CNC PROGRAMMING AND POSTPROCESSING FOR FIVE-AXIS LATHE WITH SUB-SPINDLE

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Abstract

Trend in turning centers design of last years is a construction with at least five-axis of which three (X, Y and Z) are linear and the two are rotational (B and C) and using with second spindle – sub-spindle.

Machining on lathe with sub-spindle enables to machine free form surfaces with any intervention during the process. Technology of Machining on lathes with sub-spindle using multiple-axis machining and a description of machining of five-axis turning centre with sub-spindle CTX - Alpha 500 is the focus of the article [1].

Postprocessors are important components of the part programming modules of CAM systems. In advanced CAD/CAM systems there are postprocessor generators for CNC lathes [2].

Key words

CNC, postprocessor, five-axis lathe

Introduction

Turning centers are numerically controlled machines which have at least one numerically controlled rotational axis and tool holder can clamp at least one driven tool. The axis of main spindle of the machine (work-piece axis), is C axis. Using C axis controlled movement it is possible to positioning a work-piece from 0° to 360°. Therefore it is possible machine a work-piece with driven tool using movements of tool holder in longitudinal (Z axis) and transverse (X axis) directions.

In this way it is possible to mill grooves for tongues, drill offset holes, drill perpendicularly to the axis of the work-piece. If the machine's control system allow combining axis C with one of the axis X or Z [1].

Trend in turning centers design of last years is a construction with at least five-axis of which three (X, Y and Z) are linear and the two are rotational (B and C). With controlled B-

axis implements tilting of tool spindle, what enables e.g. drilling perpendicularly on the conical surface of the part etc. [3].

In advanced CAD/CAM systems there are postprocessor generators for CNC lathes, but they are limited to the traditional mode of turning, it means to the two-axis CNC. Time consuming and expensive writing of the postprocessors in high level languages such as FORTRAN, has been substituted by writing the specification of the machine tool on special forms available as input data to the generator programs in the system. Practically, it is a semi-automation of postprocessor development. For some, non-typical control units or mechanical drives, postprocessors obtained from the generator must be carefully tested [2].

DMG CTX-Alpha 500

DMG CTX - Alpha 500 is a machine tool from Gildemeister A.G., or DMG (DeckelMahoGildemeister).

The concept of this machine consists of the following translational axis X, Y, Z and rotational axis C1 and C2. In axis X, Y and Z movements are carried by slide on where is 12 pieces – servo turret with tool drive. Holders, which are clamped in the turret have different shapes respecting the method of machining: turning (for one or more tools), drilling (axial unilateral, bilateral axial and radial) or milling (axial unilateral, bilateral and radial). Tools in holders can be powered and used for milling or drilling [1].

Fig. 1 *CNC lathe CTX-Alpha 500 V6* [4]

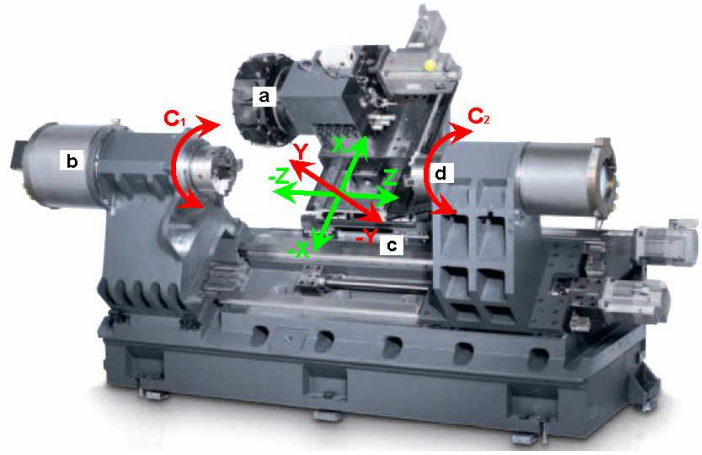

Fig. 2 *Workspace with axis* [5]

Postprocessing

Postprocessor is important component of the part programming modules of CAM system FeatureCAM.

Five-axis lathes, as a new design, are not supported by postprocessor generators in the system. When we want to use this system by programming five-axis lathes it is necessary to edit postprocessor.

Usually, there are three modes of turning/milling operations on the five-axis lathes. These modes are:

1. first mode, traditional turning operations based on the control of x and z axis,
2. second mode, milling and turning operations based on the control of x, y, z axis,
3. third mode, milling and turning operations based on the control of x, y, z axis rotational C-axis and sub-spindle.

```
<IF><TURNING><THEN>
        {N<SEQ> }{<MOTION> }{X<X-COORD> }{Z<Z-COORD> }{F<FEED> }{<COMP-STAT>}<EOB>

<ELSE>
        <IFNOT><ROTARY-OD><THEN>//                      z axis tool
                {N<SEQ> }{<MOTION> }{<COMP-STAT> }{X[<Y-COORD>:<X-COORD>] }<INCLUDE:MaybeModalYCoord>{Z<Z-COORD> }{F<FEED>}<EOB>

        <ELSE>//                                        x axis tool
                <IF>[apxeq(<@ROT1-ANSI>,0)]<THEN>//     if no angle change
                        {N<SEQ> }{<MOTION> }{<COMP-STAT> }
                        <IF>[inc_move]<THEN>
                                G90<32>
                                [:inc_move=false]

                        <ENDIF>

                        {X<X-COORD> }<INCLUDE:MaybeModalYCoord>{Z<Z-COORD> }{F<FEED>}<EOB>

                <ELSE>//                                if there is an angle change, do it as an incremental move
                        {N<SEQ> }{<MOTION> }{<COMP-STAT> }
                        <IFNOT>[inc_move]<THEN>
                                G91<32>
                                [:inc_move=true]

                        <ENDIF>
                        {X<@X-COORD> }<INCLUDE:MaybeModalYCoordInc>{Z<@Z-COORD> }C4=<@ROT1-WIND> {F<FEED>}<EOB>

                <ENDIF>
        <ENDIF>
<ENDIF>
```

Fig. 3 *The part of postprocessor for linear move*

```
        <IF><ROTARY-OD><THEN>
                <IF><USE-ROTFEED><THEN>
                        {N<SEQ> }<MOTION> C<SPNDLE-SEL>=[fabs(<ROT1-ANSI>)]<EOB>

                <ELSE>
                        {N<SEQ> }<MOTION> C<SPNDLE-SEL>=[fabs(<ROT1-ANSI>%360)]<EOB>

                <ENDIF>
                {N<SEQ> }<CLAMP-ON><EOB>
                {N<SEQ> }<MOTION> <INCLUDE:MaybeYCoord> Z<Z-COORD><EOB>
                {N<SEQ> }X<X-COORD> <COOLANT><EOB>
        <ELSE>

                <IF><ZFACE-YAXIS><THEN>
                        {N<SEQ> }<MOTION> C<SPNDLE-SEL>=[fabs(<ROT1-ANSI>%360)]<EOB>
                        {N<SEQ> }<CLAMP-ON><EOB>
                        {N<SEQ> }<INCLUDE:MaybeYCoord> Z<Z-COORD><EOB>
                        {N<SEQ> }X[<Y-COORD>:<X-COORD>] <COOLANT><EOB>

                <ELSE>
                        {N<SEQ> }<MOTION> <INCLUDE:MaybeY0> Z<Z-COORD> C<SPNDLE-SEL>=0 <COOLANT><EOB>
                        {N<SEQ> }TRANSMIT<EOB>
                        {N<SEQ> }X[<Y-COORD>:<X-COORD>] <INCLUDE:MaybeYCoord><EOB>
                        [:polar_interp=1]

                <ENDIF>

        <ENDIF>
```

Fig. 4 *The part of postprocessor for milling*

```
{N<SEQ> }<MOTION> C<SPNDLE-SEL>=[fabs(<ROT1-ANSI>%360)]<EOB>
{N<SEQ> }<CLAMP-ON><EOB>

<IF><ROTARY-OD><THEN>
        {N<SEQ> }<INCLUDE:MaybeYCoord> Z<Z-COORD><EOB>
        {N<SEQ> }X<X-COORD> <COOLANT><EOB>

<ELSEIF><ZFACE-YAXIS><THEN>
        {N<SEQ> }<INCLUDE:MaybeYCoord> Z<Z-COORD><EOB>
        {N<SEQ> }X[<Y-COORD>:<X-COORD>] <COOLANT><EOB>

<ELSE>//               use diameter and angle  positioning
        {N<SEQ> }<MOTION> <INCLUDE:MaybeY0> Z<Z-COORD><EOB>
        {N<SEQ> }X<RADIUSXY> <COOLANT><EOB>

<ENDIF>
```

Fig. 5 *The part of postprocessor for drilling*

Conclusion

Short description of machining on five-axis lathe with sub-spindle is the keystone of this article and there is briefly presented five-axis CNC lathe with sub spindle.

In the next there is a description of postprocessors creating in three steps. Then there are briefly presented the parts of postprocessor for five-axis CNC lathe with sub-spindle DMG CTX Alpha 500.

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References:

[1] PETERKA, J. 5-axis machining on lathe with counter spindle. In *Materials Science and Technology*, 2010, Number 10, Volume 2. ISSN 1335-9053.

[2] ZIETARSKI, S. System integrated product design, CNC programming and postprocessing for three-axis lathes. In *Journal of Materials Processing Technology.* 2001, 109.

[3] *Sústružnícke stroje, Poloautomatické a automatické sústruhy a sústružnícke centrá*. Košice: Technická univerzita,. p. 20. Študijný materiál. [Available on the Internet 20. 1. 2010]

[4] [Available on the Internet 20. 1. 2010] <http://www.gildemeister.com/query/internet/v3/pdl.nsf/fc9984c9a273c01ac125736a003fd9d4/$file/pt0uk09_ctxalphabetagamma.pdf>

[5] DMG leaflets and manuals.