Theoretical Study on Mechanical Product Structure Automation

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Keywords: SPC, Control Charts, Process Capability

Abstract: Aiming at the problems of low efficiency, low automation and poor innovation caused by randomness, non-physicalization and non-standardization in product structure design automation, a top-down product design process model based on generalized mapping principle is proposed. Based on the intelligent support of this principle for creative work, a software prototype system developed based on this principle is introduced.

1. Introduction

The product design process can be understood as starting from the market demand, extracting the functional requirements of the product, and then deriving the behavioral performance requirements of the product, and finally completing the structural design of the product. Product design has experienced a mapping process that spans multiple domain knowledge, namely market demand → functional requirements → performance requirements → product structure. At present, CAD systems are not competent for automated mapping between most of the application areas, and automation design of products is not supported. In terms of product innovation design, creating inventions is an item that does not exist in the material world. Its essence is the decomposition and recombination of existing items. The new invention is a recombination of the real world structure. However, the simple decomposition and reconstruction process can not solve the practical problems in engineering design. It is of great significance to study the intelligent/interactive mapping process between various fields based on decomposition and reconstruction. Based on the generalized mapping principle this paper studies the software prototype system GPAL with top-dow n style and supports product innovation design automation, and discusses its support for product structure innovation design automation.

2. Mechanical design and manufacturing and automation technology

The difficulty in achieving sustainable development in all sectors of society is due to the widespread problem of low energy efficiency. For the mechanical manufacturing industry, although the realization of mechanical manufacturing automation can promote the further development of related industries, there is a serious waste of resources in the process of mechanical manufacturing automation construction. China is a country with a large population and a vast territory, but its per capita possession is small. In recent years, resource consumption has increased, and the energy reserves of China's inherent resources have been decreasing. The mechanical design and manufacturing industry needs to pay attention to the application of energy-saving design concepts to minimize the energy consumption and pollution hazards in the mechanical manufacturing automation process to meet the stable and sustainable development needs of machinery manufacturing. The so-called mechanical design and manufacturing automation mainly refers to the application of computer technology in the process of mechanical manufacturing, to achieve a seamless combination of the two, in order to achieve mechanical manufacturing automation construction. The biggest role of mechanical manufacturing automation is to effectively improve the efficiency and quality of mechanical manufacturing. However, due to the increase in energy consumption, the deepening of the sustainable development process and the market environment, the mechanical automation has not been fully utilized. Although energy-saving design technology can effectively alleviate the pollution problem of mechanical design and manufacturing, it has not

  DOI: 10.25236/eeems.2018.060

received the attention of relevant personnel, and energy-saving and environmental protection technology has not been widely used. Even if some mechanical design and manufacturing use energy-saving and environmental protection technology, it is only in part of the operation, which will also affect the sustainable development of the machinery manufacturing industry.

3. Principles of GPAL system development based on generalized mapping principle

From the perspective of supporting the whole process of product structure design and concurrent engineering, the design process has the following characteristics: 1 from requirements to functions; 2 from functions to structures; 3 from structures to parts (or from global to local); 4 from concept to detail 5 from qualitative to quantitative; 6 from information uncertainty to complete information. In order to support the above design patterns, this paper proposes a CAD system modeling idea based on the generalized mapping principle of computer-aided demand analysis, function creation, work-structure mapping, and entity reconstruction. The design idea reflects the top-down design. process. Its core content includes the main processes of demand mapping, function mapping, and entity reconstruction (see Figure 1). The essential content of the product design method based on the generalized mapping principle is that, for the product structure design problem, the generalized scope involved is first defined, and the research content and attributes of the scope are decomposed, and the upper generalized domain is from the underlying granularity space. The lower generalized domain mapping, the mapping target and the result form a discrete set of the domain of the product, and the discrete set of the domain formed by the mapping is reconstructed from the underlying granularity space, and the reconstructed result is used as a product design solution, in the product concept In the process of structural implementation multi-program reconstruction, verify its innovation potential.

4. GPAL-CAD system features

The design requirements of the product are expressed as a static state sequence set (Object) of the manipulated object (such as the artifact), and the corresponding functional principle design work is to map and plan this state sequence set as a product behavior performance order set (Behavio r Set) the process of. A hierarchical decomposition of the various factors involved in the product's life cycle.

The mapped domain objects GDPs need to be recombined. In the structural design, the functions and structures of the individual units, such as abstract features, features, parts, functional products, etc., need to be reconstructed on the basis of decomposition. According to the relationship type of the object, the function and structure of each independent unit can be layered and integrated step by step, and reconstructed according to the order of function features - features - functional parts - functional products. Reconstruction requires comprehensive design knowledge, principles, and algorithms; in the new decomposition mode, new comprehensive knowledge needs to be developed. The functions implemented by the entity refactoring process include the following three aspects.

