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Research on Virtual Assembly Based on VR Technology

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Abstract

This article introduces the development status of virtual assembly technology, outlines the key technologies involved in virtual assembly, takes VR virtual assembly as an example, introduces the operation process of virtual assembly and virtual assembly cases in various fields, and analyzes the future of virtual assembly technology. development trend.

Keywords

Virtual Assembly; Virtual Reality; VR Virtual Assembly.

1. Introduction

An important part of virtual manufacturing is virtual assembly technology. Compared with other parts of virtual manufacturing, virtual assembly technology performs weaker. The lagging development makes the application of virtual assembly technology in society still not very common. Based on this, the development of virtual assembly technology has become an extremely important topic and task of today's virtual manufacturing technology, which helps to improve the virtual manufacturing technology and make it a complete theoretical system, which has both high efficiency, short-term and low cost. In addition to its own quality service.

1.1 Classification of virtual assembly

The current virtual assembly research can be divided into three categories according to its function and purpose, namely, virtual assembly centered on product design, virtual assembly centered on process planning, and virtual assembly centered on virtual prototype.

1.1.1 Virtual assembly centered on product design

In the process of mechanical product design, virtual assembly can more effectively assist designers in making design decisions related to mechanical assembly. Generally, computer simulation methods can be used in a virtual environment to achieve mechanical assembly assisted design. Virtual assembly is mainly oriented to assembly design theory and methods. The main problem to be solved is to find the optimal solution in mechanical assembly based on existing principles and schemes, combined with various constraints in reality, thereby determining the assembly sketch.

1.1.2 Virtual assembly centered on process planning

In the assembly process of mechanical products, the most important foundation is the information model and assembly resource model of mechanical products, which uses simulation technology and virtual technology to design and simulate mechanical product assembly. In this way, a better process plan is obtained to provide guidance for the actual assembly work. In actual work, according to the scope and level of assembly, it is subdivided into system-level and job-level assembly planning.

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System-level assembly planning is an overall plan for assembly production, including market demand, investment status, production scale, production cycle, resource allocation, assembly workshop layout, and assembly line balance. It can be used as a framework document for mechanical assembly work; job level Assembly planning focuses on the planning of the mechanical assembly process, which generally includes the planning of assembly sequence, assembly path and process route. Taking process planning as a virtual assembly center is characterized by a high degree of consistency in operation simulation. The main aspects reflected are the assembly objects, assembly process and tools used during the period are similar to the actual height. Therefore, it can intuitively reflect the actual assembly process of mechanical products, and the simulation results have a high degree of credibility.

1.1.3 Virtual assembly centered on virtual prototype

The virtual prototype is to use a computer simulation system to simulate the shape, function and performance of the product to a certain extent to produce a comparable effect with the physical prototype to test and evaluate the product characteristics. The traditional virtual assembly system is based on ideal rigid parts. The combination of virtual assembly and virtual prototype technology can effectively analyze the impact of the force deformation during the part manufacturing and assembly process on the product assembly performance. Tolerance optimization design provides visual means. The main research contents of virtual assembly centered on virtual prototype include modeling of parts manufacturing process considering cutting force, deformation and residual stress, finite element analysis and simulation, fit tolerance and part deformation, and visualization of calculation results.

2. Analysis of key technologies of virtual assembly

2.1 Product-based assembly modeling technology

Virtual assembly modeling of mechanical products is an important part of assembly design. The essence of modeling is to establish a close relationship between computer memory and external performance. The quality of the model established in the early stage is directly related to the effectiveness of the subsequent work of the virtual assembly system. Therefore, it is very important to establish a complete and highly unified mechanical assembly system model.

The most typical assembly model is the binary tree model. The most intuitive feature of this model is to treat the assembly as a binary tree, the assembly that the user ultimately needs as the root node of the tree, and the non-leaf node as the sub-assembly of the assembly system Generally composed of many parts and sub-assemblies, each part is represented as the lowest-level leaf node in the model. Each leaf node can lead to many non-leaf nodes, indicating that each part in the system can be referenced multiple times in the assembly.

