Parametric Design and Simulation Analysis of Electronic Equipment Structure

Haitao Yu1,*

1Harbin Normal University, Heilongjiang 150025, China

*Corresponding author e-mail: 3435798@hrbnu.edu.cn

Abstract. Parametric design of mechanical products should meet the requirements of standardization, generalization and serialization. For existing design examples, computer aided design and parametric design technology are used without destroying design principles and basic structural characteristics. Electronic device products have the characteristics of relatively simple structure and easy serialization. Under the condition of market economy, if the structural design of products can be quickly completed and serialized products can be derived quickly, enterprises will be in a more active position in the fierce market competition. Parametric design technology has a long theoretical precipitation period and application demonstration period. The blank in theory and instability in the application process of new ideas and methods cannot be compared with parametric design technology. Aiming at the problems existing in the parametric design of electronic equipment, this paper explores the system opening strategy of parametric design of electronic equipment based on the design requirements of mechanical products and equipment.

Keywords: Electronic Equipment, Mechanical Products, Parametric Design

1. Introduction
With the rapid development of science and technology, the pace of market globalization is accelerating, the share of product design is increasing in today's marketization, and the market competition of various products in the world is becoming increasingly fierce [1]. Electronic device products have the characteristics of relatively simple structure and easy serialization. Under the condition of market economy, if the structural design of products can be completed quickly and serialized products can be derived quickly, enterprises will be in a more active position in the fierce market competition [2]. The rapid design of products requires comprehensive application of various advanced design technologies, including modular technology, parametric technology, CAD-based design tools, finite element analysis technology and variant design, etc. Based on the research of rapid design technology, the rapid design system of products is analyzed, developed and applied [3]. Parametric design technology appeared in the third stage of CAD development, which is called the third revolution in the development of CAD technology. Parametric design of electronic equipment is related to the whole electronic equipment manufacturing and production process. The previous parametric design was cumbersome, involving a large number of computing tasks, and could not meet
the market requirements for enterprise electronic equipment production [4]. There are quite a few parts in various products of different models that are the same. If these parts are standardized and serialized according to different sizes, designers can choose them directly from the manual [5].

The penetration of computers into the standardization of various industries is no exception. Using parametric design and database technology to standardize and parametric design of electronic equipment structures can greatly shorten the design cycle and enable designers to concentrate their time and energy on innovative design [6]. Parametric design technology has already had a long theoretical precipitation period and application demonstration period, and the theoretical gap of new ideas and methods and the instability brought by the application process cannot be compared with parametric design technology [7]. Parametric design technology, with its powerful sketch design and size-driven functions, has become an effective means for product initial design, modeling and model modification, product serialization design, multi-scheme comparison and dynamic design [8]. In the product design of electronic equipment structure, the mounting bracket is used as the mounting accessory of electronic equipment structure, which realizes the quick installation and disassembly of electronic equipment structure and platform. Using structured parameter design technology can effectively improve the design accuracy of products, shorten the development cycle of products, and recommend derivative design after product design is completed, which can reduce the workload of secondary design to the minimum [9]. In this paper, aiming at the problems existing in parametric design of electronic equipment, based on the design requirements of mechanical products and equipment, the system opening strategy of parametric design of electronic equipment is explored.

2. Design of structural parts based on Parametric Technology

According to the principle of similarity and reusability, the related products are analyzed and summarized, the components of the products are divided, and the interfaces and assembly relations between the components are determined. Then, the component parts of each component are analyzed to determine whether the related parts have rapid design features and geometric mechanisms. If the part has features and geometric mechanism of rapid design, it will be extracted and the parameter features will be reflected in the product digital prototype template, and the product digital prototype template will be established. Traditional parametric modeling technology has many shortcomings, so we should find a more appropriate method for more complex problems between traditional parametric modeling technology and synchronous modeling technology. The digital prototype changes caused by different parameters are different, so it is necessary to control the related parameters, so as to control the digital prototype model. According to the specific product requirements, the algorithms such as logical judgment and molding requirements are added to control each parameter [10]. With the continuous development of artificial intelligence technology, the technology based on artificial intelligence has gradually emerged and penetrated into the parametric design of products. This kind of method is a design method based on geometric case-based reasoning. This reasoning method has relatively simple and convenient knowledge acquisition and reuse methods, and its design method is similar to human decision-making thinking process, so it obtains new models or solutions by means of reasoning, search and comparison. At present, in the design process of electronic equipment products, special attention is paid to the variant design of finalized products. Therefore, in the development of electronic equipment parametric design system, the features of existing design examples should be extracted first, and new equipment similar to the original equipment should be designed without destroying the original design principles and features, so as to ensure the rapidity, high quality and low cost of electronic equipment design to meet the changes of market demand.

