

Application of Artificial Intelligence in Mechanical Design, Manufacturing and Automation

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Abstract:

As a new computer discipline in recent years, artificial intelligence technology is a technical system mainly based on intelligent theory and in the direction of data simulation, information extension and function expansion. In understanding the intelligent operation essence of the whole computer and information control system, it can build an intelligent integration process with the characteristics of information simulation by combining human thinking mode, recognition system, neural network, expert system, etc. Further, this can realize the diversified operation of data information and reduce the transmission load of data information. Based on this, taking artificial intelligence technology as the starting point, this paper expounds the operation characteristics of mechanical design and manufacturing automation, and points out the innovative application of artificial intelligence technology in mechanical design and manufacturing automation. This paper studies the development direction of artificial intelligence mechanical design and manufacturing automation, in order to provide suggestions for the development of mechanical manufacturing automation in China.

Keywords: *BArtificial Intelligence, Data Simulation, Information Control System, Mechanical Design.*

I. INTRODUCTION

Network technology is the product of the mutual penetration and close combination of computer technology and communication technology [1-2]. It plays a more and more important role in the application of juice computer technology and information transmission. Remote design is a kind of remote design service provided by the application of network technology in the field of mechanical design [3]. There are many contents of remote design. Enterprises and design groups can establish web sites to organize their own mechanical products or parts design programs and various design information according to the logical structure through hyperlink mechanism by using web technology [4-5]. Users can access these sites through the web network, find and obtain all kinds of information they need and enjoy the services provided by the site. This paper explains and studies the application of case-based design method in the field of machinery and the key technologies in the construction of remote design system based on B / S three-tier architecture [6-7]. It has a certain theoretical depth and important practical

significance, and promotes the application of case-based design technology and remote design technology in the field of mechanical design.

II. DEVELOPMENT ENVIRONMENT AND DEVELOPMENT TOOLS

2.1 SQL Server database technology

Database system is a collection of different database software, components and databases including the following parts [8-10]: (1) database application program; (2) Front end assembly; (3) Database management system; (4) Database. The database application program is special software, and the front-end component is general database software. Using database applications and front-end components, users can manage and query data in the database. The database system not only needs to provide an interface for users to create a database and retrieve and modify data, but also needs to provide system components to manage the stored data. The database management system provides the following functions: (1) user interface; (2) Physical data independence; (3) Logical data independence; (4) Query optimization; (5) Data integrity; (6) Concurrency control; (7) Backup and recovery; (8) Security and authorization.

SQL server is a relational database management system. Compared with the early database system (network and hierarchy), relational database system is based on relational data model. The central concept of relational data model is relationship, that is, table. Therefore, from the user's point of view, a relational database contains tables. In a table, there are one or more columns and 0 or more rows. At the intersection of each row and column of the table, there is always a database value.

In SQL server, all data is stored in a file called "device". There are two types of devices: database devices and dump devices. Database devices are pre allocated hard disk files used to store databases and transaction logs. The dump device allocates files only at the beginning of backup to store database backup and transaction data. But these files do not exist before the dump action. As an administrator, you should first establish a database device where SQL server can be placed. If the administrator does not specify a database device when creating a database, the database is stored on the default database device. The default database device is the master device when the SQL server is just installed. The administrator can modify the default database device.

2.2 System development tools

Visual Basic 6.0 Chinese version is a complete windows development system. It is an object-oriented visual high-level language. VB provides powerful functions to access various databases and can be used to design database applications. At the same time, the OLE technology provided by VB can also be used to realize the link between VB and external drawings and documents, realize the functions of graphic data information storage, editing and modification, and realize the computer management of graphic information. Visual Basic is a visual, object-oriented and event driven structured high-level programming language, which can be used to develop various applications in Windows environment. It is easy to learn,

efficient and powerful. In the visual basic environment, using the event driven programming mechanism, a novel and easy-to-use visual chemical system is developed. Using the application program interface (API) functions inside windows, dynamic link library (DLL), dynamic data exchange (DDE), object linking and embedding (OLE), open data access (ODBC) and other technologies, we can efficiently and quickly develop an application software system with powerful functions and rich graphical interfaces in Windows Environment.

