Research on the Knowledge Based Parameterized CAD System of Wheat and Rice Combine Chassis

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Abstract. In this paper, through using Pro/Toolkit to do secondary development of Pro/E, it completes the parametric modeling of every key parts of rice and wheat combined harvester chassis by using the object-oriented technology, and combines with Microsoft Access database to store the relevant knowledge. Meanwhile, it collects lots of related knowledge about rice and wheat combine harvester chassis from various channels and establishes a knowledge base of key components of the chassis after sorting them which can achieve the purposes of rapid designing chassis.

Keywords: Knowledge base, Agricultural machinery chassis, Parametric modeling, Secondary development

1 Introduction

In recent years, product development gradually transformed from the data intensive to knowledge intensive which will make the CAD system develop towards digitization, integration and intelligent direction. [1] As a creative and complex activity, product design needs a lot of knowledge, a large number of historical data query, parts typical structure, process plan, evaluation results of manufacture and test, calculation parameters and performance test parameters. The knowledge is scattered storage in each designers' minds, drawer and archives which can not be merged into geometric model in traditional CAD system. So it is impossible to realize the reuse of knowledge-based resources that reduces design efficiency greatly. [2]

Knowledge-Based Engineering (KBE) technology is a new intelligent design method towards modern design requirements. [3] With the technology of parametric design based on knowledge we can greatly improve the design speed, improve product design quality reduce the research cost and shorten the development period. The knowledge base is both the foundation of applying all kinds of design knowledge and also the key technology which can realize the knowledge based CAD system. [4] The knowledge base supports rapid design, knowledge reuse and sharing in the process of product development. By using the object-oriented technology to realize the parametric modeling of every key parts of rice and wheat combined harvester chassis, using Pro/Toolkit to realize the secondary development of Pro/E and

combining with Microsoft Access database to store the relevant knowledge, this paper designs the knowledge based parameterized CAD system of wheat and rice combine chassis.

2 The general structure of chassis parameterized CAD system

2.1 The main idea of parametric design

In the process of the traditional design, geometric model of parts is fixed size, so it is complex to modify the shape of parts that even a small detail modifications need re-drawing. The product structure is determined in the process of parametric design. It designs different specifications of the products according to different structure parameters which are determinate by specific conditions and specific parameters. Its basic task is to replace the formal parameters of original graphics with the one concrete structure parameters that accord with the graphics we should design. Its concrete structure parameter is in correlation with specific products.

The basic process of the program parameters design includes that: creating original graphics, determining the graphic parameters, determining the relation between the original graphics parameters and the specific structure parameters by professional knowledge, completing the design drawings and related documents. The whole process requires a database and database management system to storage and management the various kinds of data and graphics. By using the technology of parametric design can easily modify graphics. And designers can also inherit the experience and knowledge of past design. Then designers can concentrate on creative concept and overall design to give full play to creativity and improve the efficiency of design.

2.2 System synthesis

The system consists of three modules, as shown in Figure 1. They are the parametric module of Pro/E, the parametric module based on knowledge, database management module of Access database. The Pro/E module includes the creation of three-dimensional model and the implementation of model parameter-driven. The parametric module based on knowledge includes the parametric design verification module, product examples and specific model, the knowledge of parameters variation and parts constraints. The database management module of Access database includes system authority management, model base management and database management.

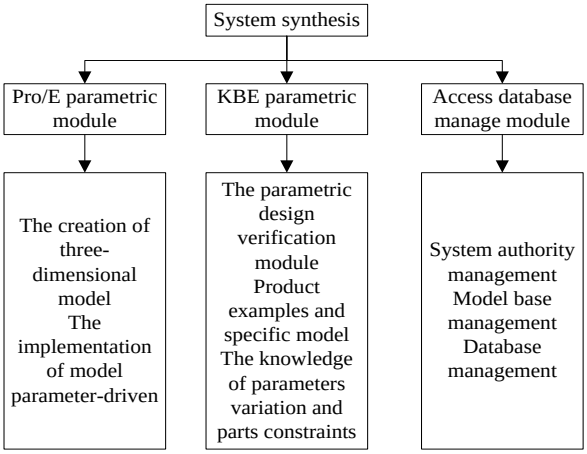

Fig.1. Parameterized CAD system of wheat and rice combine chassis

2.3 The system overall design concept

Create three-dimensional models by interactive mode and build design parameter under Pro/E. Then retrieve the design parameters of models and provide editing functions of parameters and regeneration functions of the new three-dimensional model according to the new design parameter.

By using Microsoft Access as the database, parts model library and parts parameters library which store two-dimensional models, three-dimensional models and parts related knowledge, parameter respectively are established in this system. The database connects to Visual Studio 2008(VS) by the corresponding database interface and realizes parts invoking, parts parameter matching and parts management by programming with the language of Visual C++. Through the MFC programming under VS, this system creates a user interface to facilitate the operation and management of parts. Meanwhile with the Pro / E links to VS via DLL mode, we complete the Microsoft Access database, VS and Pro / E tripartite interaction and achieve the overall design of the system.