The conceptual structure of the product is stored in the form of a product information network diagram. The product information network diagram records the relationship between the internal parts and parts of the product, between the parts and the functional carrier, and between the functional carrier and the functional carrier. The main functional features of this paper are used as functional carriers. The parts contain a set of functional features. The functional feature set does not fully express a regular entity. Therefore, it is defined as the conceptual entity of the part. The product consisting of the conceptual entities of the part is called the conceptual structure of the product. In order for the reconstructed entity to meet the functional requirements to the maximum extent, the functional surface set needs to be "aggregated and classified" according to the abstract features that may be composed. According to the default logic theory, for uncertain information, Some kind of "reasonable" assumptions are made. Therefore, the system performs abstract feature recognition and zero-thickness solid modeling based on "internal feature first method" and "external feature first method". After abstract feature recognition, zero-thickness solid modeling, and finally

The conceptual part modeling is completed. The system determines the boundary vertex data through the intersection calculation between the surfaces. Based on the surface ring data structure, the region is recursed based on the concept of “effective line segment” and the corresponding decision algorithm. The triangle is divided into three parts: a series of small triangular patches for the masking of the region, to achieve the three-dimensional display of the entity in the conceptual design phase.

5. Technical core analysis of mechanical automation

Mechanical automation technology is one of the application technologies in the mechanical industry. It can realize the continuous automatic production of processed objects in the mechanical industry and realize the optimal production process. Thereby achieving processing efficiency, reducing processing time and meeting market demands. Its application and development have been rapidly reflected in recent years, especially the adoption of advanced technical means and automated processing and production concepts, which have greatly promoted the development of the entire machinery industry. In addition, mechanical automation technology has brought epoch-making significance to the machinery industry to a certain extent, thus driving the development of the world machinery industry. First of all, the application of mechanical automation technology improves the safety of production from the production process, and the application of personnel is less. Most of them adopt the mechanical production process, and each production link is carried out according to the automatic control program, which reduces the possibility of stagnant production. Secondly, the use of mechanical automation technology can greatly improve production efficiency. Traditional artificial and workshop production can adapt to the traditional machinery industry. However, in terms of the current development situation, the application market and market demand for machinery are very large, and the traditional production mode can no longer meet such fast-paced market demand. In addition, the market has higher quality requirements for mechanical products. The use of mechanical automation technology can not only improve the production efficiency of mechanical products, but also reduce the errors in production to a certain extent. It adopts automatic control program to produce, and it also guarantees the quality of products. Finally, the application of mechanical automation technology has greatly reduced the waste of raw materials and energy. The mechanical automation technology adopts an automatic control system, in which the utilization of resources can maximize the design of the program, and reduce the resources of traditional artificial design. waste. In short, the application of mechanical automation technology is more extensive, and its substantive role is also very obvious.

The mechanical industry has higher and higher requirements for mechanical products, and CNC technology, as the core technology of mechanical automation, has met its development needs to some extent. Mechanical products need high efficiency, high precision and high end, and CNC technology is meeting these high requirements. The automatic repair technology, automatic correction technology and the advantages of ensuring high-end requirements in the processing process are reflected in the mechanical production and processing. In addition, in the process of processing, CNC technology can achieve technical adjustment and compensation of product processing to meet the requirements of various parameters. For some faults in the process, etc., timely diagnosis and treatment can be carried out, and the timeliness and effectiveness of production and processing are realized.

The network is developing rapidly, and Internet technologies will appear in various fields. In the mechanical automation technology, network technology has also been applied, and in some areas, it has become a new direction of mechanical automation technology. Among them, CAD and CAM technology and numerical control technology have been effectively combined to realize the production form of machine tool networking.

First, the development of automation performance will be toward higher-end development, high speed, high precision and high efficiency. For these high-end requirements, it is the main performance index requirement of mechanical manufacturing technology. In the application of automation technology, CNC technology is its main core technology. In numerical control

technology, high-speed CPU carries important tasks. In addition, some high-end chips cooperate with each other, which makes the automation technology reach high speed and high. Fine and efficient requirements. In addition, for the dynamic and static changes of the machine tool, the basis for meeting the high-end requirements is also achieved to some extent. Second, the flexibility of automation technology reflects the flexible design of the CNC system itself. Through the integration technology, different areas are modularized to achieve full coverage of functions. In addition, different functions can be realized for different production requirements, which is very useful for the softness of the entire system. For large groups such as mechanical production and processing, data can be dynamically adjusted to take advantage of the effectiveness of its group control system. Third, the development of multiple processes and multi-axis. The complexity of the process and multi-axis can reduce the auxiliary time and maximize the efficiency of machining and production.

6. Conclusion

The realization of the energy-saving goal of mechanical manufacturing automation needs to pay attention to environmental protection on the basis of the original improvement of production efficiency. It is necessary to start from optimizing the production process and selecting environmentally-friendly mechanical materials, effectively reducing the energy consumption of mechanical automation and ensuring that the machinery industry can The realization of the strategic goal of sustainable development.

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