Dreamweaver 4.0 is a web page editing tool based on network database launched by Macromedia company. It has intuitive and simple development effect and can greatly improve the development speed. It supports ASP, ISP and other codes, which is convenient to use. It is a popular website making tool at present. Visual InterDev 6.0 is one of the components of Microsoft Visual Studio 6.0. It is a powerful development tool for web developers to quickly establish dynamic and database driven web applications. It not only provides a visual web development platform, but also has built-in powerful web database tools. It is the best choice for developing ASP applications.

Visual basic system has strong database management function. Using the data control and data management window, you can directly establish or process the databases in the formats of windowsaccess, dBASE, FoxPro and sql server, and provide powerful data storage and retrieval functions. Visual basic provides open data connection, i.e. ODBC function, which can use and operate large background network databases, such as SQL server, Oracle, etc. through direct access or connection. In the application, the structured query language SQL data standard can be used to directly access the database on the server to realize the data exchange in different applications.

Using dynamic data exchange technology, the data in one application can be dynamically connected to another application, so that two completely different applications can exchange data and communicate, and a dynamic data link can be established between multiple applications in the way of client / server in the windows environment. When the data changes, the linked data can be updated automatically. Visual basic also provides the programming technology of dynamic data exchange, which can establish dynamic data exchange with other windows applications and communicate between different applications.

III. APPLICATION OF CASE-BASED DESIGN IN REDUCER DESIGN

3.1 Representation of instances

The description of design case is the basis of case-based design. The purpose of example description is to express an existing successful design example into data information that can be recognized and used by computer. The content and method of its description are related to the quality and efficiency of using it to solve similar problems. For the case base with few instances, the organizational structure has little impact on the efficiency of retrieval and storage. However, when the case capacity is large, the organizational structure of the case base has an important impact on the efficiency of the reasoning and solving process of the whole problem.

In the case base of reducer design system, we use the hierarchical organization method to decompose the case of multi-stage transmission reducer into the case form of single-stage reducer. In knowledge representation, the framework and object-oriented expression method reflect a certain description of knowledge hierarchy, which is more suitable for hierarchical design example expression. We express it in a framework. According to the organization mode of the framework, each level is divided into five slots: design task, design condition, design material, design result and result evaluation. Each slot is composed of different sides, and the side values are continuous numerical type, discrete numerical type and qualitative attribute value. In this way, the storage of instances becomes assigning values to different sides.

The reducer design system uses the relational database SQL server as the storage instance of the engineering database. The five slots such as design tasks are stored in five tables. Each side is a field in the table describing the slot. The five tables are connected with the design code and the series in the design, and represent an instance together with the transmission ratio table. The records with the same design code and grade in these five tables form the first level of an example. Such an organization is conducive to the realization of hierarchical retrieval, as well as the modification and storage of instances.

3.2 Instance retrieval

Case retrieval is to find similar cases suitable for the current problem from the case base by using the index of cases according to the given problem description. This step is directly related to the quality and efficiency of the design, and the key is the selection of retrieval algorithm.

(1) Nearest neighbor method. This method assigns a weight to each feature (i.e. attribute) of each instance. When retrieving an instance, it can match the input "problem description" with each feature value in the instance database, and pick out the best matching instance from the calculated maximum weighting coefficient value. The advantage of this method is simple and practical, but the disadvantage is that in most cases, each feature weight is different for each instance to be retrieved. Therefore, it is difficult to determine a set of general feature weights. (2) Inductive reasoning Induction is a learning algorithm similar to decision tree. It selects the information difference that can best distinguish the instance from other instances from the instance characteristics, and organizes the instance database into the form of a decision tree. Its index method can adopt ID3 algorithm used in building the decision tree. The other strategy adopts Feigenbaum's judgment network method, which is organized by abstract concrete hierarchical relationship. (3) Knowledge guidance method. Establish an index knowledge base, use the knowledge to determine which features in the instance are the most important in the instance retrieval, and organize the retrieval according to these features. Index knowledge includes domain principle, causal relationship between features, etc. Obviously, if the knowledge is quite complete, the knowledge guidance method can ensure the relative stability of the organizational structure of the case base. However, for a wide range of fields, it is very difficult to obtain complete index knowledge, so many systems often use this method in combination with other technologies. (4) Template retrieval policy. The retrieval process is realized with the help of specific templates or patterns.

