

COMPENSATION OF GEOMETRIC INACCURACY ERRORS BY POSTPROCESSOR

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Abstract: The paper outlines the possibility for error compensation of machine tools. That can be performed simultaneously on number of axes with the use of the Generalized Postprocessor of CAM system (Pro/ENGINEER) for the creation of CNC program. This is a relatively inexpensive way to perform high – precision work. This approach is quite useful for machines with older CNC control systems without geometric error compensation option.

Keywords: CAD/CAM, CNC, postprocessor, manufacturing

1. Introduction

Accuracy requirements become more stringent especially in 5 - axis treatment. One detail can be processed accurately, if the machine itself can track exactly the transformations of the coordinate system in a circular motion. Some causes of uncertainties at multi-access processes [1, 4] are the differences between the kinematic model, saved in the management system and kinematic conditions that actually exist in the machine.

Machine tools are manufactured with an error that in some cases cannot to be compensated. This error is due to the manufacturing process itself. After measuring and setting the value of error, there are several ways to compensate. One of them is the repair of machinery. It consists of bed re-polish, change the bearings, but this is an expensive and time-consuming solution, which sometimes seems to be unavoidable. Another way to compensate for the error is to enter the measured values into the parameters of CNC machine with a reversed sign. Modern management systems HEIDENHAIN, SINUMERIK have developed special measuring kinematic loops. They make it possible to set measurement parameters in interactive mode. As a means of measurement 3D Touch Probe is applied. The measurement is performed by fixing a sphere on the table of the machine to be used to define the required measurement values. The actual measurement takes place in different positions of the table (Fig. 1).



Fig. 1

After measuring the error of their compensation is done automatically from the CNC control.

Some manufacturers of CNC controls offer G commands, which can be compensated for their errors by directly setting and thus calculating the coordinates of control points to the offset position.

2. Compensate for errors with postprocessor

The matrix of connection between the axes is used to compensate for errors with postprocessor. Generalized postprocessor G-POST in the Pro/ENGINEER [2] has a page Transformation & Output (Fig. 2) which allows introducing measurement errors for each axis.

For machines with three controlled axes transformation is only a shift of the coordinate system in the plane XY. Four and five-axis machines require not only translation but also rotation of the coordinate system because circular axes are present and coordinates

of linear axes X, Y, Z will be different for each of the positions. For machines with two rotary axes Eulerian transformations are used (Fig. 3).

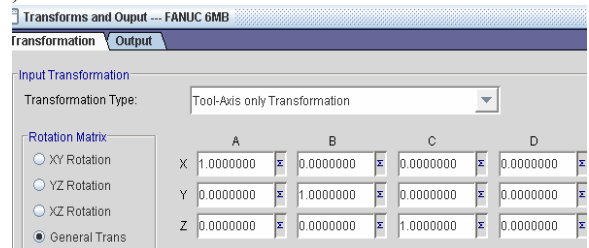


Fig. 2

They determined the position of point P in successive rotation around three axes - angle rotation φ around the axis X, turning of corner θ , around the newly formed direction of Y axis and rotation angle ψ around the newly formed direction of Z axis i.e.

$$A = A_1(\varphi) A_2(\theta) A_3(\psi)$$

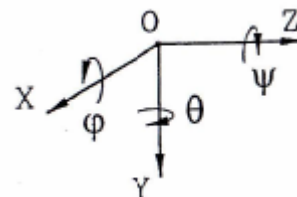


Fig. 3

Matrix that performs translation and rotation of the work coordinate system to that of the machine is rectangular and consists of 3 rows and 4 columns:

$$\begin{matrix} a1 & b1 & c1 & d1 \\ a2 & b2 & c2 & d2 \\ a3 & b3 & c3 & d3 \end{matrix}$$

Matrix uses geometric transformation from the work piece coordinate system to that of the machine. The elements of first column (a1, a2, a3) are the components of the vector of the base coordinate system along the X axis against the ASI. The second column (b1, b2, b3) defines the Y axis and the third column (C1, C2, C3) - the axis Z. Fourth column (d1, d2, d3) determines the position of auxiliary baselines system. Ancillary vectors in columns 1, 2 and 3 define the rotation matrix, and column 4 defines translation.

This work examines the possibility of compensation of errors associated with deviation from perpendicularity between axes Y and Z and the deviation from the angular position of the X axis machine for MC032. This means that to offset this type of error coordinate system must be rotated in the plane XY (to compensate the error between the axes X and Y) and YZ (between axes Y and Z). Non perpendicularity error between axes Y and Z leads to an error related to intermittent cutting depth, i.e. bottom of the treated surface will be inclined at an angle equal to the error G (Fig. 4).

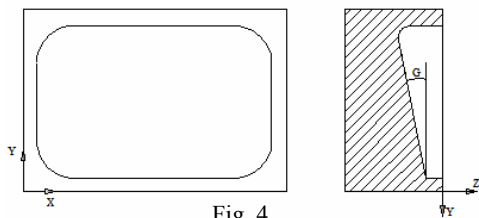


Fig. 4

In order to check whether the correct offset is set, the indicated deviation in the passport of the machine is amplified many times. In equation (1) defined in [3] the rotation of the coordinate system is calculated in the YZ plane and the result is stored in the matrix of the G-Post. For angle G a value of $G = 3.1^\circ$ is appointed. Figure 5 shows a window of the G-Post with the introduced compensation of error in plane YZ. The value of X remains 1 because the rotation of the coordinate system is around it.

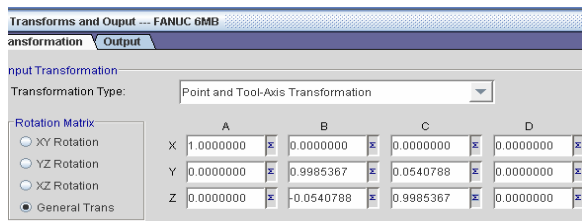


Fig. 5

Value of angle H is inserted to compensate for the error associated with deviation from the angular position of the X axis (Fig. 6).

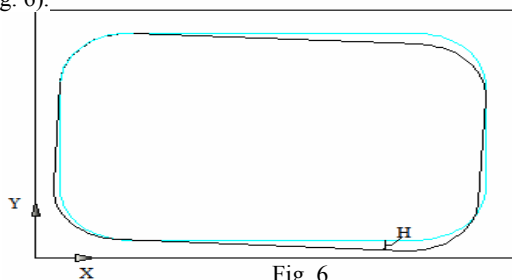


Fig. 6

Rotation of the coordinate system is around axis Z. The value of angle H is

$$H = 5.2^\circ$$

Therefore, after generating a control program coordinates to one rotated coordinate system are derived.

3. Conclusion

Technology to compensate for errors of geometric uncertainty using a matrix of links between the axes in postprocessor is developed. Models are constructed to verify the correctness of the procedure for compensated errors.

4. Literature

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