The dynamic part of the unified information model mainly stores the message format template of real-time data collected by sensor nodes, and analyzes and updates the real-time data collected according to this template to form data with the same storage format as the data service system. Table 1 shows the test data for the delivery accuracy, delivery speed and safety level of screened electronic equipment data.
Table 1. System sampling analysis atlas information

| Projects                                    | First time | Second time | Third time |
|---------------------------------------------|------------|-------------|------------|
| Detection of data security level of electronic equipment | 32%        | 38%         | 42%        |
| Delivery accuracy of electronic device data  | 62%        | 59%         | 71%        |
| Electronic device data delivery time        | 8          | 10          | 7          |

In the distribution network, the impedance on the high voltage side of the system is converted to the low voltage side, and the impedance value becomes smaller. With the increase of distribution network, the negative sequence impedance of the system becomes smaller. The negative sequence impedance of a general line is hundreds of times that of the system. Therefore, there are:

\[
\frac{d^2 \omega}{dx^2} - \frac{h}{\alpha^2 EI_0} \frac{d \tau}{dx} = -\frac{M}{EI_0}\]

(1)

Because the feeder is generally short, the negative sequence impedance of the load is larger, and the negative sequence impedance of the load is much larger than that of the feeder:

\[
\frac{d^2 \tau}{dx^2} - \alpha^2 \tau = -\frac{\alpha^2}{h} \left[1 - \frac{EI_0}{EI_\infty}\right] V
\]

(2)

Fault feature extraction is mainly used in health assessment and fault prediction. Therefore, the fault features obtained by different methods are applied to health assessment in experiments, and the results of fault extraction are verified by observing the health assessment results. The deviation curve of primary fault characteristics is shown in Figure 1.

![Figure 1. Primary fault characteristic deviation curve](image)

The product assembly template needs to include assembly constraint parameters, which can form various parts into assembly products according to certain rules. Part templates need to include part design parameters, which can control geometric features to generate parts. Parametric design of electronic equipment is a very important technology for mechanical products. Due to the increasingly fierce market competition, enterprises need to further accelerate product development and innovation and quickly respond to market demand. Parameter-driven is to define the variable dimension values of the same type of parts as parameter variables under the condition that the geometric topological structure of parts is unchanged, and give the mapping relationship between parameters. When different...
parameter values are given, parts with the same topological structure but different dimensions can be obtained.

3. The overall design and key technology of the system platform

The rapid design control program mainly controls parameters, and conditionally selects the corresponding parameters in the digital prototype template to control the generation of 3D models. Geometric constraint, when the 3D model sample machine is used for feature modeling, the dimensional standard should be strengthened and the constraint of tangency and fixed point relationship should be imposed, so as to meet the design requirements of geometric figure. To develop a rapid modeling platform based on the whole machine parameterization method, designers only need to grasp the products from the whole machine level, and only need to interact with the modeling platform to complete the whole machine level information input, such as the type of chassis, the overall dimensions of the chassis, features or the number of parts. According to the design rules, the platform will automatically call features and parts to generate component instances, and complete the parameter association and component assembly, so that the whole product model can be generated quickly and accurately [11]. Components of electronic equipment are not relatively independent, on the contrary, they are closely related in size and assembly. The relevance of electronic equipment component parameters determines the relevance of component parameter design. Three-dimensional model basically determines the size, dimensions and various parameters of electronic equipment. Only by defining design parameters and variables of model dimensions can we control the geometric dimensions and topological relations of three-dimensional model and ensure that design parameters can control the three-dimensional model.

