Development of CAM for 4.5-Axis Milling in CNC Turning Center

複合加工機用4.5軸CAMの開発

金沢大学　〇ヴェルガラ　カトレア，浅川直紀，岡田将人，金沢工業大学　高杉敬吾

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Kanazawa University 〇Cattleya VERGARA, Naoki ASAKAWA, Masato OKADA, Kanazawa Institute of Technology Keigo TAKASUGI

To make full use of CNC turning centers, two end-mills can be installed to perform milling in two directions enabling the turning center to operate near the machining capabilities of a 5-axis milling machine, thus the name 4.5-axis milling. In effect, a complex feature can be machined from two directions: parallel and perpendicular to the axis of the rotating workpiece. To facilitate this machining capability, a CAM is developed using open CAM kernel Kodatuno. CAD data in NURBS format is processed to generate cutter locations. For post-processing, an algorithm is created to differentiate the cutter locations into which end-mill can be used and then a cutting path is generated. This novel system is found to be effective in generating an NC file that is simulated and tested in the turning center.

1. Introduction

Recent advancement in technology requires the manufacture of more complex machine parts. To manufacture such complex parts more efficiently and with more precision, machining centers with more degrees of freedom are needed. The 5- or 6-axis CNC machines are ideal for such machining capability but these machines are too expensive.

A 5-axis CNC machine is able to cut complex parts with one tool using angular motion. In this study, considering the limited configuration of the turning center (Fig.1) with 4 motion axes: X, Y, Z and C, a CAM is proposed to program the multi-tool CNC turning center to perform machining as close as to a 5-axis CNC machine to be able to process more complex parts. One feature that is ideally processed with a 5-axis CNC machine shall be processed using a 4-axis CNC machine using 2 tools (Fig 2).These 2 tools are indicated in the simulated machine configuration in Figure 3.

Although currently available CNC turning centers have programming software already embedded in them, the features that can be machined are limited. To widen the range of features that can be machined, programming using EIA/ISO files can be used.

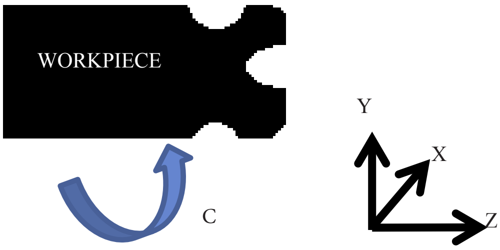

Fig.1 4-axis machining in CNC Turning Center

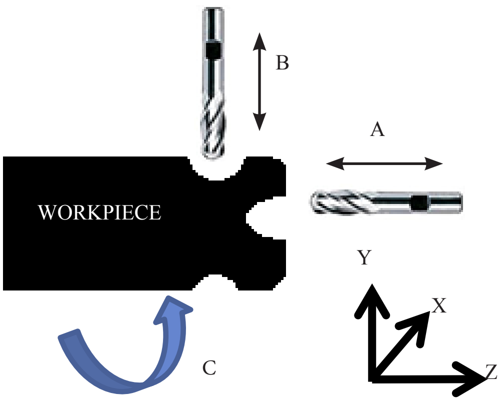

Fig.2 Proposed 4.5-axis machining in CNC Turning Center

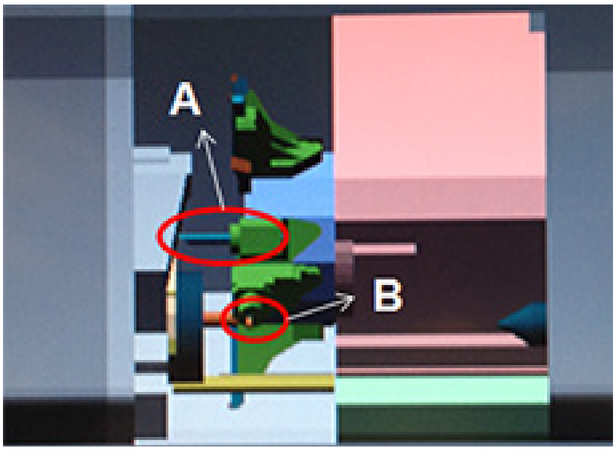

Fig.3 Simulated tool positions

2. Methodology

The system is developed using internally developed multi-platform open source CAM kernel, Kodatuno.The environment used in the development of the system is listed in Table 1.

Table 1. System Environment

Processor	Intel Core i5-2430M CPU 2.40 GHz 2.40 GHz
OS	Windows 7 Ultimate 64-bit
Build Platform	WideStudio/MWT Application Builder v3.98-7
Programming Language	C++

The development of the CAM software is divided into two parts: the main processor and the post-processor. The main processor shall generate the cutter location and the post-processor shall generate the NC file that will be readable and executable by the CNC turning machine.

