Plication of virtual machining in engine crankshaft machining

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Abstract. VM (Virtual Machining) is a digital model of actual processing in which the actual processing process is abstracted, analyzed and synthesized. It is the mapping of actual processing in the virtual environment of the computer. Virtual machining technology helps teachers to teach and enables students to understand the content of teaching more easily. This paper will introduce the processing technology of engine crankshaft and how to make dynamic simulation of the machining process of engine crankshaft by using virtual machining technology software Unity3d, 3DSMAX and cartographic software Solidworks.

1. Introduction

In this paper, based on the virtual simulation system for the processing technology of typical automotive engine parts, the crankshaft of Audi V6 engine shaft parts is used as the research object, and a set of virtual machining system is combined, and it is demonstrated. Therefore, the dynamic simulation of the crankshaft machining process of Audi V6 engine is the key content of this design.

The dynamic simulation of Audi V6 crankshaft machining process is based on 3DSMAX software, and the crankshaft's technological procedure is designed according to the structural characteristics of Audi V6 crankshaft. Then the SolidWorks3D modeling software is used to model the crankshaft blank and the tool used in the processing. The STL format that the 3DSMAX can read is introduced into the 3DSMAX to be optimized. The model of the parts used in the crankshaft processing is relatively complex, and the number of vertices and the number of surfaces contains a lot. Therefore, in order to make the 3DSMAX run better, when the dynamic simulation effect of the crankshaft process is carried out, the number and the number of the points of the crankshaft model are optimized as much as possible on the premise that the model has little influence on the model. Finally, the effect of dynamic simulation on the processing of Audi V6 crankshaft is realized by using the functions of Boolean and particle effect in 3DSMAX software, and the simulation system is embedded in the simulation system to provide the students with the dynamic simulation results. The crankshaft modeling is completed as shown in Figure 1.

2. Introduction of the composite technology of Audi V6 crankshaft and car and milling

The crankshaft is one of the typical parts of the gas vehicle engine. It mainly bears the power output function of the engine. The engine and the crankshaft are connected through the connecting rod, and the force is transferred from the connecting rod to the crankshaft. The crankshaft turns the force to the torque to output, while the other parts of the engine are driven by the crankshaft. The crankshaft bears a variety of forces, and also bears large bending moments and torque, so the crankshaft has a good stiffness and strength, and has a relatively good balance and wear resistance [1].
The crankshaft curve of the V engine is 1/2 of the cylinder number. Therefore, the crankshaft of the V6 engine is basically composed of four spindle necks, three crank, flange and three connecting rod necks. The crankshaft of the di V6 engine generally makes the middle of the spindle neck and the connecting rod neck hollow, which helps to reduce the quality of the crankshaft and the decrease of the centrifugal force during the working process.

![Figure 1. Model of crankshaft.](image)

Audi V6 crankshaft structure is not simple, the use of traditional processing technology is more troublesome, because the processing of crankshafts requires multiple clamping, so that the workpiece is easily deformed to affect processing precision and a series of problems. From the blank processing to the finished product, through the processing of multiple machine tools, the cutting tools of the crankshaft also need to be replaced many times, the process of crankshaft processing is more dispersed. The above problems have important effect on the production efficiency and product quality between the spindle neck and the connecting rod shaft neck.

The technology of turn milling can realize the process of vehicle, drilling, boring and milling in one processing, and the accuracy of machining can reach [2]. Therefore, this design plan uses the turn milling compound technology to carry on the mechanical processing to the crankshaft. Turning milling compound machining center is easy to process. It can realize rough machining and finishing of crankshaft under one clamping condition. The replacement of the fixture is greatly reduced. Turning milling compound machining center applies workpiece processing efficiency and improves the quality of workpiece.

The machining method and process of turn milling compound machining technology are suitable for simulation system. In the theoretical knowledge module of the simulation system, the theoretical knowledge of the vehicle milling complex machining technology and the car system is in line with the function of the machine tool. The character description can be expressed in different colors, and the click trigger time is given to the individual scene, and the UGUI work can be used to introduce it in the scene. The 3D model of the milling machine tool can also be modeled by the modeling software. Through the function of the part preview, the student can realize the appearance of the machine tool[3].

