Research on Postprocessor of DMU50 CNC Milling Machine Tool Based on Edgecam

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ABSTRACT

For the CNC milling in DMU50 machine tool, the problem to constructing postprocessor based on Edgecam software is researched. In this paper, The general flowchart of post-processing was concerned, the technology of kinematics and the method of construction were proposed, then, the postprocessor of SIEMENS 840D was created by Edgecam, at last, the correctness and validity of the method was certified by simulation and machining in experiments.

INTRODUCTION

Edgecam is intelligent CNC programming software for CNC lathing, CNC milling, CNC wire cutting, turn-milling machining developed by VERO Company, which widely used by many customers. Post-processing can translate the CAM programming operations to the specific CNC machine instructions, the quality of which determines the quality and efficiency of programming[1,2].

Post-processing in Edgecam integrates with CAM programming operations to easily generate NC programs for mainstream machine tools and CNC systems, construct kinematics models and geometry models of machine tools, which can simulate part machining in CAM programming and check collision.

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ARCHITECTURE OF SYSTEM

Figure 1. Flowchart of system.

Edgecam can use the constructor of CodeWizard to generate CDG file, which can be compiled to post-processing. The flowchart of system is shown in Figure 1.

The CNC program is related to the machine tool structure and CNC system, the conventional CNC machine tool from the structural point of view is a typical series system. Models in CodeWizard are mainly included by the kinematics model and the geometry model. The kinematics model represents characterization of the movement of machine tool components, including the X, Y, Z, A, B, C axis, tool axis, etc.; Geometry model is three-dimensional entity that of machine bed, table, column, beam, spindle, tool and other typical structure[3,4]. The standard components modeling menu is shown as Figure 2.

Figure 2. Standard components modeling menu.

MACHINE TOOL STRUCTURE AND PROGRAM FEATURES

The numerical control system of DMU50 is Siemens 840D, with X, Y, Z, B and C axis five coordinates, which can carry out five-axis machining, the specific parameters are shown in Table 1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>X travel</td>
<td>500mm</td>
</tr>
<tr>
<td>Y travel</td>
<td>450mm</td>
</tr>
<tr>
<td>Z travel</td>
<td>400mm</td>
</tr>
<tr>
<td>Speed</td>
<td>20-8000mm</td>
</tr>
<tr>
<td>Power</td>
<td>13kW</td>
</tr>
<tr>
<td>Rapid federate</td>
<td>24m/min</td>
</tr>
</tbody>
</table>
The special codes for DMU50 are shown in Table 2.

<table>
<thead>
<tr>
<th>Code</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>[-90,90]</td>
</tr>
<tr>
<td>C</td>
<td>[0,360)</td>
</tr>
<tr>
<td>G64</td>
<td>Continuous move</td>
</tr>
<tr>
<td>TRAORI</td>
<td>Five transformation on</td>
</tr>
<tr>
<td>TRAFOOF</td>
<td>Five transformation off</td>
</tr>
<tr>
<td>T=&quot;D30R0&quot;</td>
<td>Tool name is D30R0</td>
</tr>
<tr>
<td>D03</td>
<td>Tool compensation address is 03</td>
</tr>
</tbody>
</table>

### KINEMATICS TRANSFORMATION

In Edgecam, the point of cutting path is \((X,Y,Z,I,J,K)\), which indicate the coordinate of reference point of the cutting tool, so the main task for postprocessor is to converted it to point of CNC system used. The linear coordinates are \(X_c\), \(Y_c\) and \(Z_c\), The angular coordinates are \(B\) and \(C\).

DMU50V is a universal milling center having non-orthogonal rotary axes, which the five axes are \(X, Y, Z, B\) and \(C\). As shown in Fig. 3, \(B\) axis is the rotary axis fixed at angle of \(45^\circ\) to the spindle. The coordinate system for the part is \(O_wX_wY_wZ_w\), the system \(O_iX_iY_iZ_i\) is attached to the cutting tool. The offset vectors \(O_wRC\) and \(RCRB\) are determined by the pivots RB, RC and the point \(O_w\)^{[5]}.

Figure 3. Configuration and coordinate systems for DMU50.

The calculation in matrix form is as follows:
\[
\begin{pmatrix}
1 & X_c \\
J & Y_c \\
K & Z_c \\
0 & 0
\end{pmatrix}
= T_4 T_3 T_2 T_1
\begin{pmatrix}
0 & X \\
0 & Y \\
1 & Z \\
0 & 0
\end{pmatrix}
\] (1)

\[
T_1 = \begin{pmatrix}
1 & 0 & 0 & X_o \\
0 & 1 & 0 & Y_o \\
0 & 0 & 1 & Z_o \\
0 & 0 & 0 & 0
\end{pmatrix}
\] (2)

\[
T_2 = \begin{pmatrix}
\cos C & -\sin C & 0 & 0 \\
\sin C & \cos C & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0
\end{pmatrix}
\] (3)

\[
T_3 = \begin{pmatrix}
1 & 0 & 0 & 0 \\
0 & \cos 45^\circ & -\sin 45^\circ & 0 \\
0 & \sin 45^\circ & \cos 45^\circ & 0 \\
0 & 0 & 0 & 1
\end{pmatrix}
\begin{pmatrix}
\cos B & -\sin B & 0 & 0 \\
\sin B & -\cos B & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{pmatrix}
\] (4)

\[
T_4 = \begin{pmatrix}
1 & 1 \\
0 & 2 \\
0 & 0 \\
0 & 0 \\
\end{pmatrix}
\] (5)

Therefore, the coordinates B and C can be obtained as follows:

\[
B = \arccos(2K - 1)
\] (6)

\[
C = \arcsin\left(\frac{1 - K}{\sqrt{I^2 + J^2}}\right) + \text{sign}(J) \times \arccos\left(\frac{I}{\sqrt{I^2 + J^2}}\right)
\] (7)

If the function of TRAORI is available, then the values in NC program are obtained as:

\[
\begin{pmatrix}
X_c \\
Y_c \\
Z_c \\
1
\end{pmatrix} = \begin{pmatrix}
X \\
Y \\
Z \\
1
\end{pmatrix}
\] (8)

**POST-PROCESSOR CONSTRUCTION**

The three-dimensional solid assembly model of the machine tool is created in the UG software, which inputted to the code constructor with STL format in order to facilitate simulation and processing speed. The final model of the machine model is shown as Figure 4.
CASE STUDY

The blower impellor’s material is LY12 aluminum alloy, the actual machining part is shown in Figure 5.

CONCLUSION

Edgecam can be a good solution to designing the complex postprocessor in CNC machine tool, which is convenient, powerful and flexible control.

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REFERENCES