Development of Parametric Modeling System for the Whole High Bypass Ratio Turbofan Engine based on Secondary Development of UG

Han LIU, Gui-huo LUO*, Xi Kuang and Jia-yi GU
Nanjing University of Aeronautics and Astronautics, Jiangsu Province Key Laboratory of Aerospace Power System, Nanjing 210016, China
*Corresponding author

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Abstract. In this paper, the method of developing parametric design system based upon UG with VB (Visual Basic) and Microsoft Excel has been studied. The development strategy and implement method of the parametric modeling system for the whole high bypass ratio turbofan engine based on secondary development of UG have been put forward. The parametric modeling system for the whole high bypass ratio turbofan engine has been developed, and the parametric solid model of the whole high bypass ratio turbofan engine can be established rapidly with this system. The design period of the high bypass ratio turbofan engine was shortened, the design efficiency was heightened, and the design quantity was improved obviously. The system structure and some program codes were presented in the paper. The method presented in this paper has reference value to developing the parametric design system of complex products.

Introduction

The scheme design of aero engine involves many links. Each link is relatively independent and restricts each other. Therefore, repeated iteration of design parameters is often appeared in the process of engine conceptual design. The iterative process involves the updating and modification of the structure size. The individual modeling of each size will occupy a large amount of working time with the traditional modeling method, and the efficiency is low, which cannot meet the requirements of structural optimization design. In order to facilitate the subsequent analysis and optimization process, the establishment of engine parametric model is essential.

NX is a new generation of digital product development system of SIEMENS Industrial Software Corporation. Compared with other similar products, it provides the integrated application of the most completely related CAD/CAE/CAM products, covering product design, simulation, manufacture and complete development process [1]. Therefore, it is appropriate to develop parametric modeling program with UG.

Basic Idea of Parametric Design Based on UG

At present, secondary development tools provided by NX can be used to realize parametric design of the model by two methods. One method is variable expression and the other is programming technology.

Design Variable Expression

The method uses the combination of 3D model and program control. The 3D model is created by the interactive interface of UG. Based on creating a 3D model, a set of design parameters that can completely control the shape and size of the 3D model is established according to the design requirements of the components and parts. The program is programmed for the design parameters of the components and parts. It can query and modify the design parameters and update the model according to the new parameter values. Then the design changes are implemented. This method is
mostly applied to the construction of regular shape parts [2, 3]. The disadvantage is that the 3D model shape can not be controlled by the design parameters, due to the non-fixed size of the model.

**Programming Technology**

UG has a good high-level language interface. The language interface is NX OPEN API. Parametric design of model realized by the secondary development of UG with the language interface and VB. Changes in shape and size are implemented by secondary development programs. The whole 3D model can be driven by program. Almost all of the functions in UG can be implemented. This method is often used in complex shape construction [4]. The disadvantage is the massive workload of programming.

**Development of Parametric Design System**

**Modelling Analysis**

The high bypass ratio turbofan engine has complicated structure and numerous parts. Geometric constraints exist between different components. So in this paper, the method adopted is programming technology. In order to establish the whole engine model clearly and completely, it is divided into component level model and then assemble them. The whole engine is divided into fan and low pressure compressor, high pressure compressor, combustion chamber, high pressure turbine, low pressure turbine, and bearings. The software system is mainly composed of three modules, namely user module, data module and whole engine design module, and the overall framework of the system is listed in Fig. 1. The part with dotted line represents expansion module, this article does not introduce too much.

![Figure 1. The overall framework of the system.](image)

**User Interface Module**

According to the introduced software development method and modeling analysis, a user interface of design shown in Figure 2 is developed and designed. The structure tree is displayed on the interface, and the user can expediently choose according to the actual design requirements.

![Figure 2. User interface.](image)
Data Module

Due to the large number of parameters, the database is built to store and fetch the data. Store the data in the excel table by secondary development of excel with VB. Functions in excel can be implemented by two files. One is Office.dll, the other is Microsoft.Office.Interop.Excel.dll. These files should correspond to the Microsoft office version. The database module mainly includes two kinds of data. One is the engine structure parameter data, and the other is data needed by expansion module. When the user is modeling, the software will display the data that is being used. The user can modify the original data on the system interface. It is easy to use, flexible and quick.

Engine Design Module

During the process of modeling, build the components first, secondly assemble them, as Fig. 1 shows. Different parts are positioned by absolute coordinate. The model is built according to the data given in the database. The parametric model the software build is based on a certain type of high bypass ratio turbofan engine. So the structure of the model the software build will be similar to the certain type of high bypass ratio turbofan engine. The software has error reminding, which can help users discover the problems in time. The development of this program is similar to the development of general application programs by using VB.

Sample

There is a sample of the high bypass ratio turbofan engine model established by software, shown in Fig. 3.

![Sample image](image)

Figure 3. A sample of engine model.

Summary

Parametric modelling of high bypass ratio turbofan engine has been realized by secondary development of UG. Compared with the data of a certain type of high bypass ratio turbofan engine, the model established by the software is closer to the real model. Therefore, the model can be used to estimate the weight of the engine. And this parametric modeling platform builds the foundation for expansion module, such as rotor dynamics calculation, strength calculation of disk, casing stiffness calculation, related optimization design and so on. The requirement conditions of calculation or optimization are parameterized, and the model established in UG is used to calculate. Thus, the structural parameters of the engine are optimized and some iterative work encountered in the design process can be avoided. To a certain extent, the software can improve the design efficiency of the high bypass ratio turbofan engine, shorten the development cycle.
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Reference


