Correction Technique for Controlling the Movement of CNC Machines

Fayzimatov Shukhrat Numanovich (DSc), Matkarimov Behzod Baxtiyorjon o'g'li
Fergana Polytechnic Institute

Abstract: Improving the efficiency of mechanical processing is one of the decisive factors in the production of parts on the world market of many machine-building companies. Increasing the accuracy of CNC machines by upgrading the control system and adjusting the machine parameters of the CNC system in order to compensate for static and dynamic errors of the machine is an urgent task.

Keywords: metal cutting machines, CNC machines, precision machining, error correction compensation.

INTRODUCTION

The architecture of modern CNC systems assumes the presence of built-in summing and comparing devices. This determines the peculiarity of constructing the functional scheme of the temperature error compensation system of a CNC machine. In this case, the CNC system will include elements, from the standpoint of automatic control theory, related to various components of the control system

DISCUSSION AND RESULTS

The block algorithms for correction of the compensation system include two independent modules. The first module implements OMV technology, hereinafter referred to as "OMV correction". The second module implements "zero-correction" and "primary correction".

The algorithm includes two main blocks: control measurement and control program correction.

The control measurement block analyzes the temperature error at the end of each section of the cyclogram. This is achieved by measuring the workpiece on the machine at the coordinate for which the "critical size"is defined:

$$\Delta_{X,k}(t_{m.n.,k-1}),\ \Delta_{Y,k}(t_{m.n.,k-1}),\ \Delta_{Z,k}(t_{m.n.,k-1}) \quad (1)$$

Next, we analyze the correspondence between the predicted and measured displacement values:

$$\delta_{\xi,k}(t_{m.n..,k-1}) = \Delta_{\xi,k}(t_{m.n..,k-1}) \quad (2)$$

where $\delta_{\xi,k}(t_{m.n..,k-1})$ is the predicted value of temperature displacements.

$\Delta_{\xi,k}(t_{m.n..,k-1})$ - measured value of the part being processed.

If condition (2) is not met, then the control program correction block is switched to.

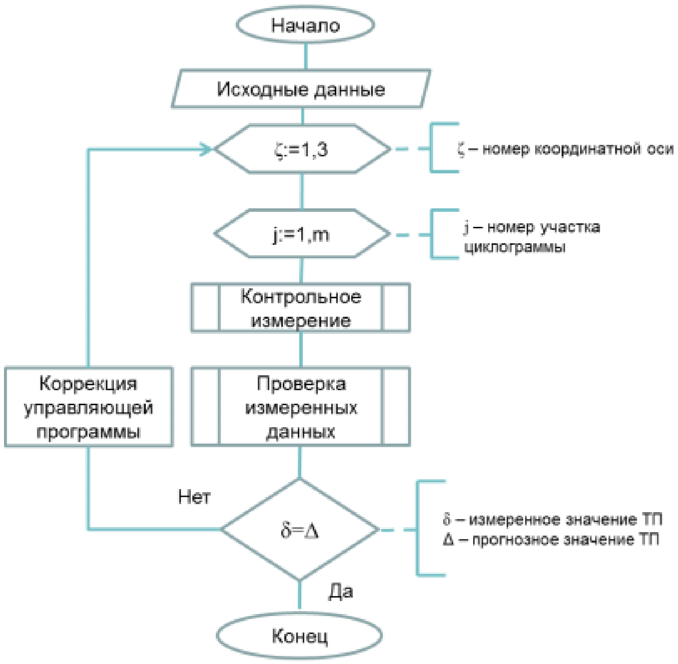

Figure 1-Correction algorithm.

The theoretical basis for correcting the control program is the refined tool path, adjusted by dependencies. The control program correction is implemented using an incremental coordinate system. For example, in Sinumerik or Fanuc CNC systems, the auxiliary G - function G91 is provided for this purpose.

Figure 2 shows the virtual result of this correction option. Curve 1 illustrates the experimental temperature shifts of the spindle for the machine cycle diagram: 3000 rpm – 35 min; 1000 rpm – 60 min; 5000 rpm – 20 min. Curve 2 (Figure 2a) illustrates the predictive characteristic obtained from the dependencies. Figure 22b shows a variant of the corrected forecast thermal characteristic for this cyclogram, which takes into account experimental values Δ_ξ at fixed time points, for example, $t_{m.n..,k-1}$. The first section of characteristic 21 does not receive any changes, because for this section, the characteristic is described by functions. The second and subsequent sections (curves 2_2 and 2_3) are described by functions (3.9), which determines the appearance of discontinuities of the approximating function at the boundaries of the sections.

