural-parametric approach to forming.

Main part. Let's present the resulting material on the example shown in Fig. 1 rough milling of open planes by end or end mills under the "zigzag" scheme [5], where the initial cutter is in the form of a plate in the form of a rectangular parallelepiped measuring l, b, h along the axes of the Cartesian coordinate system $Oxyz$.

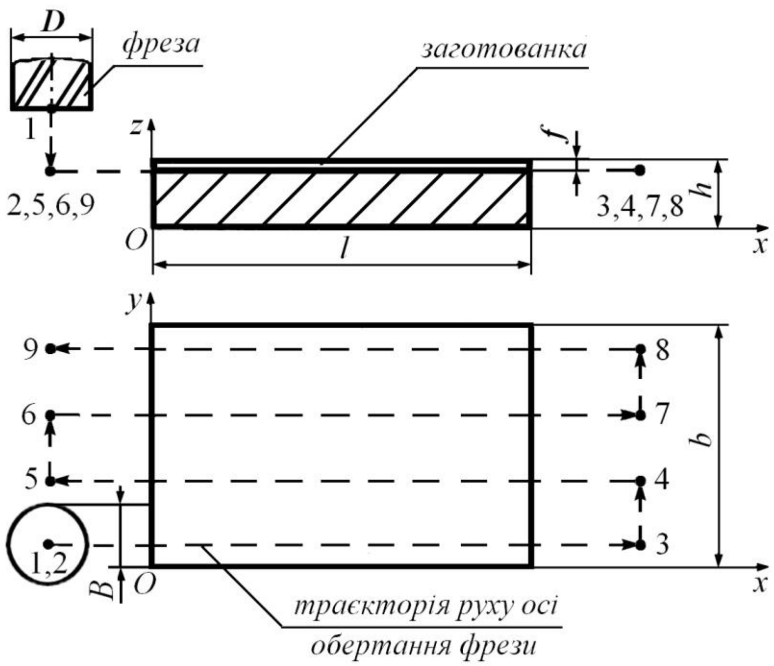

Fig. 1. Scheme of treatment of planes:
l, b. h – gauge measurements; *D* – milling cutter diameter; *f* – cutting depth; *B* – milling width; 1 … 9 – the tops of the lobe, which defines the trajectory of the axis of the milling cutter

According to the figure shown, the milling width *B* and the diameter *D* cutters are connected by the dependence:

$$B = kD, \tag{1}$$

where $k \in (0, 1]$ – the width of the milling parameter.

On the basis of expression (1) we write:

$$D = aB, \tag{2}$$

where $a=1/k$, $a \in [1, \infty)$ – diameter cutter option.

Publication [6] shows that in practice for the end mills a gap is used:

$$a \in [a_n, a_к] = [1{,}3; 1{,}8]. \tag{3}$$

Requirements for smooth cutting and quality treatment require compliance with the following condition of the milling cutter:

$$D - B = c, \tag{4}$$

where $c \in (0, D)$ – cutter offset parameter.

According to the work [6] for the end mills the gap is used:

$$c \in [c_n, c_к] = [0{,}03D; 0{,}5D]. \tag{5}$$

According to the formulas (4) and (5) we have the width of the milling:

$$B = D - c, \quad B \in [D - c_{\kappa}, D - c_{n}] = [0{,}5D; 0{,}97D]. \tag{6}$$

Let the size of the workpiece $l = 440$ mm, $b = 300$ mm, $h = 80$ mm and you must remove the allowance $f = 5$ mm for $n = 4$ work moves.

We select the approximate desired milling width:

$$B = b / n = 300 / 4 = 75\,\text{мм}. \tag{7}$$

According to the expressions (2), (3) and (7), we calculate the proper diameter of the mill and round it to the standardized value D = 100 mm. Verify compliance with condition (6). On the basis of the ratio (4) we expect the displacement of the cutter $c = D - B$ = 100 - 75 = 25 mm.

Consequently, the ordinate bi parallel to the x-axis of the straight line, along which during the *i*-th operating motion the axis of the cutter moves, is determined by the dependence:

$$b_i = D / 2 - c + B(i - 1), \tag{8}$$

where $i \in \{1, \dots, n\}$, $n \in$ N – number of work moves.