The knowledge based parameterized CAD system is shown as Fig.2.

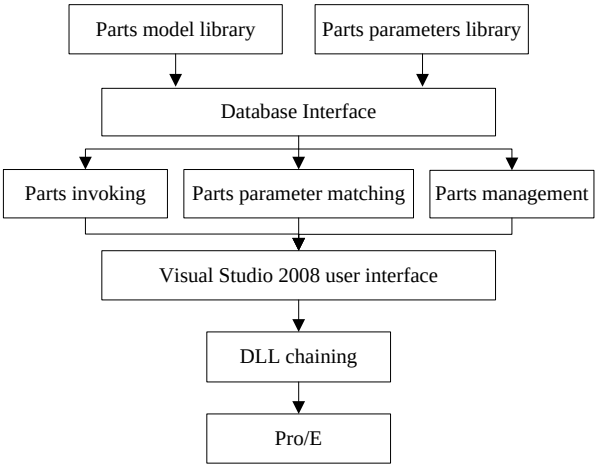

Fig.2. The knowledge based parameterized CAD system

3 The realization of knowledge based parameterized CAD system

The system mainly includes two aspects: parameterization implementation and database connectivity. Interactively create parts of original three-dimensional model, and use the parameter setting function of Pro/E to establish the design parameters and dimension relations under the Pro / E. And then establish the correlative forms in the Microsoft Access relational database. Using Visual C++ to map a Crecordset class object for interactive, then retrieve the design parameters of the model by the Pro/Toolkit application, finally input parameters and regenerate the model according to the data source object. The Access database and Pro/E is connected via VS2008 platform.

3.1 The realization of parametric system

Using Pro/Toolkit procedure development technology to carry on secondary development in Pro/E, this method consists of four steps:
1. Write source files (Source code and resource files)
2. Compile and link, create the executable file (DLL or EXE)
3. Register Pro/Toolkit application
4. Run the application

3.2 Database connection

3.2.1 Establish the database tables and data sources

Design a data table by Microsoft Access, as shown in Table1.

Field Name	Field Type	Notes
Number	AutoNumber	As the primary key, documents identification
File Name	text	File name, including the extension operator
Path	text	The storage path of documents

Table 1. The model file directory

After design data tables, create a new data source DB in Administrative Tools under the menu of Control Panel, and connect to the database created. The process is shown in Figure 3.

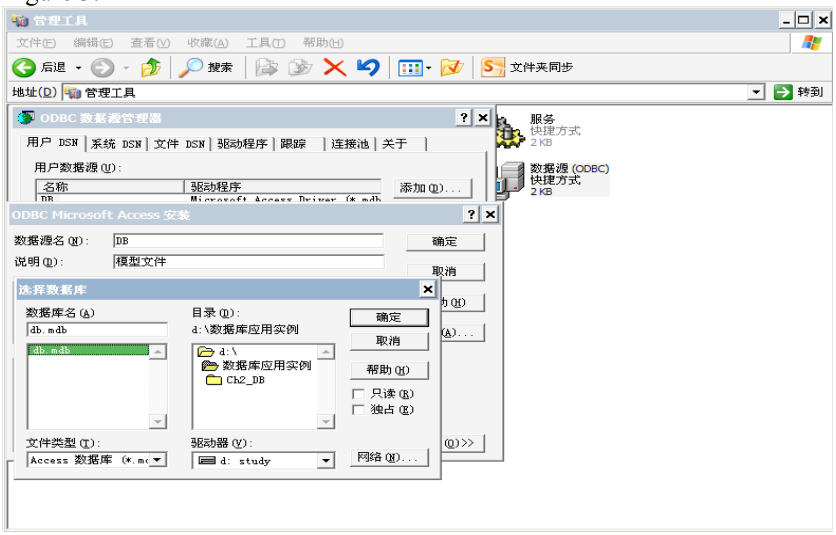

Fig.3. The connection process of data source

3.2.2 Create MFC program and design dialog

Build a new MFC DLL program under VS, complete the basic setup and add Pro/Toolkit header files and initialization function user_initialize () and termination functions user_terminate () in the item master file.

Add dialog resources in the menu of resources under VS. And add the appropriate button controls in the dialog box, complete ID and attribute settings. After finish designing dialog interface, double-click interface to generate CDBDlg dialog class.

3.2.3 Set up the data table class

In this paper, we connect databases by setting up the data table class using ODBC. Using CRecordset class to bind the data table, click [Add Class] under the menu [Project] in VS, select the MFC ODBC user and then choose the added data source DB, define the name of data class and complete the work of adding class.

