SOME PROSPECTS FOR FURTHER DEVELOPMENT OF PARAMETRIC DESCRIPTION OF GEOMETRIC FIGURES

V. Vanin, G. Virchenko, S. Virchenko

Summary. Some directions for further development of parametric description of various figures are analyzed in this research. The proposed approach is promising for practical application in the field of modern geometric modeling of many technical objects and processes for their manufacture and use. The materials are the theoretical basis for the development of appropriate software for the automated design.

Keywords: **geometric figures, method of polyparameterization, parametric description, structural-parametric shaping, parametric description.**

Formulation of the problem. Geometric modeling is the basis of many computer-aided design of technical objects and processes of their manufacture and operation. The most common is the parametric description of the figures used. Implementation of effective computer play in the development and use of industrial products requires constant improvement of existing software based on the appropriate mathematical support. Hence the relevance of the problem of finding new productive theories of computer-aided geometric modeling.

Analysis of recent researches. To improve parametric approach to computer modeling of technical objects by science school of applied geometry, National technical University of Ukraine "Kyiv Polytechnic Institute" (NTUU "KPI") methodology of structural-parametrical morphogenesis is developed [1, 2]. This theory got its further development in the form of a combinatorially-variational approach [3].

Currently, the researchers are carried out in terms of dynamic variational constructions of various geometric figures [4, 5] and the corresponding computer modeling of technical objects and processes of their manufacture and operation.

The wording of the purposes of the article. The purpose of this publication is to systematize and generalize scientific results at the chair of descriptive geometry, engineering and computer graphics, NTUU "KPI" towards to the parametric shaping to determine promising directions for further research.

Main part. The main idea of proposed in work[4] of method of polyparameterization is the use of structural-parametric and combinatorially-analysis approaches to parametric regions defining lines, surfaces and bodies, which are as follows

$$\mathbf{r} = \mathbf{r}(u), \tag{1}$$

$$\mathbf{r} = \mathbf{r}(u,v), \tag{2}$$

$$\mathbf{r} = \mathbf{r}(u,v,w), \tag{3}$$

where *r* is the radius-vector of figure point with the values of the parameters *u, v, w*.

With the aim of unification of the created computer software in the formulas (1) ... (3) respectively individual segments, squares and cubes are used for the areas studied parametric definitions of geometric figures.

In the publication [5] it was shown that the method of polyparameterization, as a set of tried and tested methods, techniques and algorithms of its realization, allows to implement by flexible and productive automated means the dynamic construction of various objects. In these cases, expression (1) ... (3) get more specific its definition.

Thus, in particular, in rectangular Cartesian coordinate system *Oxyz* have to:

- cylindrical helix

$$\mathbf{r}(u) = \mathbf{r}(x,y,z) = \mathbf{r}(R\cos(2\pi nu), R\sin(2\pi nu), Pnu), \tag{4}$$

where *R* is the radius of rotation the generatrix of the point, *n* is the number of turns, *P* is the pitch, $u \in [0, 1]$ is the parameter;

- cylindrical spiral ribbons

$$\mathbf{r}(u,v) = \mathbf{r}(x,y,z) = \mathbf{r}(R\cos(2\pi nu), R\sin(2\pi nu), Pnu + Hv), \tag{5}$$

where *R* is the radius of rotation of the segment forming a straight line, *n* is the number of turns, *P* is the pitch, *H* is the width of the tape, $u \in [0, 1]$ and $v \in [0, 1]$ – parameters;

- body-based movement of forming circle with a radius *r* along the guide cylindrical helix

$$\begin{aligned} &\mathbf{r}(u,v,w) = \mathbf{r}(x,y,z) == \mathbf{r}((R + rw\cos(2\pi u))\cos(2\pi nv), \\ &(R + rw\cos(2\pi u))\sin(2\pi nv), Pnv + rw\sin(2\pi u)), \end{aligned} \tag{6}$$

where *R, P, n*, respectively, the radius of rotation, pitch and number of turns for the formation of a helix; $u \in [0, 1]$, $v \in [0, 1]$, $w \in [0, 1]$ – parameters.

Analysis of relations (4) ... (6) in comparison with expressions (1) ... (3) shows that in this case, in addition to the parameters *u, v, w* there are also other quantities that define the shape, size and position in space of the modeled geometric shapes.

