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Study and Application of Parametric Feature Modeling Technology for Shaft Part

[1]Lanting Zhang and [2]Yicheng Zhang
[1]College of Mechanical Engineering, Inner Mongolia University of Technology, Hohhot, 010051, China
[2]Bureau of Complete Machinery and Equipment of Inner Mongolia, Hohhot, 010020, China

Abstract: At present, parametric design and feature modeling are the two main developing direction of CAD. Integrating feature modeling with parameterized technology is the effective method and measure to three-dimensional design and modeling, which product feature is modeled by parameter. According to it's characteristic, common basic feature of shaft part is analyzed and feature of shaft part is classified and described concretely and feature information model is established in this study. Feature modeling method and parameterized feature modeling technology of shaft part are studied and parameterized feature modeling module based on UG NX for shaft part is developed. The results prove that the feasibility and effectiveness of this modeling technology and method.

Key words: Parametric feature modeling, form feature, information model, structured approach, shaft part

INTRODUCTION

Traditional CAD systems adopt solid modeling as its main technology and it can't meet the requirement of system integration of CAD, CAPP and CAM.

Li and Chen (2006) discussed the parametric modeling design based on PRO/E and introduced the practical implementation of gear design. Su and Wei (2006) developed the feature modeling system of part based on feature design on AutoCAD platform with Objcet ARX. Ying and Zhang (2003) analyzed the correlation between parametric feature model and dimension model and established a method of parametric feature model. Ma (2009) analyzed the parametric modeling technology of UG NX based on parametric design and feature design. Cui and Yang (2008) built 3D solid models of three elements of a military diesel engine, block, crankshaft and cylinder-head separately by using feature technology and parametric technology and then assembled into combined structure model.

At present, parametric design and feature modeling are the two main developing direction of CAD. Integrating feature modeling with parameterized technology, product feature can be modeled by parameterization and feature can be defined and operated through dimension driving or variable design. This is the effective method and measure to 3D design and modeling (Lin *et al*., 1998).

PARAMETERIZED MODELING OF SHAFT PART BASED ON FEATURE

Feature information model of shaft part: Shaft part is used widely and has typical representative in mechanical design. Shaft has strong regularity and similarity in geometric shape. Feature is obvious and its parameterized design can be realized easily (Han *et al*., 1998). Because of its wide range and complex structure, it is very difficult to express shaft part by one typical structure only. But no matter how the structure is, shaft part has a strong regularity in the geometric shape. Any one shaft part is composed by a number of common basic graphical elements. Because these elements have definitive engineering meaning and are corresponding to definite processing method, they can be defined into feature completely.

Shaft is rotational parts and can be expressed, respectively by cylinders, cones etc., in the three-dimensional modeling. In order to coordinate with other features, three ways of left open the right closed, right-open left off and totally enclosed can be adopted to draw such features. Common basic feature of shaft parts is shown in Fig. 1.

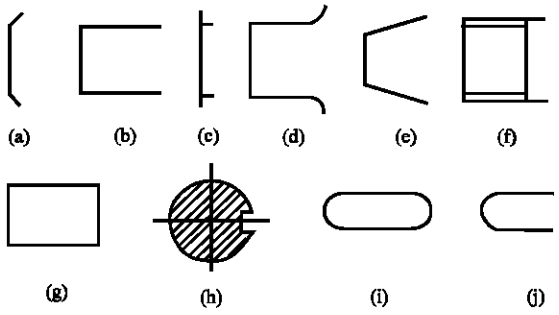


Fig. 1: Common basic feature of shaft part

Corresponding Author: Lanting Zhang, College of Mechanical Engineering, Inner Mongolia University of Technology, Hohhot, 010051, China

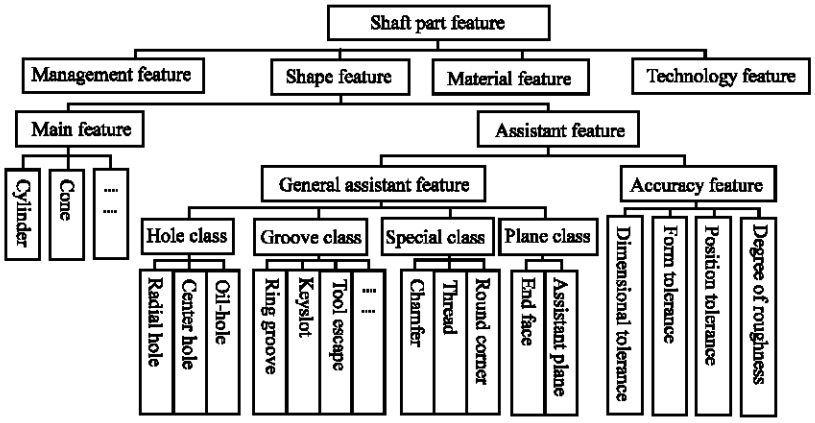


Fig. 2: Feature information model of shaft part

According to feature definition, classification and shaft characteristic, feature information model of shaft part is established (Fig. 2).