The connection sequence between assembly points provided in the structural assembly tree is the most important information, and its interconnection represents the sequential assembly sequence of a model and the relationship between instance extraction and location. Although the connection between wireframes seems simple, it is precisely because of this simple and easy-to-comb connection relationship that we can preliminarily formulate the brief design rules of products according to the trend of assembly tree, which lays a foundation for the establishment of subsequent rules. Parametric programming method is to design some programs that can create corresponding parts according to given parameters, and one program can create a series of parts, and these parts are not designed in advance, so no corresponding storage space is needed. In the model structure, each dimension value corresponds to a dimension parameter, and the design parameter can only be associated with the dimension parameter to complete the function of driving the change of model parameters. In normal operation, it is usually in a closed state, and the tie switch is usually used to connect the node with other feeders. When the structural parts of electronic equipment fail, the tie switch can be closed to provide auxiliary power supply to the node that is out of power [12]. There is a certain relationship between the parameters of the model, which can be used to establish the parameter constraint model of chassis. When establishing the features of model base and parts model, the association between local design parameters and size parameters is completed by model preprocessing, and the parameter hierarchy is divided according to the division of parts model by structural assembly tree. The linkage relationship between whole machine design parameters and local design parameters is expressed by parameter constraint model.

In order to ensure the safe, economical and efficient operation of electronic equipment structures, open-loop operation is usually adopted in power grid operation. Although the structure of electronic equipment sometimes runs in closed loop, too large circulating current impact will be produced when the distribution network runs in closed loop, which will make the relay protection act and cause the failure of closed loop. If the traditional design method is used, the designer has to re-specify every matching parameter between each part, which is inefficient, but these tasks can be automatically completed by programming and programs. For early warning of equipment failure, there must be enough basic data of equipment, and basic parameters of equipment must be collected and stored. For the basic information of power equipment, the production manager can manage it timely and
dynamically. It can be seen from Table 2 that the error between the natural frequency of power equipment obtained by numerical simulation and the natural frequency calculated by finite element is less than 5%. By comparing the two, the accuracy of the description of elastic deformation is proved.

**Table 2. Comparison of results**

| Order number | Numerical simulation frequency (Hz) | Calculate modal frequency (Hz) |
|--------------|-----------------------------------|-------------------------------|
| 1            | 18.535                            | 19.746                        |
| 2            | 90.475                            | 88.543                        |
| 3            | 184.091                           | 188.541                       |
| 4            | 257.484                           | 273.689                       |

Because the wires of electronic equipment structures are usually very long, the resistance and reactance of the wires are very large, and the power loss caused by the heating of the wires is also relatively large in the process of power transmission. The parametric constraint model diagram provides users with intuitive parametric constraint relationships, and gives them ideas on how to draw up appropriate design parameters and how to build the relationship between parameters. In order to ensure the integrity and security of the database, the data type and uniqueness of each attribute of each table of the database are set according to the actual function of the database. For system behaviors with dynamic characteristics, we can extract the intrinsic characteristics of data that are beneficial to reflect system behaviors through unsupervised training, and then improve the expression of characteristics through supervised training. For the modeling platform, the model diagram can't provide parameter information for it, so it is necessary to transform the parameter constraint model diagram into expressions related to the model design parameters before it can be accepted by the platform and play its function of parameter constraint. In order to realize the system's monitoring and fault warning for different equipment and improve the analysis results of different equipment monitoring methods, the system needs to have certain extensibility for the monitoring and warning methods of power equipment. The network model of electronic equipment structure is shown in Figure 2.