Let position 1 of the lower point of the cutter on its axis of rotation in the coordinate system of the *Oxyz* workpiece is described by the vector

$$\boldsymbol{P}_1 = (x_1, y_1, z_1), \tag{9}$$

where $x_1 < 0$, $|x_1| > D/2$, $y_1 = b_1$, $z_1 > h$.

The vertical section between the points 1 and 2 of the milling axis is characterized by the acquisition of the necessary rotation and moving to the desired height of the processing, that is

$$\boldsymbol{P}_2 = (x_2, y_2, z_2), \tag{10}$$

where $x_2 = x_1$, $y_2 = y_1$, $z_2 = h - f$.

Link 2-3 involves moving to the beginning of cutting the cutter into the gutter, the working stroke and moving to position 3, for which

$$\boldsymbol{P}_3 = (x_3, y_3, z_3), \tag{11}$$

where $x_3 > l + D/2$, $y_3 = y_2$, $z_3 = z_2$.

Then an auxiliary move to point 4 with coordinates is performed:

$$\boldsymbol{P}_4 = (x_4, y_4, z_4), \tag{12}$$

where $x_4 = x_3$, $y_4 = b_2$, $z_4 = z_3$.

Further movement of the milling axis along the broken 4 ... 9 is carried out in the same way as the displacement analyzed along the broken 2 ... 4 using the similarities of (8) ... (12) dependencies.

The dynamic area of the tool (DAT) will be called part of the space that this tool covers during its movement.

For the aforementioned mills, their rotation provides a corresponding straight circular cylindrical dynamic region with a volume

$$ДОІ_{О} = \pi D^2 H / 4, \qquad (13)$$

where *D* and *H* – diameter and height of cutting part of milling machine.

Parallel transfer milling cutters perpendicular to its rotation axis implements a dynamic region, which is a combination of two vertical halves of a straight circular cylindera $ДОІ_{О}$ according to the expression (13) and a rectangular parallelepiped arranged between them with measurements *S, D, H*, where *S* is the absolute value of the vector of parallel transfer.

Then the proper dynamic field of rotation and transfer of the cutter has the volume:

$$ДОІ_{ОП} = \pi D^2 H / 4 + DHS. \qquad (14)$$

In our case, see Fig. 1, dynamic regions (14) are appropriately considered as gradually increasing in time due to the longitudinal *Sx* or transverse *Sy* feeding the milling machine.

The dynamic area of logging (DAL) We will call a part of the space that covers the binder at a certain time of its processing.

The computer dynamic geometrical modeling of the investigated technology of manufacturing the part is proposed to be presented as a set of rotational and translational motion of the cutter and the corresponding change of the milling unit, which is received as a result of the Boolean subtraction operation from the current DAL of the proper DAT.

Conclusions. The article describes the method of computer dynamic geometric modeling of milling processes on the basis of structural-parametric approach to forming. Prospects for further research are the distribution of the developed techniques to other typical elements of the parts, for example, various grooves, grooves, cavities, etc.

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НЕКОТОРЫЕ АСПЕКТЫ КОМПЬЮТЕРНОГО ДИНАМИЧЕСКОГО ГЕОМЕТРИЧЕСКОГО МОДЕЛИРОВАНИЯ ПРОЦЕССОВ ФРЕЗЕРОВАНИЯ

Вирченко С.Г.

Предложена методика компьютерного динамического геометрического моделирования процессов фрезерования на основе применения структурно-параметрического подхода к формообразованию. Определены перспективные направления проведения дальнейших научных исследований.

Ключевые слова: компьютерное динамическое геометрическое моделирование, структурно-параметрический подход к формообразованию, фрезерование.

ДЕЯКІ АСПЕКТИ КОМП’ЮТЕРНОГО ДИНАМІЧНОГО ГЕОМЕТРИЧНОГО МОДЕЛЮВАННЯ ПРОЦЕСІВ ФРЕЗЕРУВАННЯ

Вірченко С.Г.

Запропоновано методику комп’ютерного динамічного геометричного моделювання процесів фрезерування на основі застосування структурно-параметричного підходу до формоутворення. Визначено перспективні напрямки проведення подальших наукових досліджень.

Ключові слова: комп’ютерне динамічне геометричне моделювання, структурно-параметричний підхід до формоутворення, фрезерування.