2.2 Assembly sequence planning strategy

In the process of assembling mechanical products, the most important point is the installation order of parts and sub-assemblies. The same mechanical products can use a variety of different assembly sequences; different assembly sequences in turn produce different assembly sequences. When assembling, it only needs to follow a specific assembly sequence to successfully organize the assembly work, and it is the mechanical assembly that can meet the final design requirements. It is undeniable that there will still be some assembly sequences that are difficult to achieve the expected assembly target for various reasons.

2.3 Virtual assembly simulation technology

The application of this technology is mainly to check the coordination and ease of installation between mechanical parts in the design stage, which greatly improves the accuracy of mechanical design. Simulation technology can support people to browse products digitally, verify the sequence and path of mechanical assembly planning, evaluate product assembly, and obtain feedback information by relying on assembly procedures, so that designers can quickly adjust designs and further improve the quality of mechanical design.

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3. Application Examples of VR Virtual Assembly

VR virtual assembly is an indispensable review link for industrial design. Such virtual operation can help engineers and designers to find out various problems during assembly and maximize the optimization of the actual assembly of the product in terms of design interface, component appearance and size efficiency.

Virtual assembly is based on the evaluation and simulation functions of virtual prototypes. Through Inventor, Siemens Jack, 3DVia, Siemens NX and other virtual prototype design software and VR display equipment, engineers and product managers can design in the software. The product disassembles and records the path of component movement and possible collision paths. Advanced virtual assembly can even record the entire assembly process, and simulate the parameters of force and force feedback of the component through the physics engine to help designers and engineers improve product development.111In VR virtual evaluation software, the virtual assembly module can realize component identification, selection and operation. At the same time with the application software interface (such as CATIA connector, Navisworks connector, NX connector and Creo connector, Inventor connector, solidworks connector) can identify and display the part information defined in the PLM product lifecycle management database. By identifying the structure of components and the type of interface, engineers can maximize the modification and perfect the equipment assembly.

3.1 Operation flow of virtual assembly

3.1.1 Identify the interface of each spare part in VR software

In VR virtual evaluation software, the virtual assembly module can realize component identification, selection and operation. At the same time with the application software interface (such as CATIA connector, Navisworks connector, NX connector and Creo connector, Inventor connector, solidworks connector) can identify and display the part information defined in the PLM product lifecycle management database. By identifying the structure of components and the type of interface, engineers can maximize the modification and perfect the equipment assembly.321Define the motion relationship constraints (axial rotation, linear, etc.) between parts or between parts and the environment. After defining these motion relationships and rules, the simulated virtual assembly can be expanded in the virtual environment.

3.1.2 Define constraints

Define the motion relationship constraints (axial rotation, linear, etc.) between parts or between parts and the environment. After defining these motion relationships and rules, the simulated virtual assembly can be expanded in the virtual environment.321The collision detection virtual assembly software can display the interference area, physical collision simulation or haptic feedback. By recording these data feedback, engineers can easily modify their products at a later stage.

3.1.3 Record all collision and assembly paths

The collision detection virtual assembly software can display the interference area, physical collision simulation or haptic feedback. By recording these data feedback, engineers can easily modify their products at a later stage.123After recording the collision and assembly path, engineers can redefine the assembly process through different interface optimization, equipment assembly process optimization, and assembly space optimization.

3.1.4 Optimize all assembly paths and reduce collision elimination paths

After recording the collision and assembly path, engineers can redefine the assembly process through different interface optimization, equipment assembly process optimization, and assembly space optimization.