The instance and design goal are described as some points of a hyperspace, and the dimension of the hyperspace is equal to the number of quantitative attributes of the instance. Due to the different dimensions of continuous attribute values and the nature of describing examples, there are often great differences in values. For example, the transmission ratio is generally less than 60, but the service life is more than 10000. If the coordinates are directly established, it will bring distortion. The attribute values should be dimensionless and fall within the [0,1] interval. The calculation formula is [11-12]:

$$x_{ij} = \frac{f_{ij} - \min(f_{1f}, f_{2f}, \dots, f_{nf})}{\max(f_{1f}, f_{2f}, \dots, f_{nf}) - \min(f_{1f}, f_{2f}, \dots, f_{nf})} \quad (1)$$

Thereafter, the coordinate axis is shortened or elongated according to the weight coefficient of each quantitative attribute. The space vector X_i after the transformation of m quantitative attribute values of example c_i is as follows:

$$X_i = W_1 * x_{i1} + W_2 * x_{if} + \dots + W_m * x_{im} \quad (2)$$

In general, the similarity of quantitative attributes is measured by the distance between two sample spaces. However, there are some deficiencies in dealing with design problems only considering distance. Because when the values of attributes are different, the difference between two samples with the same distance is different. For example, there are four samples as follows: (1) power 20kW, (2) power 40kW, (3) power 380kW (4) power 400KW. The distance between samples 1 and 2 is 20, and the distance between samples 3 and 4 is also 20. Obviously, the similarity between 1 and 2 and the similarity between 3 and 4 are not equal. Based on the above reasons, this paper proposes the following calculation formula of similarity:

$$S(X_i, X_j) = 1 - \frac{|X_i, X_j|}{\max(|X_i|, |X_j|)} \quad (3)$$

Qualitative attribute values are divided into Boolean attribute, nominal attribute and ordinal attribute. The attribute values of Boolean attribute and nominal attribute are independent of each other, and their calculation formula is as follows:

$$S_i = \begin{cases} 1 & f_{ii} = f_{ij} \\ 0 & f_{ii} \neq f_{ij} \end{cases} \quad (4)$$

3.3 Case modification technology of reducer design system

Due to the rich knowledge and experience in the field of reducer design, a relatively perfect modification rule base can be established. Knowledge-based modification is widely used in reducer system. For example, it is easy to establish the following rules: if the power P is the maximum mismatch attribute, then if the instance is larger than the newly designed P , reduce the modulus or increase the number of pinion teeth; If the example is smaller than the newly designed P , increase the modulus or reduce the number of pinion teeth. The idea is to first find out the difference between the best similar instance and the attribute values of the task to be designed, and then find two instances from the similar instance. The difference between their attribute values is close to the difference between the best similar instance and the attribute values of the task to be designed. Refer to the difference between the attribute values of their design results to adjust the best example to meet the new design task. This method has direct adjustment and high efficiency, and is suitable for CBD system with rich examples. For example, in the reducer design, there are the following tasks to be designed and similar examples: except for different power, all other design conditions are the same. The design results of each example are shown in Table 1:

TABLE I. Design results of each example

Result parameters	Mn	Z1	Z2	β	ϕ_d
Best similar instance	3.5	24	117	9°22'	0.4
Example i	5	23	115	9°22'	0.4
Instance k	6	22	110	9°22'	0.4

After comparison, the modulus difference is the largest, and Example k is one level larger than Example i (in the standard modulus series), so it can be calculated by reducing the modulus of Example 1 by one level, that is, taking it as 3. Finally, the design results are $Mn=3$, $Z1=22$, $Z2=110$, and β and ϕ_d are the same.

V. CONCLUSION

To sum up, this subject makes an in-depth study on the key technologies in case-based design, and combines intelligent CAD technology with Internet to establish an Internet-based remote design system, which provides a mechanical product design and analysis environment for remote users. In this system, the real-time display of online product model is realized by using network programming language VBScript / htul. Using ASP, ADO, SQL and ODBC technology to realize the remote knowledge query of common technical data in mechanical industry and the exchange of experience between users; Through web, VB and other technologies to achieve high-performance computing resource sharing, complete the transfer of computing tasks, and realize online remote computing.

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