Development of Feature Recognition and Extraction System Based on NX Platform

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Abstract. The research is to improve the level of CAPP automation and CAD/CAPP integration and lays the foundation for the development of an interactive CAPP system. Feature recognition and extraction from a part based on NX system is beneficial to the integration of CAD/CAPP. Based on the NX/Open interface provided by NX system, the geometrical data of the part can be obtained from its 3D model. Then, non-geometric data and subsidiary relations are added to a feature model that are needed to complete feature recognition and extraction. Thus, the transformation from geometrical data to processing technical data can be realized.

Introduction

Box-type parts, most of which are cast, play a role in supporting, orientation, accommodation, seal and decorating. So the box-type parts are an integral part of machinery products. Because of their complex internal and external shape and large form, it is very difficult to rely on automatic feature recognition approach to realize the processing feature data extraction, especially for combination features and intersection features. The paper presents an interactive feature recognition and extraction method to achieve the identification and extraction of processing feature data, which cannot only reduce the difficulty of feature recognition, but also improve the recognition accuracy.

The Classification of Form Features of Box-type Parts

The information model of a box-type part can be divided into three levels, i.e., part layer, feature layer and geometry layer [1-2], as shown in Fig. 1. The part layer mainly reflects part's general information, including management information (such as part name, part numbers, GT code, designers, etc.) and material information (such as material name, material number, material properties, etc.). It is also the index or address of sub-part models. The feature layer contains features and the interrelationship between them that forms feature graph or tree structure. It includes feature sizes, feature constrains, feature semantic information, etc. The geometric layer main reflects the points, lines or surfaces geometric and topological information of the part. Herein, obtaining product processing data from the feature layer is the core of feature extraction and recognition of the part.

Feature Definition. A feature is a meaningful area on the surface of a part. According to their shape, features are divided into six categories, including passage feature, depression feature, protrusion feature, transition feature, area feature and deformation feature. Shah defined that a feature is the carrier of product information that can facilitate communication and exchange between design, manufacturing and other engineering tasks. Product information is divided into five categories, i.e., feature shape, feature accuracy, feature technology, feature material and assembly feature [3]. In a word, the features should contain the following information.

- Express a certain degree of functional semantic meaning and imply a certain amount of engineering knowledge.
- Act as the carrier of non-geometric information of a product.
- Express design intend for designers.

The feature types of box-type parts are shown in Fig. 2.