Shape feature is the main feature and is the basic element structured part shape. It describes geometric composition of feature and relation among geometric elements. Shape feature has given function, processing method and engineering meaning.

Structural size of each specific feature can be defined by a series of parameters (Sun *et al*., 2002).

Figure 2 shows that there is hierarchy in feature information model of shat part. Any shaft can be assembled by several shape feature instance.

The relationship between features can be divided into:

- **Adjacency relationship:** It is the spatial position relationship among main features
- **Slave relationship:** It is the dependency relationship that auxiliary feature attach to a main feature or another auxiliary feature
- **Array relationship:** It expresses that same shape features can be exist by some array mode

A complete part model can be formed by topology combinatorial operation of each feature. One main feature can associate with multiple main features and multiple auxiliary features may belong to one main feature. Such relations of dependence between main feature and auxiliary feature, first auxiliary feature and secondary auxiliary feature is the specific externalization of feature hierarchical relationships. Feature hierarchy reflects the order of the machining process.

FEATURE MODELING OF SHAFT PART BASED ON STRUCTURED APPROACH

Feature can exist independently. According to structure of shaft, its general character part of similar structure can be abstracted by shape analytic technique. For example, one complex shaft can be divided into several shaft segments and each segment usually contains several shape features. One basic segment is corresponding to one data structure and data structure of multi-basic segment composes graphics database of shaft element. When one complex shaft is designed, basic segments composed the shaft are selected based on its structural characteristic by definite way and precedence table and joining relationship are recorded. Drawing each basic segment, shaft part structure is formed by assembly according to its precedence table and joining relationship. Shaft segment can be divided hierarchically by establishing their affiliation relations and infinite kinds of multidiameter can be formed by assembly through those discrete features. This process is just the application based on structured approach and is one of the main methods for parameterized design (Zhao and Qin, 2006).

As a example, the transmission shaft showed in Fig. 3 can be assembled by five segments and there are different shaft features of chamfer, circular bead, keyslot and threading in each segment.

PARAMETERIZED FEATURE MODELING OF SHAFT PART

Geometry size of shape feature is substituted by parameter in parameterized feature modeling and it includes independent parameter and relevant parameter. Independent parameter is assigned a value according to

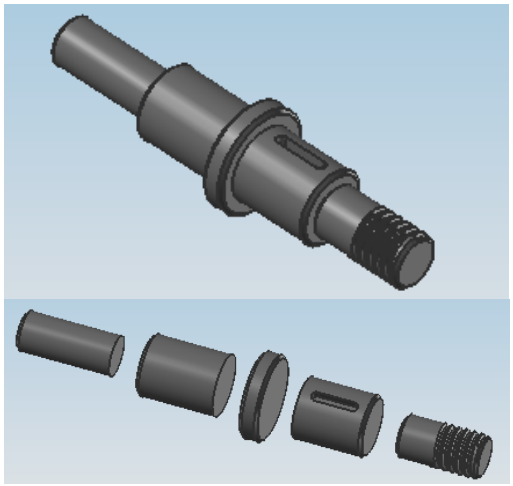


Fig. 3: Shape feature of shaft part

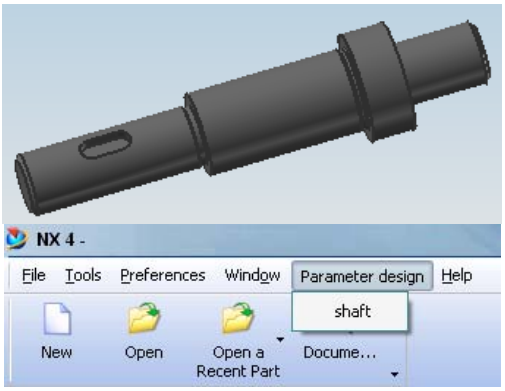


Fig. 4: 3D solid templet of shaft and menu

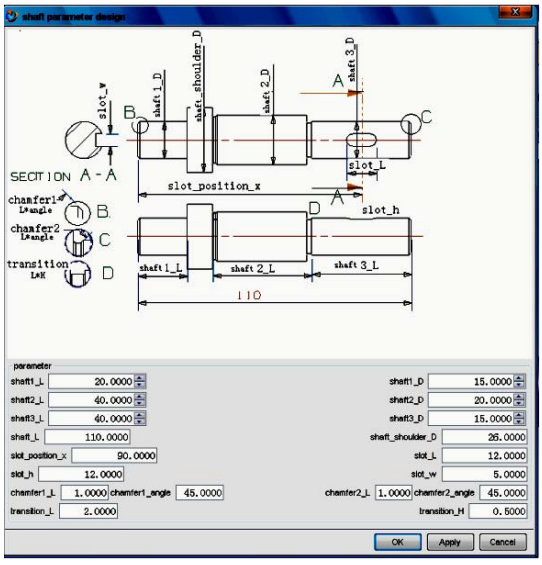
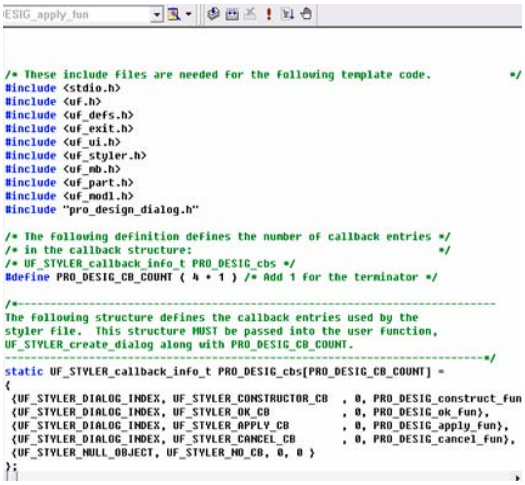


