Interactive Learning and Application of Virtual Simulation Machining of CNC Machine Tools based on VERICUT

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Abstract: As a powerful numerical simulation software, VERICUT set processing, precision testing and simulation of machine Settings, process optimization, the cutting and residual contrast functions in one, can let the user experience to the machining tool path and the occurrence of various collision, can be a change in time, avoid to cause unnecessary loss. In this paper, the existing vertical machining machine VMC850, processing a convex table parts, and further introduce the specific functions of VERICUT.

1. Introduction
With the popularization and development of the domestic numerical control technology, numerical control machine tool in mechanical processing enterprises and a growing share of that schools need to keep up with the trend of the development of the society, set up the theory associated with numerical control technology course and practice teaching, in the case of NC machine tools hardware guarantee, improve the student's ability of programming and processing can be accomplished, However, such teaching cannot fully apply theoretical knowledge, and practice teaching can only provide a single practice method, which cannot enable students to use relevant knowledge in a deeper level. Therefore, students' numerical control machining ability cannot be comprehensively improved [1].

2. Establishment of machine tool model and generation of parts program

2.1 Establishment of machine tool model
In Vericut, there are two ways to build a machine tool. One is to directly fetch the required machine tools in the VERICUT software library, which collects more than 100 kinds of machine tools of major brands such as FADAL, FANUC, Heidenhain for users to choose. The second method is to build a machine model according to the existing machine tool in other 3D modeling software, and then export the corresponding model file to STL format, which can be used in Vericut.

The vertical machining machine VMC850 is selected in this paper. The size of the machine bed (length × width × height) is 3000mm×2600mm×2600mm, the appearance size of the table (length × width) is 1050mm×500mm, and the maximum load-bearing capacity is 500KG. The cutting tool can move in the direction of Z axis on the main shaft, so as to realize the three-axis machining of the blank. Table 1 is the main
technical parameters of the machine\cite{2}.

Table 1. main technical parameters of vertical machining machine VMC850

| project                                | parameter  |
|----------------------------------------|------------|
| X-direction travel                     | 800[mm]    |
| Y-direction travel                     | 500[mm]    |
| Z-direction travel                     | 500[mm]    |
| Main motor power                       | 7.5-11[KW] |
| Distance from spindle center to table  | 110-651[mm]|
| Spindle speed                          | 8000[r/min]|
| The power supply voltage               | 380[V]     |

2.2 Generation of CNC program
As one of the most important parts of NC machine tool processing, the correctness of NC program is crucial, human programming is not only workload, but also error-prone, this paper uses UG processing module to achieve programming. This paper takes machining milling machine parts (Figure 2) as an example.

![Figure. 1 Part dimension drawing](image)

(1) open before the parts, choose from the menu and processing module, into processing mode choice "creation process", the general processing and you just need to rough machining and finish machining, so we need to create two groups working procedure, in order to after the operation is convenient, can be respectively in the two groups process named "unfinished", "refined".

(2) roughing, in order to make the surface of the parts smooth and smooth, set the bottom margin of 1mm, the wall margin of 0.5mm, to finish the margin processing can be removed.

(3) In the column of "Process Navigator - Program Sequence" on the left side of the interface, double-click the coordinate system in the parts to set the reference coordinates. The setting of the coordinate system is particularly important, which is related to the accuracy of the placement of the blank and the machining position of the tool when it is imported into Vericut\cite{3}.

(4) Select in the "Operation navigator - processing method" to set the good processing operation, right-click for post-processing. Post-processing operations can name and save files. It should be noted that the default processing size of UG is inches, which needs to be changed to millimeters during each post-processing. Click OK and you can see the corresponding program as shown in Figure2.

3. Vericut Virtual Simulation

3.1 Construction of virtual machine tools
Firstly, the pre-established machine tool model is imported into VERICUT in STL format. Click "New Project", select units in millimeters, and click "OK". Select "Base" in the project tree, right-click, select "Add", and then add "X Linear", "Y Linear", and "Z Linear". Right-click "X Linear", "Y Linear"
and "Z Linear" respectively to add the corresponding machine tool model, and then add the spindle in "Z Linear" for adding the tool. According to the actual attachment relationship, the three linearly can be adjusted. In this paper, "X linear" is attached to "Y linear". The related project tree is shown in Figure 3.

Figure 2. Part of the program diagram

Figure 3. Machine Tool Project Tree

3.2 Tool setting
VERICUT software comes with various types such as spher mill, milling cutter, double-click the column of "task tree item in the" tool ", the user can set the length of the blade according to need, tool diameter, Angle circle radius, the length of the handle and so on, click on the task bar clamping "automatic" "automatic knife point", then click "save", you can use the tool[4].

4. Example Verification
Vericut software can simulate APT tool location track and G code tool location track file, and APT code file is output by CAM system. This code is an intermediate file and cannot be called directly by the machine tool. Before it is applied to CNC machine tools, it must be post-processed into a file containing the specific G code format of the CNC machine tools used. Vericut software can achieve code conversion to improve the program's adaptability to CNC equipment. This paper takes the workpiece of milling machine (Figure 2) as an example. After the completion of UG modeling, click the "block" button, and the system will automatically create the corresponding blank according to the shape of the part, and then import it into Vericut in STL format. There are also many zeros in Vericut, such as the zeros of machine tools: It is generally located in the center of the workbench of the machine tool model and is the starting point of all imported models[5].

Tip zero point: it varies according to the length of the tool. The point zero point is the default point position of the system. Machining zero point: also called program zero point, which is the starting
point of tool machining when the program runs, is a key step in zero setting. Machining zero setting error, will lead to the tool in the blank above, processing less than anything, or in the blank below, resulting in a collision between the tool and the machine tool. Pay attention to the location of the zeros during the import process. Because the parts in this paper are created by using the system's own coordinate system, the stretching direction is the positive direction of the Z axis, so the machining zero point of the parts in this paper is set in the center of the bottom surface of the parts[6]. After the machining is completed, the machining accuracy of the parts needs to be verified. There are two methods. One is to use the measurement button in the software toolbar directly to carry out manual precision calibration. The other is the use of automatic comparison button, can directly on the parts of the "allowance/overcut detection", the overcut part shows red, the residual part shows blue. Figure 4 shows the automatic comparison of artifacts.

As can be seen from Figure 4, there is no over-cut part, but there is residual part, which is mainly due to the large choice of tool diameter, leading to the cutter has to leave a surplus in order not to destroy the wall. You need to add a new tool when finishing, and set the diameter of the tool to 8cm.

5. Conclusion
This paper takes a common three-axis machine tool as an example, and makes a comparison between the workpiece and the target part to prove the feasibility of VERICUT in interactive learning, and explains the indispensable role of VERICUT in the process of students learning CNC machine tools. And the school machine tool types are limited after all, we can build different machine tool models, using the simulation function of VERICUT to learn different models, different systems of various machine tool operation, increase the scope of knowledge, can better serve the society in the future.

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