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DEVELOPMENT OF AN ALGORITHM FOR A LINEAR INTERPOLATION SYSTEM OF CNC MACHINES USING VARIABLES IN COMPASS 3D

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ABSTRACT:

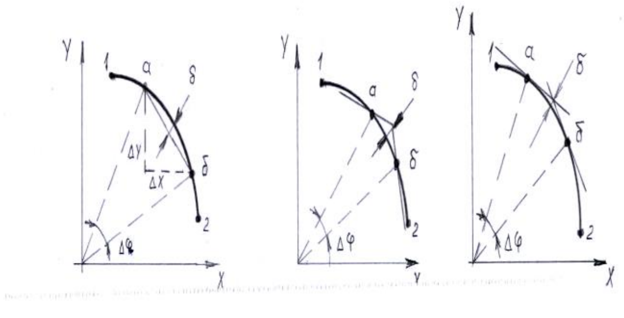
In this paper, we have analyzed the system programming algorithm available in the interpolator device used in CNC systems. Interpolation is a function of the interpolator structure used to process straight lines, circles, and parabolas. The CNC device cannot perform two motions at the same time and feels the need for interpolation when performing a shift along a curved contour relative to any system line on its coordinate axis. Using the Compass 3D program, we created a machine model and included system algorithms that perform interpolation.

INTRODUCTION:

The control program's working frame information is general in nature, meaning it provides the coordinates of the end point of the trajectory (in the absolute computational system), or the distance the working body has to travel (in the relative computational system). In this case, the frame does not contain information on how to perform the given displacement, that is, how the CNC device controls the thrust drives to ensure a given displacement trajectory.

Because the coordinate system of CNC machines is right-angled and the machine guides are parallel to the coordinate axes, a curved (or inclined to the coordinate axes) trajectory can be programmed and guided by conventional methods. will not happen.

To do this, the nonlinear contours of the workpiece are approximated, that is, the nonlinear contour is replaced by other simpler geometric elements. Replacements are made with straight lines, arcs, circles, or parabola sections. For example, Figure 1 shows the approximation of the curve y = f (x) bounded by points 1 and 2 with the chord, intersection, and experiment lines. As a result of the approximation, the curve bounded by points 1 and 2 is replaced by straight lines 1-a-b-2 forming broken lines, where the section "a - b" is called the approximation area.



a) b) v)

Figure 1. Approximation of nonlinear contours a) with chordas; b) with intersecting lines; c) with test strips

In this case, the approximation error is measured with the bending arrow d, which in turn is determined by the approximation step.

The approximation step depends on the value of the Δx and Δy coordinate small pushes or the central angle Δφ. To increase the accuracy of the approximation, the length of the straight line sections should be reduced.

The approximation step for the approximation methods is found in the following formulas:

A) to approximate with chordas: $\Delta\varphi = 2\ \arccos\left(1 - \frac{\delta}{R}\right)$

B) to approximate with intersecting lines: $\Delta\varphi = 2\ \arccos\left(\frac{R-\delta}{R+\delta}\right)$

V) to approximate with attempt lines: $\Delta\varphi = 2\ \arccos\left(\frac{R}{R+\delta}\right)$

In these formulas, R is the radius of the arc, δ is the approximation error. The approximation step can also be specified with small shifts in ΔX va ΔY coordinates.

As mentioned above, in order to bring the actual trajectory closer to a given trajectory, it is necessary to increase the number of intermediate points (or approximation fields), as well as to provide a sequence of coordinate thrusts to the instrument between these points.

The addition of additional reference points leads to a sharp increase in calculations and program size when creating a management program. Therefore, in practice, a detailed representation of the trajectory of the instrument between two intermediate points is carried out using a special computing device - an interpolator. Or, in other words, for the approximation to take place, the motion must be performed on the two coordinate axes at the same time interval, and the trajectory of the center of the instrument must correspond to the "a - b" intersection. This requirement is met by a special device - an interpolator.