![Figure 2. Network model of electronic equipment structure](image)

The parameters extracted from the database are suitable for products with high standardization, and the data of each standard parameter is stored in the database. When designing related products, users only need to retrieve the database and extract the parameter data, which can realize the rapid design of products. Traditional assembly is the most basic assembly based on points, lines and faces. Any unfixed part must be completely defined by three constraints. If manual assembly is used, the process is tedious and inefficient, while if the assembly based on heat exchanger parts is used, the situation is obviously improved. Parametric design system of electronic equipment should be based on dimensional constraints, engineering constraints and topological constraints, and with the help of computer-aided design, to realize the modification of traditional parametric feature-driven dimensions, and to realize the corresponding modification of other associated dimensions. All the design and modeling processes start with the disassembly and analysis of product prototype structure. In traditional modeling methods, the more designers know about product structure and the clearer the spatial position of products, the smoother the modeling process and the more accurate and realistic the obtained model will be.
4. Conclusion
Parametric design system of electronic equipment should meet three requirements: first, it has a large number of previous electronic equipment parameter data, so as to facilitate parameter correction and modification. To develop a rapid modeling platform based on the whole machine parameterization method, designers only need to grasp the products from the whole machine level, and only need to interact with the modeling platform to complete the whole machine-level information input such as the type of chassis, the overall dimensions of chassis, features or the number of parts. The rapid design system of electronic equipment mounting rack can be constructed by applying the structural design technology based on parameterization and combining with the framework theory of structural design system. Parametric design system of electronic equipment should be based on dimensional constraints, engineering constraints and topological constraints, and with the help of computer-aided design, to realize the modification of traditional parametric feature-driven dimensions, and to realize the corresponding modification of other associated dimensions. In the development of electronic equipment parametric design system, the features of existing design examples should be extracted first, and new equipment similar to the original equipment should be designed without destroying the original design principles and features, so as to ensure the rapidity, high quality and low cost of electronic equipment design to meet the changes of market demand.

References
[1] Zhu Yugang, Wang Li. Parameterized design of radar electronic equipment chassis based on Pro/E[J]. Industry, 2015, 000(025):246-247.
[2] Li Ji. Research and realization of rapid product design based on parametric technology[J]. Machinery and Electronics, 2019(6):35-37.
[3] Zheng Xiaowen, Qian Lili. Product parametric design method based on SiemensNX software[J]. Electronic Engineering, 2015, 000(001): 49-51.
[4] Zhang Lei, Liu Jian, Li Yan. Parameterized design of the basic reflector unit of a large spherical antenna [J]. Measurement, Control and Communication, 2017, 041(001): 22-28, 39.
[5] Miao Xiaodong, Liu Bing, Wang Dalin, et al. Research on rapid design technology of electronic equipment structure based on Pro/E layout control[J]. Aerospace Control, 2015, 033(004): 90-94.
[6] Bo Zhifeng. Design of automatic test system for radio altimeter based on LXI bus[J]. Ship Electronic Engineering, 2015, 35(4):139-143.
[7] Geng Minggui. Research on Parametric Feature Modeling Method in Mechanical Design [J]. Urban Construction Theory Research (Electronic Edition), 2016, 000(015): 5118-5119.
[8] Jia Chaobin, Cheng Heng. Research on parametric design method of screw conveyor[J]. Machine Design and Manufacturing, 2015, 000(004):206-208,213.
[9] Wu Hongen, Liu Youcheng, Fang Tingshun, et al. Parametric design and verification of cylindrical gears based on Pro/Toolkit [J]. Coal Mining Machinery, 2016, 37(005): 169-171.
[10] Yao Yunbin, Li Xiumei, Cui Yukun, et al. Parameterized design of flange standard parts library based on Solidworks[J]. Modern Manufacturing Technology and Equipment, 2015(1): 29-30.
[11] Feng Guangzhi. Parametric design and practice of mechanical equipment [J]. Industry and Technology Forum, 2020, 019(001): 57-58.
[12] Liu Zhenji, Gao Shiying, Ran Qiyou. The parametric design method of radar altimeter sensitivity test system[J]. Computer Measurement and Control, 2016(24):129-131.
[13] Liu Wenhua, Liu Fuyun, Yu Hanhong, et al. Parametric design of diaphragm spring meeting engineering constraints[J]. Coal Mine Machinery, 2019, 040(001): 23-25.