3.2.4 The key program code of connection

Through the MFC programming, database is connected to Pro/E and the dialog function is completed, the key part of the code is as follows:

```
BOOL CDBDlg::OnInitDialog()
{
        CDialog::OnInitDialog();
        //connect to database
        if(!m_Set.Open())
        {
                AfxMessageBox("Database connection failed！ ");
                SendMessage(WM_CLOSE,0,0);
                return FALSE;
        }
        m_List.SetExtendedStyle(LVS_EX_FULLROWSELECT|LVS_EX_GRIDL
INES);
        //insert column
        m_List.InsertColumn(0,"Number",LVCFMT_LEFT,50);
        m_List.InsertColumn(1,"FileName",LVCFMT_LEFT,80);
        m_List.InsertColumn(2,"Path",LVCFMT_LEFT,150);
       ShowList();
        return TRUE;    // return TRUE unless you set the focus to a control
        // unusual：OCX Property page should return FALSE
```

3.3 Application example

3.3.1 The system interface

This paper designs the knowledge based parameterized CAD system of wheat and rice combine chassis and realize the Microsoft Access database, VS2008 and Pro/E tripartite interaction. A screenshot of system interface is shown in Figure 4.

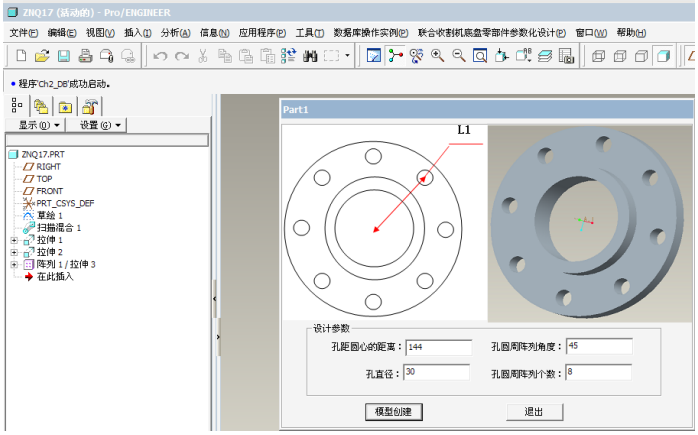

Fig.4. The system interface

3.3.2 The knowledge database

This paper collects lots of related knowledge about rice and wheat combine harvester chassis from various channels and establishes a knowledge base of key components of the chassis after sorting it. The knowledge database consists of case library, rule library, parameter library and material library. Part of the knowledge of wheat and rice combine chassis is shown in figure 5.

参数ID	参数名	参数代号	参数单位	参数说明
1001	发动机额定功率	P	kW	此值为整机所提供给传动系的设计要求，有些功率用马力作单位，1马力=
1002	发动机的额定转速	ne	r/min	(null)
1003	最大行走速度	Vm	km/h	联合收割机一般前进速度范围为V=1～20kM/h、倒挡的速度范围是V倒=2.
1004	最大负重	G	N	整机最大质量*重力加速度g
1005	最大爬坡度	α	度（°）	一般要求车辆爬坡度30%，即20°左右。
1006	驱动轮动力半径	R	m	驱动轮动力半径，依据《拖拉机设计手册》，可按轮胎新胎外半径乘0.93
1007	最大收获效率	ξmax	hm^2/h	收获效率指纯小时生产率（hm^2/h） 1hm^2=10000m^2,1公顷为15亩

公式ID	公式名称	公式结论代号	公式体	公式结论单位	说明
1001	最小作业速度	Vmin	ξmin*1000...	km/h	ξ_min是纯工作小时生产率最小值，单位是hm^2/h
1002	最大作业速度	Vmax	ξmax*1000...	km/h	ξ_max是纯工作小时生产率最大值，单位是hm^2/h
1003	行走底盘传...	Ped	G*Vmax*f/...	kW	本公式计算行走底盘所需的最大功率，G*f得到整机
1004	行走底盘传...	Ted	9550*Ped/ne	N·M	确定了行走底盘传动系的最大功率和相应的转速，ξ
1005	总的最大传...	imaxx1	G*R*(f*co...	1	最低速时，传动系传到驱动轮上的扭矩应能够驱动
1006	总的最大传...	imaxx2	120*ne*n*...	1	传动系总的最大传动比应能够使车辆速度降到联合收
1007	总的最大传...	imaxs1	G*0.8*φ*R...	1	根据驱动轮与地面的附着情况，确定最大传动比的

Fig.5. Combine working parameters and engine parameters

4 Conclusions

Based on above studies, we develop a rice and wheat combine harvester chassis parametric knowledge base. The implementation of the system adopts four basic modules: the user interface module using VC++6.0 to develop with VS2008 as a platform, 3D model library module created by Pro/E, Pro/Toolkit program modules to achieve Pro/E system menu loading and parametric, knowledge base module in which the Microsoft Access as the database.

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