An interpolator is a computational part of a numerical control device whose main function is to continuously find the coordinates of a moving point on a line of approximation or an analytic curve with a certain discreteness and transmit information about these coordinates to the control unit. consists of. The function of the interpolator can also be expressed as: to provide a functional connection between the coordinates of the base points during the movement of one base point to another base point per minute, as well as to transmit signals about these coordinates to the control device.

The function performed by the interpolator is called interpolation. Depending on the approximation method, the interpolation can be linear, circular, or parabola.

The rule of interpolation implementation (interpolation algorithm) is mainly based on the solution of algebraic equations, relying on the method of estimation function. In linear interpolation, the evaluation function for each intermediate point of the trajectory can be expressed by the following formula:

$$F_{i,j} = y_j x_k - x_i y_k,$$

In this case x_i , y_j are the coordinates of the intermediate point with respect to the beginning of the line section; x_k ,y_k - coordinates of the end point of the line section; I, j is the number of elementary thrusts along the “x” and “y” axes. The length of each elementary slip (interpolation step) is equal to the discreteness of the CNCQ.

The rule of interpolation can be seen in the graph below

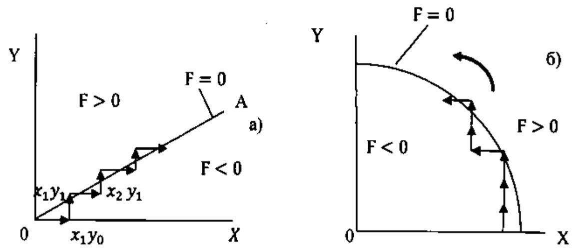


Figure 2. Interpolation: a) linear interpolation; b) circular interpolation

As can be seen from the figure, the straight line contour being processed by OA is not parallel to the coordinate axes. This means that in order to form such a contour, there must be an interpolation that provides a sequence of step pushes along the X and Y coordinate axes. The line OA drawn on the interpolation divides the XY coordinate plane into two areas: 1) the value of the evaluation function is positive at the top of the line OA (F> 0), and 2) the function has a negative value at the bottom (F <0). On the interpolated line itself, the value of the evaluation function is "0" (F = 0).

For this case, the interpolation is performed with a sequence of small thrusts along the X and Y axes. The interpolation rule is as follows: 1) if the moving point is located in the field F≥ 0 at the end of the next step, the next step is performed on the + X axis; 2) If the point is in the field F <0, the next step is performed on the + Y axis.

We created our own layout in Kopmas 3D by analyzing the interpolation seen in previous systems.

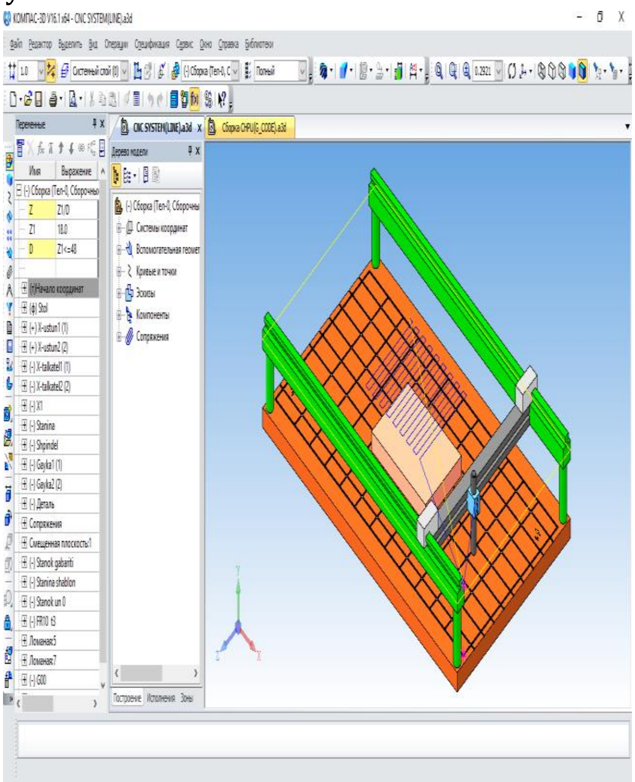


Figure 3. Machine layout

Here the machine parts are assembled and prepared for interpolation. The use of variables in Compass 3D gives us a wide range of possibilities.