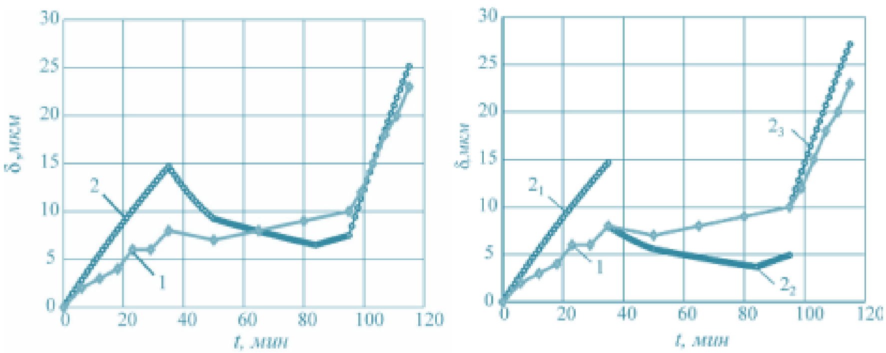

Figure 2 - Results of the correction algorithm

When implementing the "zero-correction" (Figure 3), the temperature shift in the second section of the cyclogram will have the form:

$$\delta_{\xi,2}(t_j)=\begin{cases} 0, t_j \in [t_{21}, t_{22}] \\ x_{1,\xi,2}(1-e^{-(t_j-x_{4,\xi,2}-t_{22})/x_{2,\xi,2}})+\delta_{\xi,2}(t_{12})\cdot e^{-(t_j-x_{4,\xi,2}-t_{22})/x_{2,\xi,2}}, t_j \in [t_{22}, t_{23}] \\ x_{1,\xi,3}(1-e^{-(t_j-x_{4,\xi,3}-t_{23})/x_{2,\xi,3}})+\delta_{\xi,2}(t_{13})\cdot e^{-(t_j-x_{4,\xi,3}-t_{23})/x_{2,\xi,3}}, t_j \in [t_{23}, t_{24}] \end{cases} \quad (3)$$

A special feature of the implemented "zero-correction" is the zeroing of the initial temperature shift at each section of the cyclogram – this explains the accepted term "zero-correction". The criterion for calculating the first "zero-correction" is exceeding the regulated valuetemperature displacement of the spindle $\Delta_{\xi,p}$ along ξ the Y – axis.

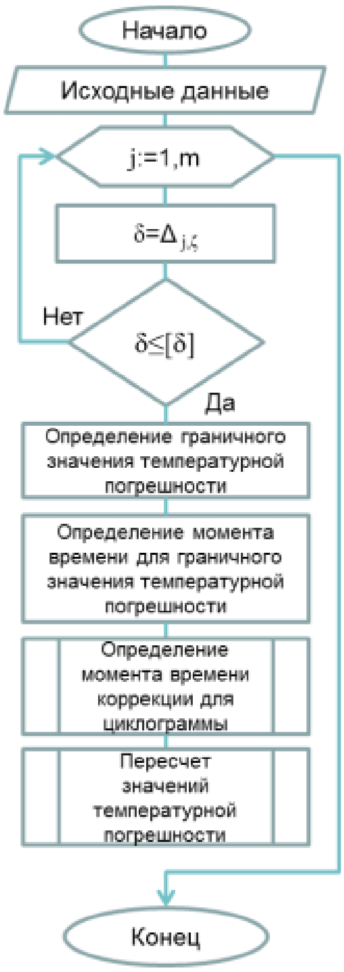

Figure 3-Zero-correction algorithm

The need to perform the second and subsequent "zero-corrections" is accepted by the user of the automated system. This is because

that at this stage of development, the temperature error correction system is not designed to work in real time. Its purpose is to support the technologist's decision-making when developing a control program for CNC machines.

There are no fundamental differences between the "primary correction" and "zero-correction" algorithms. The difference lies in the procedure implemented in the fifth block. In the primary correction algorithm, temperature displacements are zeroed out both on the section of the cyclogram where the boundary value of the temperature error of the machine is fixed, and at each first moment of time on all subsequent sections of the cyclogram without analyzing the fulfillment of the ratio. In the "zero-correction" algorithm, temperature movements are reset only once in the section of the cyclogram where the limit value of the machine's temperature error is set.

The algorithm for applying "zero-correction" and "primary correction" is shown in Figure 4.