Fig. 5: Parameterized design dialog box of shaft



```
/* These include files are needed for the following template code.          */
#include <stdio.h>
#include <uf.h>
#include <uf_defs.h>
#include <uf_exit.h>
#include <uf_ui.h>
#include <uf_styler.h>
#include <uf_mb.h>
#include <uf_part.h>
#include <uf_modl.h>
#include "pro_design_dialog.h"

/* The following definition defines the number of callback entries */
/* in the callback structure:                                      */
/* UF_STYLER_callback_info_t PRO_DESIG_cbs */
#define PRO_DESIG_CB_COUNT ( 4 + 1 ) /* Add 1 for the terminator */

/*-------------------------------------------------------------------------
The following structure defines the callback entries used by the
styler file.  This structure MUST be passed into the user function,
UF_STYLER_create_dialog along with PRO_DESIG_CB_COUNT.
-------------------------------------------------------------------------*/
static UF_STYLER_callback_info_t PRO_DESIG_cbs[PRO_DESIG_CB_COUNT] =
{
 {UF_STYLER_DIALOG_INDEX, UF_STYLER_CONSTRUCTOR_CB  , 0, PRO_DESIG_construct_fun
 {UF_STYLER_DIALOG_INDEX, UF_STYLER_OK_CB           , 0, PRO_DESIG_ok_fun},
 {UF_STYLER_DIALOG_INDEX, UF_STYLER_APPLY_CB        , 0, PRO_DESIG_apply_fun},
 {UF_STYLER_DIALOG_INDEX, UF_STYLER_CANCEL_CB       , 0, PRO_DESIG_cancel_fun},
 {UF_STYLER_NULL_OBJECT, UF_STYLER_NO_CB, 0, 0 }
};
```

Fig. 6: Interface of application program

specific design. There is given relational expression between relevant parameter and independent parameter. Relevant parameter changes along with independent parameter.

To shaft part, basic size of each main feature is set as parameter. When structure difference causes change of part size, corresponding size is changed through changing related variable value in parameter file. Re-driven drawing module, parameterized drawing of part can be finished (Gao *et al*., 2010).

DEVELOPING OF PARAMETERIZED FEATURE MODELING MODULE FOR SHAFT PART BASED ON UG NX

Developing parameterized feature modeling module of shaft part, the actual method is to customize based on commercial CAD software. Because C/C++ has better portability and expandability and function of UG/Open API is powerful, VC++ 6.0 is used as programming language and UG NX is adopted as customized flatform.

Three-dimension model templet of shaft established in UG NX and designed menu based on UG/OPEN MenuScript are shown in Fig. 4.

UG/OPEN UIStyler module provides powerful function to make dialog box with Unigraphics style, parameterized design dialog box of shaft is established Fig. 5.

Through programming, defining variable and UG NX object, calling C/C++ and UG/Open API function to design, operate and compile, dynamic link library is generated. As shown in Fig. 6, Inputting parameter in dialog box, shaft part model is generated Fig. 7.

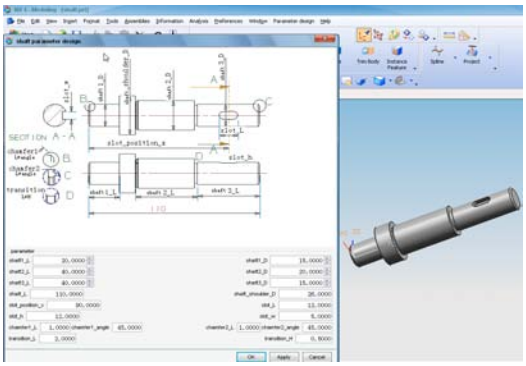


Fig. 7: Generation of shaft parts model

CONCLUSION

Feature of shaft part is obvious. Shaft can be divided into several shaft segments easily and each shaft segment usually contains several shape features. Integrating feature modeling with parameterized technology, basic geometry size of each feature is set as parameter. Through changing value of independent parameter, related parameter changes correspondingly. Re-driven drawing module, parameterized model based on feature can be realized effectively automatically.

ACKNOWLEDGMENT

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