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GEOMETRIC MODELING OF COMLEX OBJECTS ON THE BASIS OF REFERRED POLYPOINTS MAPPIING OF CUTTING DIRECT LINES

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In the paper we propose the use of weight coefficients in the method of polypoints mapping of lines for geometric modeling of complex objects.

Keywords: discrete given curve, direct, polypoints mapping of lines.

Formulation of the problem. Counterform transformations are used in the design of geometric objects of complex form in mechanical engineering. Expansion of the possibilities of political transformations is an important problem at the present time.

Analysis of recent research and publications. In previous publications [1-4] we consider methods of linear transformations based on the optimization of deformation of distances of straight lines to a given set of points, but this does not consider the possibility of extending this method to the transformation of point-defined curves, which narrows its application in the design of complex geometric objects.

Formulating the goals of the article. The purpose of the article is to apply straight lines in the method of field-mapping mappings for geometric modeling of complex objects.

Main part. In [1] the method of line-point mapping of lines is presented, which is concluded in the following.

Suppose that the plane xy is given (Fig. 1):

- points of the initial basis $T_{pi}(x_{pi},y_{pi})$, i=1,2,3,….M,
- points of the secondary basis $T_{vi}(x_{vi},y_{vi})$, i=1,2,3,….M,
- direct - a prototype, which is given in coefficients a_{proob}, b_{proob}, c_{proob}, which determine the direct in an implicit form:

$$a_{proob}x + b_{proob}y + c = 0. \quad (1)$$

All points of the initial basis have distances to the direct-prototype in the form:

$$\beta_i = a_{proob}x_{pi} + b_{proob}y_{pi} + c_{proob}. \neq 0, i = 1,..., M. \quad (2)$$

When displaying a straight-prototype, it becomes a straight-image in the form:

$$a_{ob}x + b_{ob}y + c_{ob} = 0. \quad (3)$$

The direct image will have the following distances from the points of the secondary basis in the form:

$$\gamma_i = a_{ob}x_{vi} + b_{ob}y_{vi} + c_{ob} \neq 0. \quad (4)$$

When converting distances γ_i will be equal to:

$$\gamma_i = \omega_i \beta_i. \quad (5)$$

where ω_i - while uncertain factor.

From

$$\omega_i = \frac{\gamma_i}{\beta_i}. \quad (6)$$

Determine the next functional

$$S = \sum_{i=1}^{M} (\omega_i - 1)^2 \Rightarrow \min, \quad (7)$$

which will mean that the relation of new coordinates γ_i to the original coordinates β_i will strive to 1.0.

Differentiate (7) by a_{ob}, b_{ob} i c_{ob}:

$$\frac{dS}{da_{ob}} = \sum_{i=1}^{M} 2(\omega_i - 1)\frac{x_{obi}}{\beta_i}, \quad (8)$$

$$\frac{dS}{db_{ob}} = \sum_{i=1}^{M} 2(\omega_i - 1)\frac{y_{obi}}{\beta_i}, \quad (9)$$

$$\frac{dS}{dc_{ob}} = \sum_{i=1}^{M} 2(\omega_i - 1)\frac{1}{\beta_i}. \quad (10)$$

Substitute (6), (2) and (4) in (8-10). We obtain a system of three linear equations:

$$\left.\begin{aligned} A1a_{ob} + B1b_{ob} + C1c_{ob} &= D1, \\ A2a_{ob} + B2b_{ob} + C2c_{ob} &= D2, \\ A3a_{ob} + B3b_{ob} + C3c_{ob} &= D3, \end{aligned}\right\} \quad (11)$$

where

$$\left.\begin{aligned} &A1 = \sum_{i=1}^{M} \frac{x^2_{vi}}{\beta_i^2},\ B1 = \sum_{i=1}^{M} \frac{x_{vi} y_{vi}}{\beta_i^2}, C1 = \sum_{i=1}^{M} \frac{x_{vi}}{\beta_i^2},\ D1 = \sum_{i=1}^{M} \frac{x_{vi}}{\beta_i}, \\ &A2 = \sum_{i=1}^{M} \frac{x_{vi} y_{vi}}{\beta_i^2} = B1,\ B2 = \sum_{i=1}^{M} \frac{y^2_{vi}}{\beta_i^2}, C2 = \sum_{i=1}^{M} \frac{y_{vi}}{\beta_i^2},\ D2 = \sum_{i=1}^{M} \frac{y_{vi}}{\beta_i}, \\ &A3 = \sum_{i=1}^{M} \frac{x_{vi}}{\beta_i^2} = C1,\ B3 = \sum_{i=1}^{M} \frac{y_{vi}}{\beta_i^2} = C2, C3 = \sum_{i=1}^{M} \frac{1}{\beta_i^2},\ D3 = \sum_{i=1}^{M} \frac{1}{\beta_i}. \end{aligned}\right\} \quad (12)$$

The solution of system (11) will give new coefficients a_{ob}, b_{ob}, c_{ob} transformed straight-images of a point-given curve.

Let's make a modification of the index map as follows.