3. Dynamic simulation of processing process of Audi V6 crankshaft

Before the dynamic simulation effect of the Audi V6 crankshaft machining process needs to be optimized, there are two methods for 3DSMAX optimization, one is ProOptimizer optimization and the second is more advanced than the first one, and the optimization of the crankshaft is to make the mold as possible as possible when the crankshaft is normal. The number of vertices and the number of surfaces is less[4]. This can reduce or avoid the phenomenon of software Catton and improve work efficiency in the next step of software rendering. The MultiRes function optimizes the crankshaft
model by manual method. It adjusts the number and number of the vertices of the model through visual effect. Because the contour of the model is complex and the vertex is many, the MultiRes is easy to make mistakes and affects the simulation results. Therefore, this design uses the function of ProOptimizer. The crankshaft model is optimized and processed. Under the function of ProOptimizer, the number of crankshaft blank vertices calculated by computer is about 23580. After optimizing the crankshaft model, its number of vertices is designed to be 6500. After optimizing the design of the three-dimensional model of the crankshaft, the model should be selected and adjusted to make the relative position between the blank and the cutter well.

In the process of simulation, turning machining is similar to milling, so the process of dynamic simulation of Audi V6 crankshaft is related to four kinds of machining methods: drilling, milling, milling and turning. The dynamic simulation of the crankshaft is very similar to the dynamic simulation of the precision machining. The differences are the different positions of the cutter at each axis and the shape of the workpiece after the workpiece is processed. This design mainly takes milling flange surface, drilling center hole, turning spindle neck and milling keyway as an example.

(1) Milling flange plate. The simulation results of flange and face milling are basically similar, and the difference is the appearance of workpiece deformation and the displacement of cutter on the Y axis. First, the relative position between the face milling cutter and the workpiece is mobilized, and then the disc of the crankshaft flange is segmented by the function of Boolean partition[5]. Next, the displacement of each milling cutter is set on the Z, X and Y axes, and the angle of rotation around the Y axis is set for each frame face milling cutter. Finally, the workpiece is processed according to the working path of the cutter. After embedding the simulation system, the demonstration effect is shown in Figure 2.

![Figure 2. Demonstration of milling effect of flange surface.](image)

The crankshaft main neck of the simulation system is not very intuitive. It is necessary to use the rendering to further optimize it to enhance his intuition and make the processing of the workpiece more vivid. After the end of the rendering, the file is saved in AVI format, then the format conversion factory software is converted into OGV format, and the file is introduced into the Unity3D software for simulation demonstration of the processing process.

(2) Drill the center hole. The simulation process of the hole on the crankshaft is simulated by the Boolean segmentation function of 3DSMAX software. In order to process accurately, first of all, we need to adjust the relative position between the drill and the workpiece, and then design the sequence frames for each step[6]. The drilling center hole is different from the virtual simulation of the machining of the two flanges. The Boolean segmentation function of the milling two ends is divided into one by one, and the dynamic simulation of the machining process of the drilling center hole is the function of the Boolean difference set, and the difference set is calculated from the crankshaft blank
and the precreated cylinder. After embedding the simulation system, the demonstration effect is shown in Figure 3.

Figure 3. Demonstration of central hole processing effect.

(3) Coarse and fine machining of the spindle neck. The Audi V6 crankshaft contains four spindle necks, each of which needs to be split through the Boolean, and the crankshaft is deformed by the zoom and extrusion function. After the implementation of the Boolean segmentation, the setting of the tool in each frame should be set in the direction of each frame, and then the dynamic simulation of the machining process of the rough spindle neck is realized. After embedding the simulation system, the demonstration effect is shown in Figure 4.

Figure 4. Demonstration of effect of rough lathe spindle neck.

(4) Milling keyway. The keyway on the Audi V6 crankshaft is the shaft slot. The machining method used is milling. The milling method is simple and convenient and can meet the accuracy requirements of the workpiece. There are three types of shaft grooves: closed slot, through slot and half through slot. There are three types of through trough and closed trough. Because of the working requirements of the crankshaft, closed groove is adopted in its shaft slot. Key groove milling cutter is selected for the cutting tool of crankshaft. The demonstration effect after embedding the simulation system is shown in Figure 5.
Figure 5. Demo effect of milling keyway.

4. Conclusion
This paper mainly introduces the application of virtual machining technology in machining crankshaft parts of Audi V6 cylinder block. The application of virtual machining technology not only saves the processing cost of the product, but also plays a great role in improving the production efficiency of the product, and is a favorable tool for modern teaching. Virtual machining technology may sometimes increase workload in some product processing, so the virtual machining technology should be applied rationally.

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