

Research of Mould Virtual Assembly System Based on EON

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Abstract—Aiming at the features of stamping mould, a interactive three-dimensional simulation system of virtual assembly was developed by VC++ and EON. The architecture of simulation system was given through analysis of the system implementation process from the part of the modeling, model optimization, model data conversion, the logic of the mould assembly, human-computer interaction, etc. Finally, the simulation of mould virtual assembly process was carried out in the simulation platform by means of the event-driven and routing mechanism.

Keywords- Virtual Assembly; Mould ; Simulaton ; EON

1. Introduction

The mould virtual assembly didn't require material objects. It just required creating physical models in three-dimensional modeling system and manipulating each component model directly to complete the mould assembly process through human-computer interaction in virtual environment (VE). Using virtual assembly experiment can make up for the limitations and shortcomings of time and space caused by the real experiment, and promote student's understanding and perception of knowledge [1].

At present, the researchers at home and abroad have made a lot of studies in the development areas of virtual assembly simulation system. Overseas, Washington State University developed a virtual assembly design environment-VADE which made the success application of virtual reality technology in the assembly field. In the recent years, domestic studies on virtual assembly have also made a lot of achievements such as the assembly sequence planning and evaluation system based on virtual prototype developed by Huazhong University of Science and Technology. Zhejiang University has studied the virtual assembly manipulations based on semantic recognition. Harbin Industry University has build the virtual assembly environment based on geometric constraint, etc. [2]

The software environments used by virtual system almost could be divided to three classes: First, advanced programming language coupled with hardware-oriented graphics development interface is a direct hardware-oriented programming method and has a great degree of difficulty and workload; Second, the secondary development based on commercial CAD software does not have the real interaction; Third, the method of advanced programming language coupled with virtual reality environment generating tool has a high development speed and a strong system interaction[3].

In this paper, the third method was adopted. The stamping tool assembly simulation platform was developed by the virtual reality software EON coupled with programming software VC++. And this virtual assembly simulation system had certain practical value for teaching.

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2. System Architecture

The main purpose of this developed system was the realization of automatic assembly demo aimed at the design and assembly process of 3D model. Further, through human-computer interaction, it can realize the control of virtual assembly process.

The virtual mould assembly simulation system constructed in this paper used EON Studio as the development platform of virtual simulation. Due to EON Studio was not a drawing software and can not create model, the mould model imported need to model in other modeling first. And the function of interaction and control in the mould assembly process were realized by Java Script programming. Finally, it used VC++ as the secondary development tools and called the interface function of EonX control to design system interface, integrated each functional sub-module and controlled mould virtual assembly behavior. The mould virtual assembly simulation system architecture was shown in Figure 1.

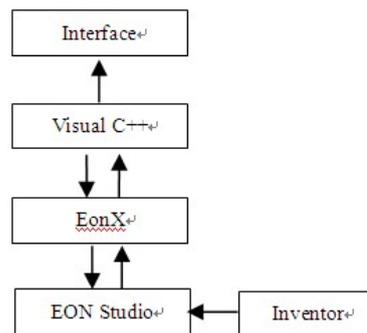


Fig.1. Architecture of Simulation System

3. Structural Characteristics and Assembly Requirements of the Mould

3.1. Structural Characteristics of the Mould

Stamping die was special technical equipment. Its structure and type varied with stamping content. In the paper, the virtual assembly system was designed including the virtual assembly of single process die, compound die and progressive die for blanking, blending and drawing.

According to their different effects, the components of mould could be divided into two categories: technology parts and structural parts. Although a set of mould contained lots of components, there were many standard parts in the structural components. Therefore, when creating the 3D model of mould components, using this feature can reduce the workload.

3.2. Assembly Requirement of the Mould

Mould assembly including subassembly assembly and final assembly. When assembling, the assembly reference must be determined first. Then according to the relationship between components, the assembly sequence can be determined. Module assembly includes the assembly of die shank, the assembly of punch and dead plate, and the assembly of concave die and dead plate.