Determine the direct - the prototype (2) in the form of a segment of the line, given by two points $A_p(x_{Ap},y_{Ap})$ and B_p (x_{Bp},y_{Bp}). In this case, the coefficients of the straight line (2) are determined by the following formulas:

$$a_{proob} = y_A - y_B, b_{proob} = x_b - x_A,\ c_{proob} = -(a_{proob} x_A + b_{proob} y_A). \qquad (13)$$

In case of poly-reflection (7) on the basis of coefficients (13) we obtain new values a_{ob}, b_{ob},c_{ob} to determine a new line (4):

$$\gamma_i = 0. \qquad (14)$$

For a new line (14) we assign abscissas of new points $A_{ob}(x_{Aob}$, $B(x_{Bob})$. Based on these abscissas and formulas

$$c_{ob} = -(a_{ob} x_{Aob} + b_{ob} y_{Aob});$$
$$c_{ob} = -(a_{ob} x_{Bob} + b_{ob} y_{Bob}), \qquad (15)$$

find ordinates of new points A_{ob} and B_{ob} :

$$y_{Aob} = -\frac{c_{ob} + a_{ob} x_{Aob}}{b_{ob}},$$
$$y_{Bob} = -\frac{c_{ob} + a_{ob} x_{Bob}}{b_{ob}}. \qquad (16)$$

Thus, the prototype (a segment of a straight line A_p-B_p) turned into an image (a straight line A_{ob}-B_{ob}).

The proposed method differs from the usual field-mapping mappings by the fact that as a prototype non-direct ones, which are given in implicit form, and straight lines that are given by points, are invented. Thus, the prototypes can be set by a plurality of points and receive a transformed set of points, which will set a new transformed image, which will be given by a new set of points, which is much more convenient than the usual polyhedron mappings of a plurality of lines.

On the basis of the proposed linear mappings of straight lines, an AutoLISP computer program was developed in the AutoCAD system environment. A test case is presented in Fig. 1. In Fig. 1 represents the result of a five-point circle display. Here are points with indices P-points of the primary poly-base basis. Points with indices V - points of the secondary polygon basis. As we can see, the circle thus turned into an oval, which as if approximates the secondary basis 1_v-5_v.

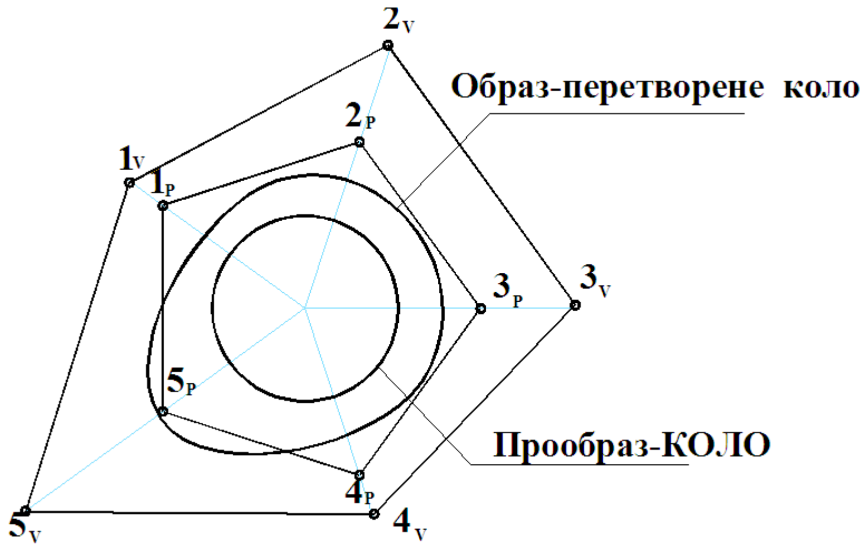

Fig.1 A five-point circle display

Conclusions. The proposed process of field-point mapping of the segments direct method differs from the usual field-mapping mappings by the fact that as a preimage, non-direct ones, which are given in implicit form, and straight lines that are given by points, are invented. Thus, the prototypes can be set by a plurality of points and receive a transformed set of points, which will set a new transformed image, which will be given by a new set of points, which is much more convenient than the usual polyhedron mappings of a plurality of lines.

The proposed method can be used in the implementation of geometric modeling of complex forms with the ability to control the shape of the simulated object by changing the points of the filamentous basis. As shown in the test example, the shape of the transformed shape changes in such a way that it approximates the new base-point.

As a disadvantage of the proposed method, it is possible to indicate the insufficient level of predictability of the result.

Further researches are offered in revealing of properties of application of field-point maps in the direction of increase of level of predictability of the received results for effective application in geometric modeling of complex objects.

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ГЕОМЕТРИЧЕСКОЕ МОДЕЛИРОВАНИЕ СЛОЖНЫХ ОБЪЕКТОВ НА ОСНОВЕ ПОЛИТОЧЕЧНЫХ ОТОБРАЖЕНИЙ ОТРЕЗКОВ ПРЯМЫХ

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В работе предлагается метод политочечных отображений отрезков прямых в геометрическом моделировании сложных объектов, который отличается от обычных политочечных отображений тем, что в качестве прообраза можно задавать не прямые в неявном виде, а множество точек и получать преобразованный объект в виде множества точек.

Ключевые слова: дискретно заданная кривая, отрезок прямой, политочечные отображения.

ГЕОМЕТРИЧНЕ МОДЕЛЮВАННЯ СКЛАДНИХ ОБ'ЄКТІВ НА ОСНОВІ ПОЛІТОЧКОВИХ ВІДОБРАЖЕНЬ ВІДРІЗКІВ ПРЯМИХ

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В роботі пропонується метод політочкових відображень відрізків прямих в геометричному моделюванні складних об'єктів, який відрізняється від звичайних політочкових відображень тим, що в якості прообраза можна задавати не прямі в неявному вигляді, а множину точок і отримувати перетворений об'єкт у вигляді множини точок.

Ключові слова: дискретно задана крива, відрізок прямої, політочкові відображення прямих.