<u>2.1 Main Processor.</u> The workpiece is drawn using CAD software and saved in IGES format (Fig.4). The IGES data is parsed and is converted into NURBS (non-uniform rational B-splines) data (Fig.5).

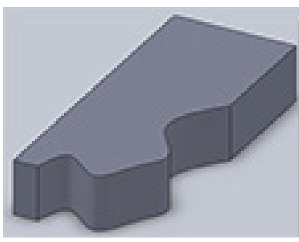

Fig.4 CAD data

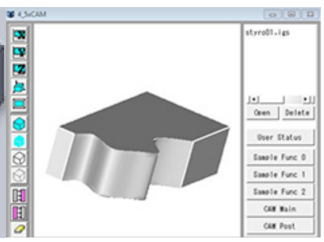

Fig.5 IGES data

To generate contact points, a feature is selected from the "body" as in Figure 6, that is assigned as the "object". Upon selection, the following parameters are required for subsequent calculation: number of cutting points that will be generated, the length of the workpiece, and the maximum depth of the groove in the Z direction. The "object" represented as a NURBS surface is processed to generate cutter contact points by dividing the surface into U and V parameters. The product of which becomes the number of contact points that are generated as in Figure 7.

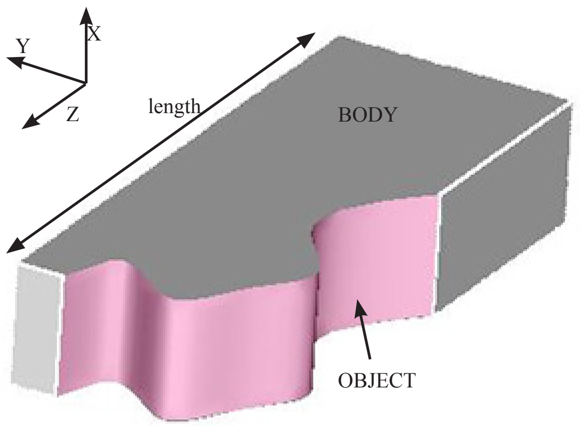

Fig.6 Object selection in CAM sofware interface

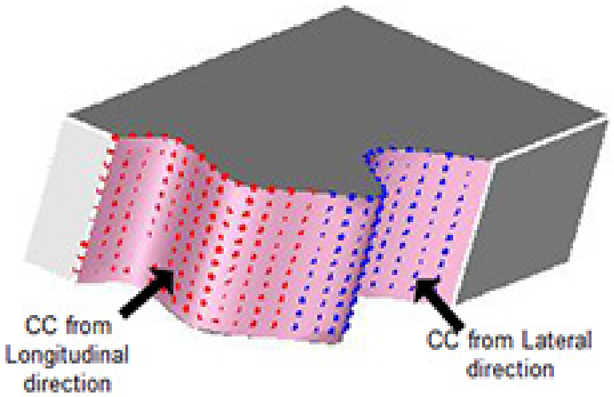

Fig.7 Cutter contact (CC) points classified into two

The points are then classified into 2: longitudinal cutter contact (CC) points and lateral CC points. The CC points in the longitudinal direction will be cut by tool A as shown previously in Figure 3, in the direction parallel to the axis of rotation of the workpiece. The CC points in the lateral direction will consequently cut by tool B, in the direction perpendicular to the axis of rotation of the workpiece.

<u>2.2 Post Processor.</u> The generated cutting paths are inserted with the applicable header and G-codes for machining. Default settings initially set for the CNC turning center as prescribed in the machine's EIA/ISO programming manual were considered and were written into the output file.

3. Results

The CAM software was able to generate an NC file in .EIA extension that can be processed in the CNC turning center. Simulation was done but actual machining was not realized due to errors in the machine parameters.

4. Conclusion

The CAM developed was successful in processing CAD data for generating a path that can be used in a CNC turning center for milling a complex feature outside the prescribed list of features machinable by the CNC turning center's embedded software.

In the future, roughing techniques should be improved and actual machining should be realized.

5. References

[1] Takeuchi, Y. (n.d.). 多軸複合加工用CAM. 1st ed. Nikkankogyoshinbunsha.

[2] Piegl, L. and Tiller, W. (1997). The NURBS book. 1st ed. Berlin: Springer.

[3] Takasugi, K. (2014). Kodatuno User's Guide. [online] Www-mm.hm.t.kanazawa-u.ac.jp. Available at: http://www-mm.hm.t.kanazawa-u.ac.jp/research/kodatuno/usersguide/R2.3/ [Accessed April 2013-July 2014].