To assemble a mould with mould base, the mould base should be installed first, and then other components. Progressive die has a high request of step pitch precision and positioning accuracy. When assembly, choosing concave die as the assembly reference, installed the bottom part first and then installed the top part. The structure of compound die was tight and had a high requirement of the assembly accuracy. When assembly, choosing concave-convex die as reference part, installed the top part first and then installed the bottom part. The same relation components may not differentiate the assemble sequence.

4. System Implementation

4.1. Modeling and Optimization of Mould Components

(1) Entity Modeling

Constructing a simulation system need to build mould component model first, and then optimize the model.

Inventor, Pro/E, Solid Works, UG were common 3D design software used in mechanical design. The models build in Pro/E, UG had high accuracy but the process of modeling was complex or troublesome relatively. While the models build in Inventor, Solid Works had low accuracy but the process of modeling was simple relatively. Moreover, it was easy to operate and the effect of rendering was better. As large number of parts and heavy workload, Inventor software was used to build solid model. Figure 2 is the example of 3D solid model of mould components established by Inventor.

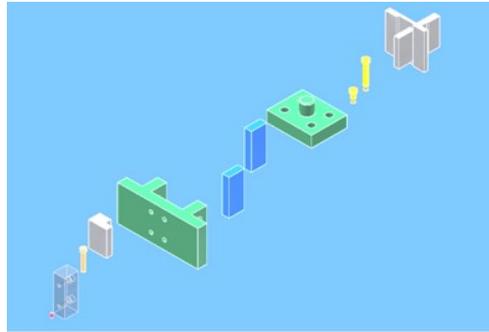


Fig. 2. Example of Mould Components Model

(2) Model Optimization

The simulation system developed contained a variety of mould's assembly, and each set of moulds included many components, so the model needed to be optimized in order to enhance the mould display speed since the big data quantity and serious memory consumption when mould component models were imported to EON. Data that used to describe entity model surface had the redundant phenomenon frequently, and these redundant polygons usually were in invisible position. When established the mould model, deleted the back and the interior of the model or the polygon covered suitably could reduce the drawing time and complexity of the model. Moreover, differential operation should be reduced as far as possible in modeling to reduce the model capacity.

4.2. Conversion and Import for the Model Format

When importing 3D model build by 3D modeling software into EON platform, due to the expression mode of the 3D model was different, it need to transfer 3D model to triangular patches format by specialized data interface, and then created the polyhedron model through each top normal and color of the triangular patches to satisfy the real-time rendering of virtual environments [4]. Therefore, mould components were imported to EON environment after format conversion. Meanwhile, according to simulation, the model needed to adjust the position, scaling, texture, color and lighting in the EON platform, and finally the virtual mould components can be generated.

4.3. Implementation of Interactive Control for Assembly

The control of mould component movement and assembly behavior under the virtual environment needed human-computer interaction to realize. The human-computer interaction of simulation system was realized by sensor triggering, event driven and route [5]. When the user issued his orders, through sensor located in the system to receive instructions, the routing sent out the relevant data, and then the system executed behavior according to the requirements of user. Eventually, human-computer interaction was realized.

(1) Assembly Constraints

There were certain restrictions between mould components, such as coaxial, close, fixed and so on. The constraint relations between different mould components were not the same. In order to realize the accurate localization when component assembling, its coordinate restraint relations must be established and stored in the data structure.

When virtual assembly, the system would test the relative space between components to be installed and components have installed constantly according to the logic relations set in EON, judge the interference between them, and determine the potential constraint relations between them according to the constraint identification rules. So that assembly components transformed position by identified constraint, and entered the target constrained location automatically to realize the accurate positioning of components [6].

Figure 3 showed the example of logic relation set for mould component assembly constraints realized by using Script nodes.

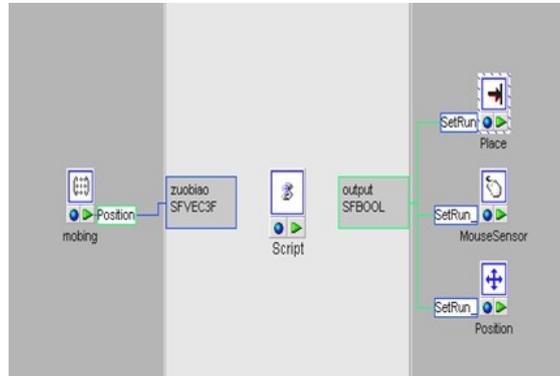


Fig.3. Logic Relation Set of Assembly Constraint

(2) Assembly Planning

Most of the mould components had some requirements of assembly sequence. So the system needed to plan each component's assembly sequence according to the mould assembly requirements, and provide the correct sequence of component selection for virtual assembly. Using the routing mechanism can realize the call order and behavior control of components in the process of mould assembly. Figure 4 was the partial routes of component assembly selection established according to the mould assembly rule.