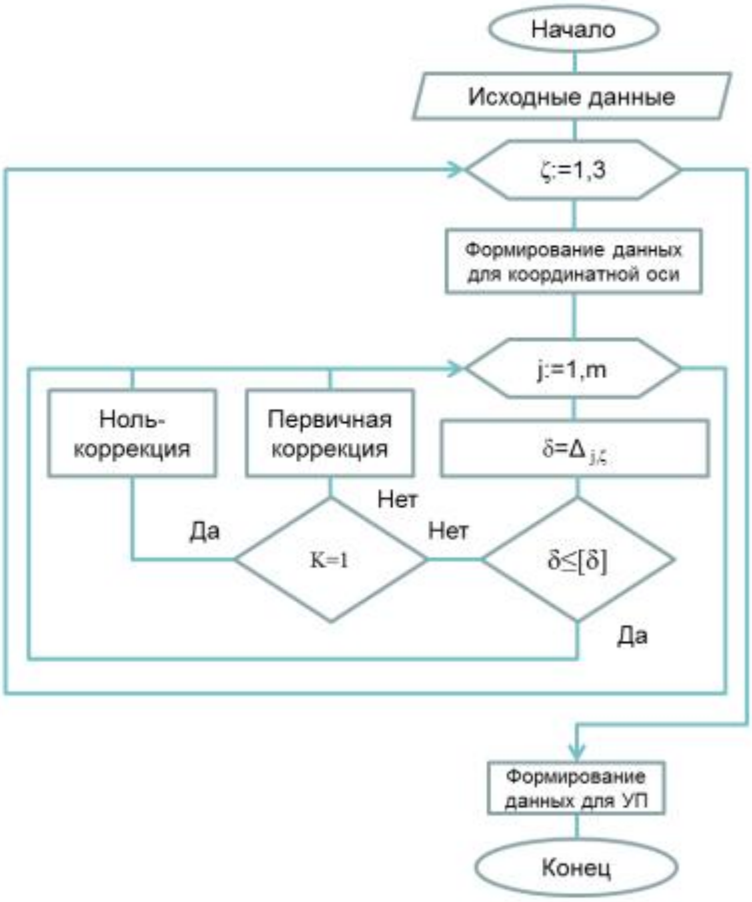

Figure 4-Algorithm for applying "zero-correction" and "primary correction"

The algorithm includes two loops. A loop with index j iterates through sections of the cyclogram. A loop with an index ξ performs iteration of coordinate axes.

Performing "zero-correction" showed that the level of corrected displacements in the first and second sections of the cyclogram (Figure 5a) satisfies the condition:

$$\left|\delta_{\xi,1}(t)\right| \leq \Delta_{\xi,p} \text{ и } \left|\delta_{\xi,2}(t)\right| \leq \Delta_{\xi,p} \quad 4)$$

Curves 2_1 and $2_2$are illustrations of parts of the piecewise function in the first section of the cyclogram. The curve 2_3 did not undergo any fundamental changes, but it turned out to be shifted along the ordinate by an amount $\delta_{\xi,1}(t_{m.n.,1})$.

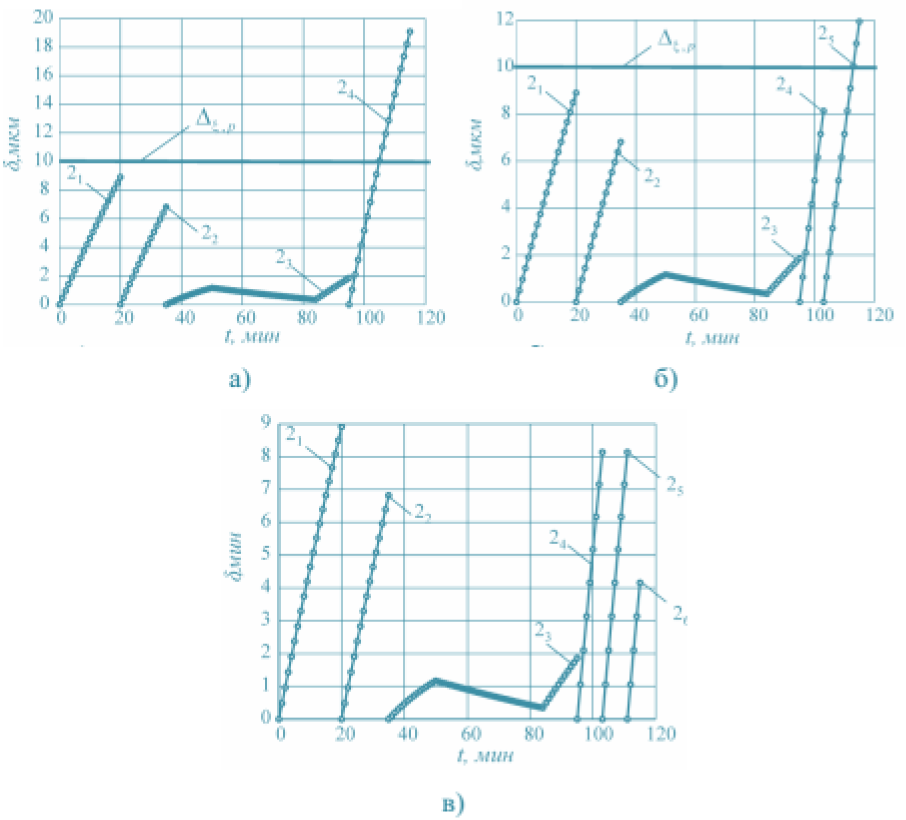

Figure 5 - Results of the zero-correction" and primary correctionalgorithms

In the third section of the cyclogram, two zero – correctionswere required.