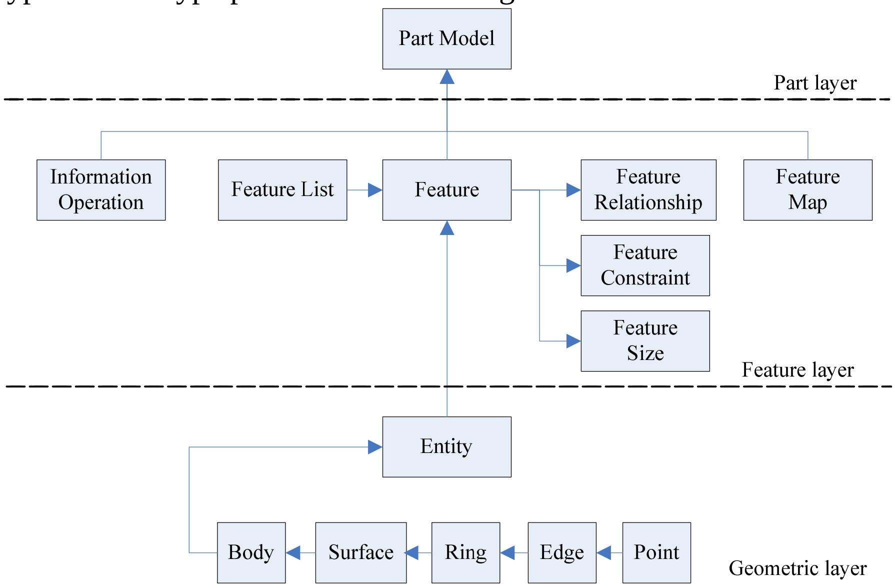

Fig.1 The part information model

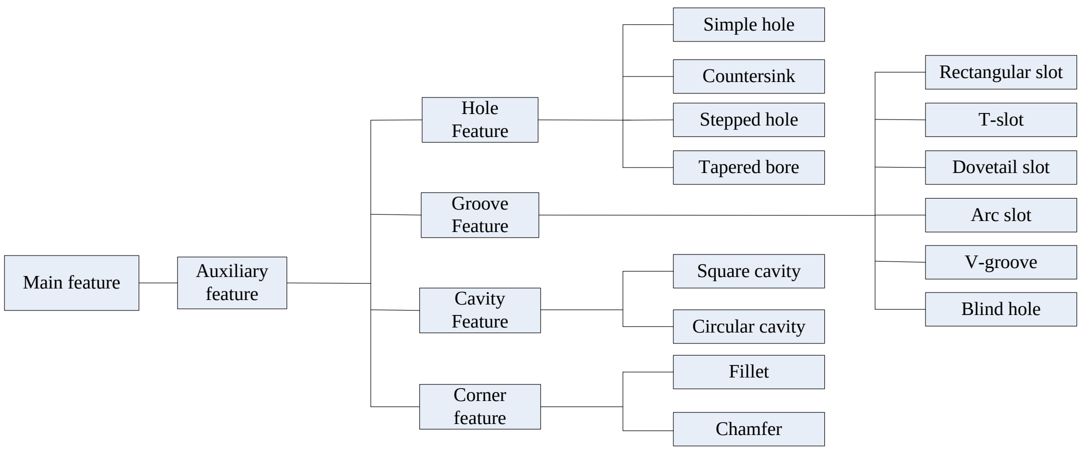

Fig.2 The feature types of box-type parts

Main feature. The blank of a box-type part is generally made by casting that already has the approximate shape of the finished part. So the main feature of the box-type part usually adopts the blank's geometric shape, which includes transition feature, area feature, deformation feature, etc.

Auxiliary Features. An auxiliary feature is the sub-feature attached to the main feature [4]. For the box-type part, the auxiliary feature mainly includes depression feature and transitional feature. The auxiliary feature is the detailed information of the part in product design. It cannot exist alone, but can only be attached to the main feature so that some relationships are formed between the auxiliary features, such as, parent-child relationship, fraternal relationship, etc. According to their characteristics, the auxiliary features can be further divided into following categories.

➢ Simple features include through hole, groove, chamfer and other primary undercut features.

➢ Combine features are a combination of several undercut features, for example, T-slot is a combination of the two rectangular grooves. There is no intersection area for a combined feature. Several features are simply assembled to form a relative complex new feature. The combine features are the most common features for the box-type parts. In actual production, combined tools are usually used to machine the combined features.

➢ Intersection features are formed by the intersection of several undercut features, such as, two interpenetrating cylindrical holes. Such features are the difficult and pivot of automatic feature recognition and one of the key technologies for CAPP.

➢ Array features are the array of the same type of auxiliary features in a certain way.

Feature Description. The methods of feature description can adopt the form of curve equation and that of parametric expression. There are some limitations in the curve equation description. It can only describe simple and special features, such as, plane, sphere, cube, cylinder, and so on. With the application and development of CAD systems, the parametric expression based on geometric and topological relations is able to express design information and process information of the feature better. The feature can be described as below.

$$G_i = F_i(x_1, x_2, x_3, x_4, \cdots, x_n) \tag{1}$$

Herein, x_j is a parameter.

