Brief Report

Automatic Process Design Technology for Two-dimensional Machining

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1. Introduction

With performance improvements to CAD/CAM systems, process design for mold cavity parts forming a decorated surface plane can be automated to find the optimal machining process for achieving high efficiency.[1,2] CAM work automation for two-dimensional machined parts comprising holes, grooves and surface planes is also progressing; however, taking into account the machining efficiency, no technique has been found that can flexibly adapt to changes in machining methods. This report discusses a new automated process design technology for two-dimensional machining that can maximize efficiency while reflecting the know-how of skilled technicians for two-dimensional machined parts, including mold structures and primary structural components.

2. Process Algorithm

The machining process involves the use of a sequence of tools for machining an area to the necessary precision and surface roughness (requested quality). Calculating this process involves determining the finishing process based on the features of the machined area and the requested quality, in addition to the required pre-machining process.

2. 1 Determining the Finishing Process

In terms of machined areas, certain shapes are classified and referred to henceforth as the features of the design: holes, surface planes, grooves, shoulders, seats and pockets. In machine shops, the type of tool to be used for each feature is standardized in many cases based on its suitability. Taking into account the requested quality and tool type, the potential finishing processes are narrowed down based on machining efficiency and non-interference of tools, as determined from a construction method database, which will be described later.

2. 2 Determining the Pre-machining Process

The step before the finishing process is referred to as the pre-machining process. As the combination of tools between the processes is predetermined in most cases, the tool types for pre-machining can be narrowed based on the types to be used in the finishing process. Once the finishing tool types have been selected, the pre-machining process can be set.

2. 3 Reflecting the Construction Method Database and the Know-how of Skilled Technicians

In order to reflect on-site know-how, the combination of tools for the finishing and pre-machining processes is registered in the construction method database in accordance with the combination of features and requested quality.

The database uses keywords based on worksite terminology, and is simplified for maintenance by a technician. Quantitative numerical information such as tool diameter is not registered in the construction method database; an abstract tool type represents the processes. Tools are automatically determined in accordance with the target dimensions and shape from the registered tool information. The system then flexibly adapts to account for changes in the machined pieces and tool inventory.

2. 4 Determining the Tools

Tools that fulfill the requirement of being able to machine all target pieces without leaving any scratches on the surfaces are selected from the possible tools as determined in Sec. 2. 3. Larger diameter tools are selected first in order to maximize the machining efficiency. A dedicated two-dimensional simulator was devised to allow for tool selection, which led to an efficient, highly rigid machining with no interference possible.

2. 5 Determining the Machining Direction

In order to reduce the number of tooling changes in the machining of mold structures and large mechanical parts, a 5-axis machining center is often used as it can change the machining direction. In such cases, the direction must be determined efficiently as every face can be machined from multiple directions.

For example, when machining the plane in **Fig. 1** below, there is five possible directions for cutting. Based on the tooling rigidity of the machine, the jigs and the workpiece as given by the machining simulation, the most efficient direction is determined.

Thus, decision about the machining direction and applicable tooling is made by a simulation.

Therefore, you can determine more optimal and efficient tooling than that could be decided by a skillful operator.

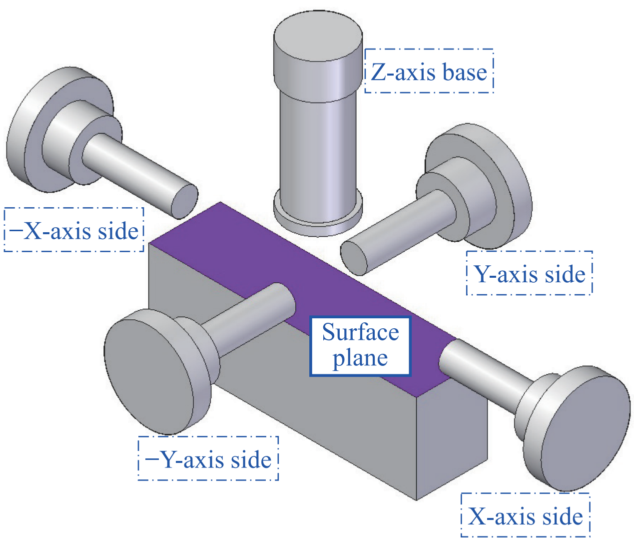

Fig. 1 Surface plane and machining direction.