The fundamental difference between the two groups of quantities is that the parameters *u, v, w* are changed in certain intervals, and the parameters, in particular, *r, R, P, n* when we are building a particular variant of the object they save their settled values. Based on the above the first are referred to as parameters-variables, and other parameters-permanent. Also we see that the number of parameters-variables equal to the dimension of the simulated figure.

Thus, the following expression is a generalization of relations (1) ... (6)

$$\mathbf{r}=\mathbf{r}\,(u_1,\dots,u_j,\,p_1,\dots,\,p_k);\;\;u_j\in[u_{\min j},\,u_{\max j}],\;\;j\le n, \qquad (7)$$

which determines, in parametric form the radius-vector *r* of an arbitrary point of the figure in *n*-dimensional space, where n is a natural number; *uj* – variable parameters; *pk* are parameters of steel; *j, k* – non-negative integers.

In the formula (7) variable parameters we assume the elements of the internal parameterization of the figure, and dimensions of steel – means of external parameterization.

One of the important tasks to be solved by the directed method was developed polarimetric, is to integrate internal and external parameterization for the further improvement of the dynamic variant of forming different geometric figures and on their basis of their optimal computer modeling of technical objects and processes of their manufacture and operation.

So, on the basis of the vector parametric equation of a right circular cylinder with base in the *xy*-plane and the center of this framework at the beginning of the Cartesian coordinate system *Oxyz*:

$$\mathbf{r}(u,v,w)=\mathbf{r}(x,y,z)=\mathbf{r}(Rv\cos(2\pi u),Rv\sin(2\pi u),wH), \qquad (8)$$

where *R* is the base radius; *H* – the height (length) of the cylinder; u∈ [0, 1], v∈ [0, 1], w∈ [0, 1] – parameters-variables
dynamic geometric modeling of turning parts is implemented(Fig. 1) in the environment of computer aided design using SolidWorks program, which is written in Visual Basic.

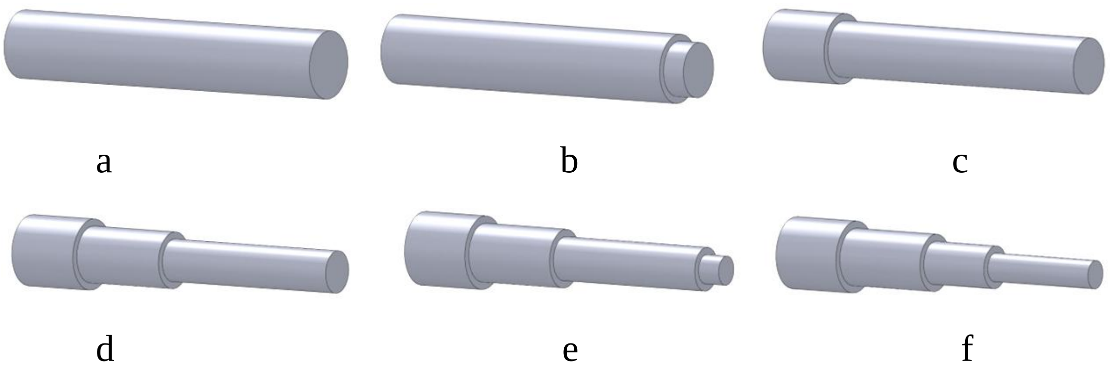

Fig. 1. Dynamic modeling of cultivation lathe

In Fig. 1, *a* the work is illustrated; Fig. 1, *b* and Fig. 1, *c* are the beginning and the end of the first turning of processed cylindrical surface of the element. Fig. 1, *d* ... *f* respectively illustrate second made surface, the beginning and the end of the third turning of machined cylindrical surface.

A promising direction of the examined subject is to integrate the application of structural-parametric shaping on the external level parameterization, for example, in the form presented in work [2] models of turning cultivation, and parametric descriptions of the form (8) at the level of the internal parameterization using dynamical computer models (Fig. 1).

Conclusions. In this article, on the basis of systematization and generalization of scientific results, the prospects of further research in the field of structural-parametric forming of technical objects by improving their mathematical parametric descriptions are defined.

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