Each processing feature should determine its processing parameters and properties in order to meet the needs of CAPP. Geometric data at the low layer cannot be used as processing information in the process planning decision-making because they do not have enough engineering semantic information. The processing parameters are the abstract expression of the geometric model and the macroscopic properties of the feature. A small part of the processing parameters can be obtained from the geometric model of the feature based on a CAD system. The rest of the processing parameters need to be recognized and determined interactively by the user to determine, especially for complex features and freeform surface features.

Part Data Acquisition and Addition

Based on VC++, three-dimensional NX platform provides a good environment for the secondary development. Secondary development interface NX/Open can be used to develop and expand the NX system in order to make it more convenient and more efficient to meet the user's specific needs. Geometric data, sizes and topologic information of the feature of a part model are gained by NX API functions. Due to the diversity of the feature modeling methods, there are different methods to get the feature data. For NX system, the features are divided into self-contained features, user-defined features, combined features and surface features. The interactive mode can take advantage of the respective advantages of the user and NX system. The API functions are used to compile related programs to achieve the component surface selection of the defined feature in turn. Then, standard feature parameters are computed by background programs. And then, the user adds locating datum, dependence, size accuracy, form and position tolerances, surface quality and its technical requirements, and so on in order to meet the needs of CAPP. Finally, the geometric and processing data of the features are stored in a database to support CAPP decision-making. The whole interactive feature recognition and extraction process is shown in Fig. 3.

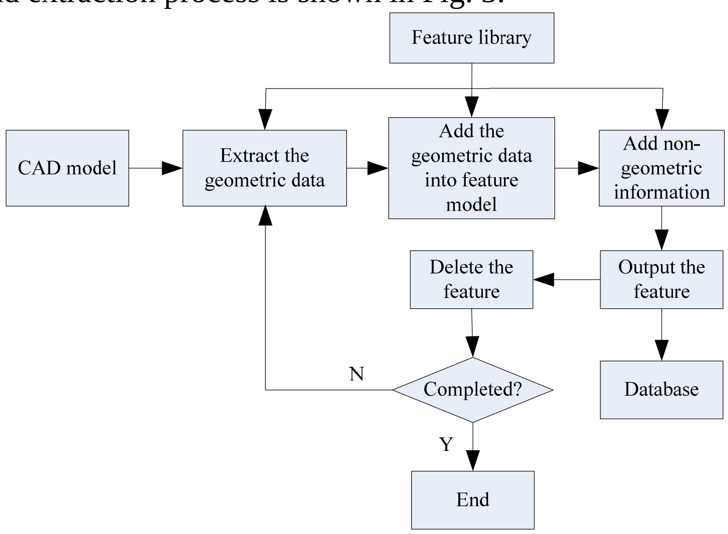

Fig.3 Flow chart of interactive feature recognition and extraction

System Development

The system development of interactive feature recognition and extraction is based on based on NX environment and VC++. Match the extracted geometric objects and features contained in the feature library to determine their feature type. Then, according to their feature type, extract their geometric, processing, location and other data of the features and the position relationship between the relevant features. For simple features, they can be automatically recognized based on rules [5]. But for complex features, usually adopt man-machine interactive methods to recognize them and extract their data. Pick up the corresponding surfaces to obtain their geometric parameters by according to the system prompting. Then, gain the processing sizes, technological references, feature placement surface through background program operation. Finally, add non-geometric parameters and output all the processing related data.

Conclusions

By the secondary development of three-dimensional design system to extract design data, converting the design data into necessary processing data is one of the effective ways to implement the CAD/CAPP/CAM information integration. After interactive recognition of various types of features from the CAD solid models, the system can automatically obtain their geometric and topological information and the user adds corresponding dimensional tolerances, geometrical tolerances, technical requirements, processing references, feature placement face and other necessary processing information by man-machine interaction. Then, all the data are stored into a database that can provide support for process planning decision-making and CAPP system. Feature recognition technology will eventually develop towards automation, so it is necessary to strengthen the automation degree of identification system. Besides, it is also required to shorten the development cycle of products, improve intelligence and information management of production generation, and so on.

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