3. Structure of the Automated CAM System

The proposed automated CAM system is shown in **Fig. 2**. It includes a database for registering the construction methods, and has a solver unit for calculating the tooling and processing steps. It operates in conjunction with a commercial CAM system via an intermediate file. Upon receiving the geometric model, the CAM system automatically extracts the machining areas, generates the tool path, performs NC post-processing, and creates NC data and work instructions.

4. Conclusion

The automated process design technology constructed for two-dimensional processing has the following characteristics:

(1) It can factor in the know-how of skilled technicians using an easily maintained database.

(2) It enables high-efficiency machining direction decision than that of a skilled person.

(3) Using a custom interference simulation to set the tool diameter, the optimal tool diameter can be determined automatically.

This system was evaluated at a machine shop and is expected to reduce NC data creation time by 60%.

References

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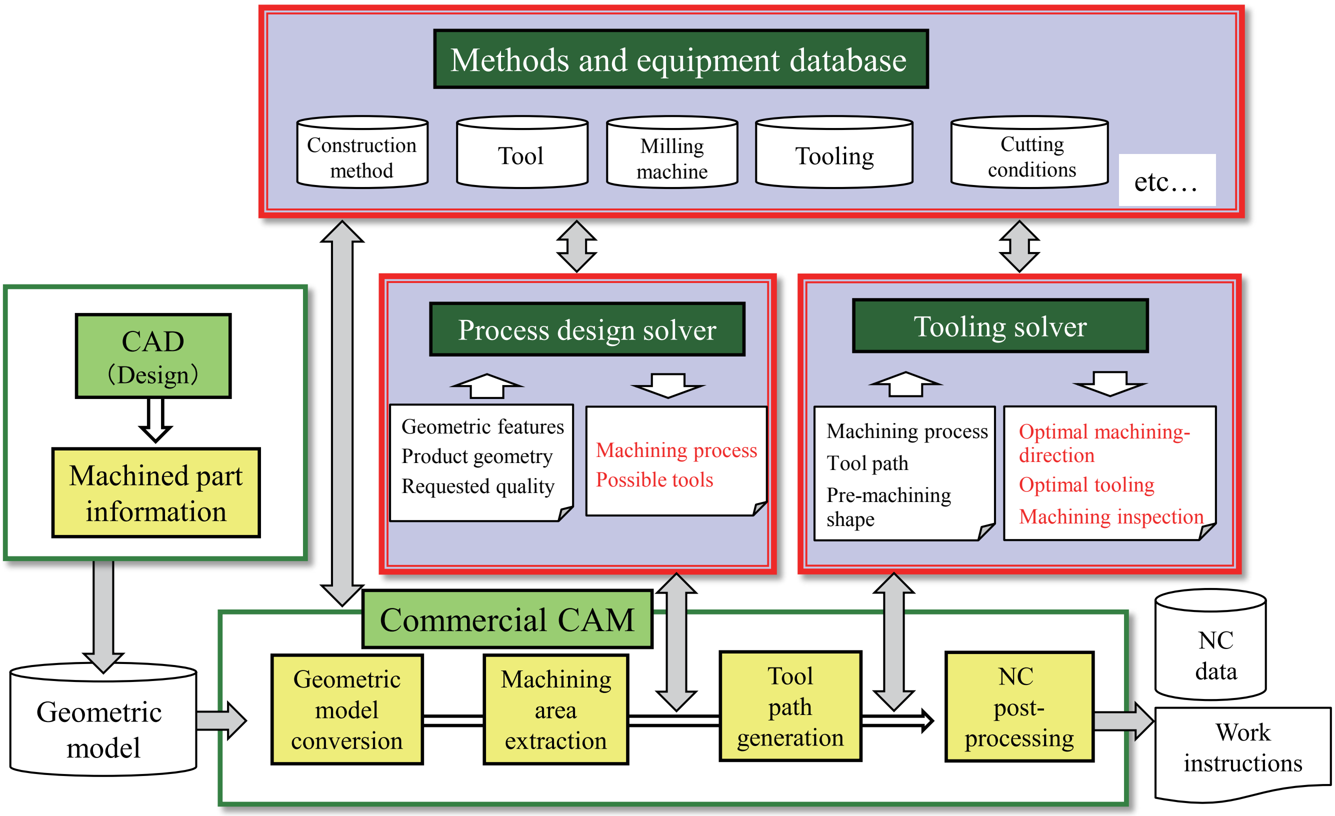

Fig. 2 Automated CAM system.

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