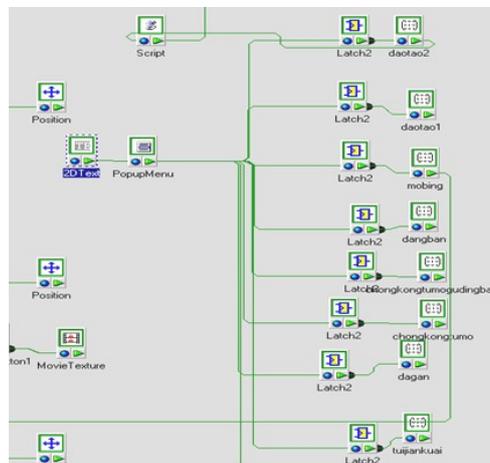


Fig. 4. Partial Routes of Component Assembly

4.4. Simulation of Virtual Assembly

When running simulation system, the user can choose the mould species that need to assemble through the user interface, then the system would generate the mould components menu automatically required by mould assembly and select components according to the components assembly sequence (if choice was not correct, the selected components would exit the assembly interface automatically). Figure 5 was the screenshot of the assembly process. Through mouse and keyboard, observation, drag, position trimming, and other operations can be done for the selected components from different perspectives until the completion of the entire assembly process.

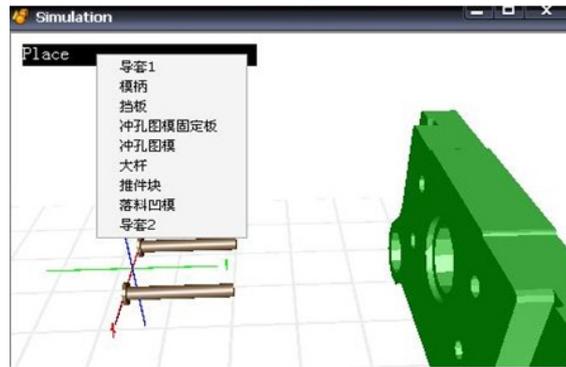


Fig.5. Screenshot of the Mould Assembly Process

Simulation results showed that the operator can simulate the mould assembly process according to the intention of system, and make the corresponding response for the wrong operations which violated the geometry constraints. Figure 6 was the effect picture after assembly completed.

In addition, the system also had the demo function of automatic assembly. Clicking the appropriate button would demonstrate the mould assembly process automatically, which provided the appropriate help for learners.

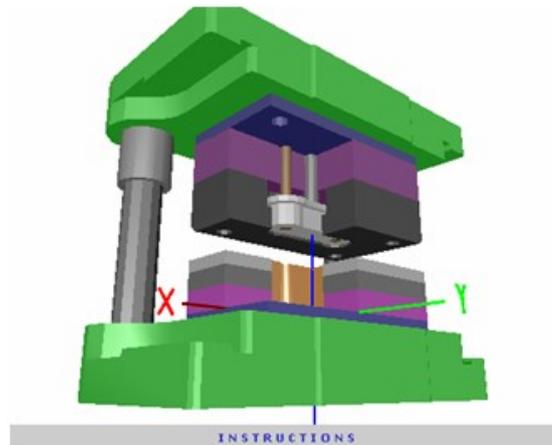


Fig. 6. Effect Picture after Assembly

5. Conclusions

According to the features of mould experimental teaching, using the virtual reality technology and computer simulation technology to develop the mould virtual assembly system. The assembly process that was complex and difficult to describe was realized in the system by means of human-computer interface in simulation environment, which can instead of material objects presentation and operation. The study and development of virtual mould assembly system had the guiding sense to the development for the virtual simulation teaching software.

6. Acknowledgment

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7. References

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