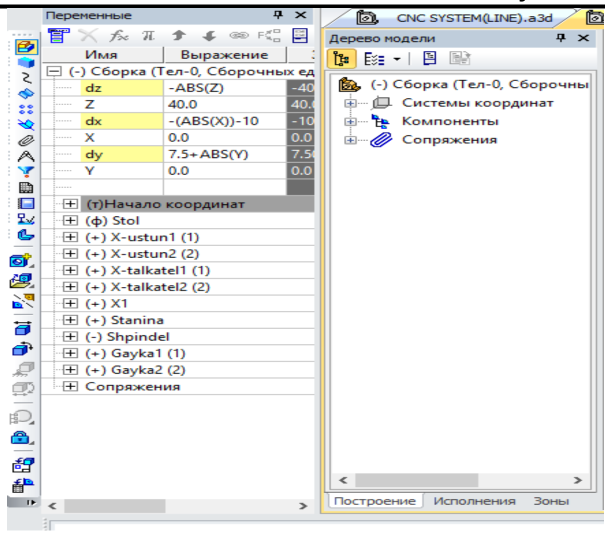


Figure 4. Interpolation algorithms

ABS – it takes the modulus of the number and accepts an arbitrary variable as a positive number.

X – a variable that allows the machine to move along the X axis.

Y - a variable that allows the machine to move along the Y axis.

Z - a variable that allows the machine to move along the Z axis.

The machine is attached to the XYZ coordinate system, and the displacement of the zero point is done by the variable values X, Y, and Z. To ensure optimal movement during processing, the above:

$$F_{i,j} = y_j x_k - x_i y_k,$$

formula was used. Let's take a look at the detail processing scheme in the newly developed system.

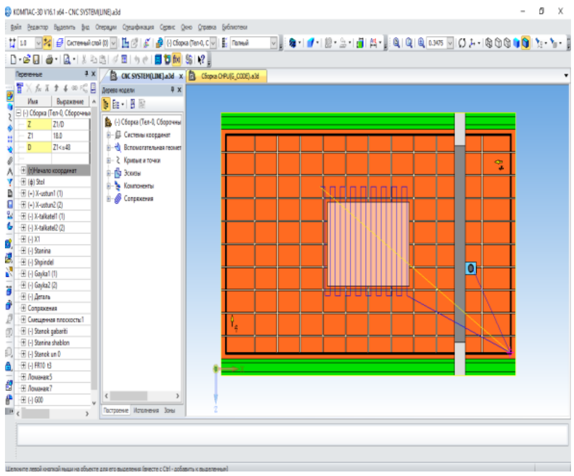


Figure 5. Schematic of prismatic detail processing

We perform animation in the Compass 3D program:

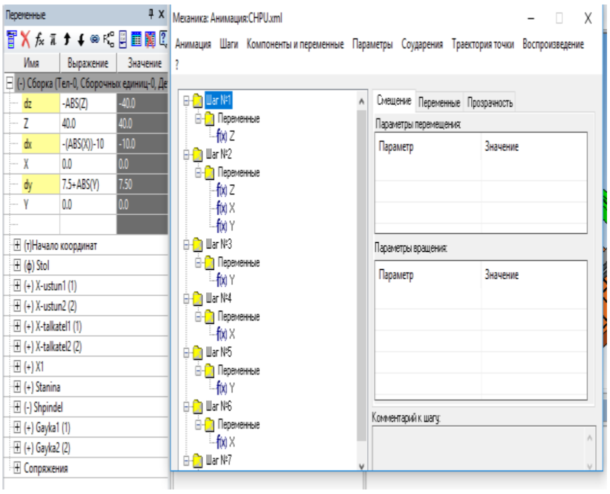


Figure 6. Animation sequence

CONCLUSION:

In this paper, we performed the interpolation operation used on CNC machines using the Compass 3D program. We know that modern production is impossible without CAD, CAM, CAE technologies. However, the capabilities of CAM technology in Compass 3D are somewhat limited. We have shown that this program can be used as well. We also created an Interpolation Algorithm in the Java programming language.

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