3.2 Essential functions of virtual assembly software

Gradually implementing fine displacement is one of the necessary functions of virtual assembly, which can help engineers record the path of displacement and improve component design. At the

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same time, displaying the position and orientation of parts and defining constraints are also functions that must be equipped in virtual assembly. Associating parts through position and direction After tracking the target and after the constraints are defined, the assembly process of the component can also be simulated without maximizing it.

A qualified virtual assembly software can group and move multiple parts of the model as a whole. By viewing the collision and recording the path, it is convenient for future reloading for research. Virtual assembly is not only used before it is put into production, it can also be used to verify disassembly and assembly tasks, maintenance operations, or training. Most of the virtual assembly software has the function of connecting to the PLM product structure tree, which means that for large design projects, the virtual assembly function can be called in the PLM product lifecycle management software.

3.3 Application examples of virtual assembly

3.3.1 Application range and case of manufacturing virtual assembly

There are more cases of virtual assembly in manufacturing than in other industries, especially in the fields of automobiles, ships, and aerospace. Virtual assembly is mainly used in the two areas of design assembly and process evaluation.

Taking the automobile industry as an example, a new car model has many important components such as shape and internal mechanical parts, external parts, and cockpit interior. If the R & D team uses Catia or Siemens NX for R & D according to the parts, the design and assembly of each part are supported by engineering documents. However, due to the large project, complicated process and many assembly parts. If the components are produced and then tested and assembled, it will greatly reduce the energy efficiency of R & D and increase the production time.

3.3.2 Application range and cases of virtual assembly in the industrial field

The industrial field covers a lot of industries, from energy acquisition such as mine mining to oil and gas mining, metal raw material production to chemical material production, and waste product recycling. Such industries require extremely precise equipment and specialized operating procedures. Virtual assembly in plant design, production equipment design, production evaluation, etc. can help companies eliminate various problems and failures in their industrial fields. At the same time, owners can even do maintenance on the equipment after it is put into production Systematic verification to ensure that the equipment can be maintained at the lowest cost.

3.3.3 Application range and case of virtual assembly of architectural interior design

In the field of architectural interior design, virtual assembly can be the virtual assembly of certain electromechanical equipment, such as large indoor roller coasters, elevators on high-rise floors, etc., and many external factors must be considered during assembly. Supported by the software, simulating the entire assembly and construction process, you can find out the possible problems, such as the optimization of equipment assembly steps, the optimization of indoor circuits and pipelines, and the problems that may be encountered when disassembling and disassembling a component during later replacement and maintenance Problems, etc.

4. Conclusion

Virtual assembly is the realization of the actual assembly process in the virtual reality system. At present, the research of virtual assembly technology has achieved certain results, and it has been initially applied in the field of automobiles and aviation. In the future, the key development direction will be mainly reflected in the following aspects.

(1) Integration of virtual assembly system and CAD system. At present, the virtual assembly systems at home and abroad are all related digital models of products from commercial CAD systems. At the same time, the virtual assembly system can also feed back assembly simulation results and product transformation information to the CAD system, Directly affects the work efficiency of the virtual assembly system. Therefore, in order to realize large-scale commercial applications, the CAD system

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and the virtual assembly system must be integrated to ensure the smooth flow of information between the systems.

(2) Towards a collaborative development based on the network. At present, the globalization of the manufacturing industry is constantly advancing. How to involve designers, process compilers and assembly manufacturing workers all over the world in assembly-related design is a problem that virtual assembly needs to solve. Therefore, the establishment of a collaborative virtual assembly system based on the Internet is one of the future development directions.

(3) Improve the rationality and comprehensiveness of the assembly process modeling. In the actual processing and assembly environment, the shape and position errors of the parts will cause the product to not be assembled during assembly, or the product performance after assembly cannot meet the design requirements. For example, due to the influence of factors such as cutters and residual stresses during actual processing, parts will produce dimensional and shape errors. Different environmental temperatures and assembly forces during assembly will affect the assembly accuracy of the final product. Therefore, it is necessary to consider the processing and assembly environment in the assembly modeling process.

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