CONCLUSION

From experimental studies, it was found that today the application of the developed error compensation algorithms in accordance with the developed methodology provides a processing error of up to 10 microns. Improving the accuracy of processing is achieved by taking into account the changing processing mode.

Список литературы:

1. ўғли Ўлмасов А. А. и др. Замонавий машинасозликда автомобил ойналарининг аҳамияти //Science and Education. – 2021. – Т. 2. – №. 5. – С. 390-394.
2. Маткаримов Б. Б. У., Ўлмасов А. А. Ў. ПОВЫШЕНИЕ ТОЧНОСТИ ОБРАБОТКИ НА ФРЕЗЕРНЫХ СТАНКАХ С ЧПУ //Academic research in educational sciences. – 2021. – Т. 2. – №. 12. – С. 1367-1371.
3. Fayzimatov S. N., Gafurov A. M. THE IMPORTANCE OF AUTOMATION IN THE DESIGN OF SHAPED SURFACES //Scientific progress. – 2021. – Т. 2. – №. 6. – С. 1564-1570.
4. Ўлмасов А. А. Ў., Исмоилов О. Х. Ў. ШТАМЛАРНИ ИШЧИ АСБОБЛАРИНИ БАРҚАРОРЛИГИНИ ТАЪМИНЛАШ МАСАЛАЛАРИ //Scientific progress. – 2021. – Т. 2. – №. 1. – С. 913-917.
5. Fayzimatov S. N. ENCREASING OF EFFICIENCY OF CUPTURE INSTALLATION ON AUTOMATIC MANIPULATOR //Актуальные проблемы современной науки. – 2011. – №. 1. – С. 192-194.

6. Ульмасов А. А., Абдухакимов Н.Ж. Процесс и эксперимент фрикционного бурения //Наука и образование. – 2021. – Т. 2. – №. 5. – С. 335-342.
7. Fayzimatov S. N., Tojiyev B. A., Jo'rayev S. D. METHOD OF IMPROVEMENT IN THE PROCESS OF STRETCHING NON-FERROUS METAL WIRE //International Scientific and Current Research Conferences. – 2021. – С. 51-57.
8. Ўлмасов А. А. Ў., Исмоилов О. Х. Ў. Штамплар барқарорлигини ошириш итиқболлари //Scientific progress. – 2021. – Т. 2. – №. 1. – С. 924-928.
9. Todjiboyev R. K., Ulmasov A. A., Sh M. 3M structural bonding tape 9270 //Science and Education. – 2021. – Т. 2. – №. 4. – С. 146-149.
10. Файзиматов Ш. Н., Маткаримов Б. Б. У. Автоматизация назначения режимов обработки и интегрирование конструктивных параметров комбинированного импульсно-ударного центробежного раскатника с системой Компас 3D //Academy. – 2016. – №. 7 (10). – С. 12-16.
11. Файзиматов Ш. Н. и др. КИЧИК ДИАМЕТРГА ЭГА БЎЛГАН ЧУҚУР ТЕШИКЛАРНИ ДОРНАЛАР ЁРДАМИДА ИШЛОВ БЕРИШДА ЮЗА АНИҚЛИГИНИ ОШИРИШ //Science and Education. – 2021. – Т. 2. – №. 3. – С. 181-187.
12. O'Lmasov Ahadjon Akramjon O. G. et al. New approaches in the diagnosis and monitoring of rotor oscillations using shaft sensors //Science and Education. – 2020. – Т. 1. – №. 1. – С. 158-166.
13. Маткаримов Б. Б. У. Модернизация фрезерных станков с ЧПУ //Scientific progress. – 2021. – Т. 2. – №. 6. – С. 142-149.
14. Маткаримов Б. Б. У., Ўлмасов А. А. Ў. МОДЕРНИЗАЦИЯ ДИП500 С ЧПУ ПОД КОНКРЕТНЫЕ Е ЗАДАЧИ //Academic research in educational sciences. – 2021. – Т. 2. – №. 12. – С. 1384-1390.
15. Ходжиева, Ф. О., & Норбутаев, Ф. М. (2018). ПУТИ РАЗВИТИЯ КРИТИЧЕСКОГО МЫШЛЕНИЯ ПОДРОСТКОВ. In *INTERNATIONAL SCIENTIFIC REVIEW OF THE PROBLEMS AND PROSPECTS OF MODERN SCIENCE AND EDUCATION* (pp. 78-79).