

Research on Secondary Innovation Design of Valve Products based on 3D Printing Technology and Reverse Engineering

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Abstract

This study will take simple valves as the research object, the data extraction of some parts of valves, explore the research idea of three-dimensional model reconstruction of valves based on reverse engineering technology using forward and reverse integration modeling method, and deeply analyze the application prospect of 3D printing technology and reverse engineering technology in the valve industry. For domestic and foreign valve product users to provide rapid prototyping, secondary innovation design can be used for reference ideas.

Keywords

3D Printing; Reverse Engineering; Valve Product; Innovation Design.

1. Introduction

In the national economy, the valve is one of the indispensable industrial pipeline accessories and equipment, is installed in a variety of pipelines and equipment and other fluid transmission system control device, with regulation, diversion, diversion, prevent countercurrent, cut off, distribution and other functions, widely used in power plants, oil fields, gas fields, steel plants, chemical plants, nuclear power, ships, farmland, long-distance pipelines and other places. It covers agriculture, transportation, medicine, nuclear industry, electricity, metallurgy and other fields, and plays an indispensable role in the development of the national economy. Once the valve fails in various application scenarios, it will lead to pipeline leakage and other situations, which need to be replaced and repaired in a short time, and in some scenarios, the valve is a small batch of customized parts, which cannot directly provide replacement parts, resulting in significant property losses and huge maintenance costs, which cannot meet the needs of modern maintenance.

Literature review the existing scholars' research results and review reverse engineering. Reverse engineering was born in the 1990s, with the rapid development of computer science, reverse engineering technology has become a research hotspot and has been widely used in various fields. Xia Huifang et al. used 3D scanning equipment and reverse engineering technology to conduct model rapid prototyping by taking terracotta Warriors and terracotta crafts as an example, to improve the development ability of complex surface products to a certain extent. [1] Li Pei applied 3D printing and reverse engineering techniques to the field of children's toys and studied how to apply them in this product. [2] Wang Shulin applied reverse engineering technology to plastic mold design, designing specific steps for its application to promote more efficient plastic mold design. [3] Liang Youchang applied 3D printing technology and reverse engineering technology to the field of water gun casting. [4] James Jastifer et al. [5] used reverse engineering software to build a rapid pre-operation model of human feet and ankle, and Mattias kettner et al. [6] used reverse engineering technology and SLS technology in 3D printing to build a skull scan model to simulate head impact trauma. Huang Zhongyong et al. reverse-engineered and 3D printed pump impellers to verify the feasibility of these two

applications in the repair of complex components. [7] Chen Baocheng introduced the application of reverse engineering technology in the field of mechanical manufacturing. [8]

3D printing technology and reverse engineering technology are widely used in medical, construction, product development and design, mechanical engineering and other major fields, mainly including three levels, respectively, the copy and reconstruction of the existing model, relying on the existing model structure and performance evaluation, optimization and improvement design, and innovative design based on the former two. [9] Reverse design can quickly obtain the three-dimensional data of products, optimize the design according to the shortcomings of existing products, further improve the superior performance of products, shorten the development cycle of products, and be widely used in various fields. [10]

With the rapid development of the economy and society, there are requirements for the replacement speed of the required products. At the same time, due to the high-quality development of the industry, the demand for product update iteration is increasing. This also means that it is bound to reduce the time spent on each node of the valve production or key parts production supply chain, the most critical part of which is to continuously reduce the whole life cycle of product design update iteration, therefore, product optimization and innovation through reverse engineering technology has become an indispensable trend of development. This paper will study the innovative design of valve products through 3D printing technology and reverse engineering technology, which can achieve the purpose of reducing its production cycle to improve efficiency, and on this basis, secondary innovation can be carried out to promote the development of valve industry.

2. Innovative Design of Valve Products based on 3D Printing Technology and Reverse Engineering

In order to solve the problem of valve failure in a certain application scenario, it can quickly provide replaceable parts to solve the problem in a short time, and apply reverse engineering technology and 3D printing technology to improve and innovate the existing technology. This paper will take simple valve as the research object, study the data extraction of some parts of the valve, and discuss the three-dimensional model reconstruction of the valve based on reverse engineering technology by adopting the forward and reverse integration modeling method. At the same time, it can draw on advanced experience and technology at home and abroad, and then carry out secondary innovation design.

In the implementation process of reverse engineering technology and 3D printing technology, the whole system engineering is divided into three parts: 3D digital process of product physical 3D measurement, 3D data reconstruction, reverse design process of point cloud data, secondary innovation design process of 3D model, and visualization process of final product. Taking simple valve products as an example, the application process of reverse engineering technology and 3D printing technology is analyzed as follows.

2.1. Valve Component Point Cloud Data Acquisition and Processing

The product point cloud data file needs to pass 3D scanner, and suitable data acquisition design can be selected according to specific working conditions, including contact data acquisition, non-contact scanner, layer by layer scanning, etc. In this paper, handheld laser 3D scanner is used for measurement (other measurement methods can also be selected), so as to obtain the valve product point cloud data file, and then the data is pre-processed. Remove clutter, noise, etc., in order to get a smooth surface, after optimizing the point cloud data, the data file is encapsulated in stl format.

2.2. Valve Product Model Reconstruction

The so-called model reconstruction is to use reverse software to build the CAD data model of the product. Sort out the reverse workflow based on Geomagic Design X software, and use the reverse Design software Geomagic Design X to process the data files of valve components, conduct reverse design, including structural feature modeling, surface modeling, etc., and conduct comparative analysis at the same time. To prove that the reverse reconstruction speed is fast, the accuracy is high, and the product development cycle can be shortened.

2.3. Secondary Innovative Design of Valve Components

On the basis of the original reverse design 3D data model, improve and innovate the design according to existing needs or existing problems, including structural design, structural optimization design using finite element technology, product function improvement and other aspects of secondary innovation design, and use 3D printing technology for verification. It provides a new idea, new method and new way for the rapid innovative design of valve and electromechanical related products in the future.

The secondary innovation design of valve components requires the designer to improve and innovate the product according to the changes in the existing working conditions, and make it more suitable for the current working conditions. Based on user needs, on the basis of ensuring product reliability, firmly grasp the principles of economy, practicality and other innovative design.

2.4. 3D Model Printing

After 3D modeling software is used to build 3D digital models, 3D printers can be used for printing. Under the principle of ensuring the safety of electricity, high temperature and mechanical damage, the printer is levelled, printing materials are installed, parameters are set, etc., and the slicing software is imported into the 3D data file, and then the 3D printer can identify layers of files, and finally print layers of files according to each layer.

3. Application Prospect Analysis of 3D Printing Technology and Reverse Engineering Technology in Valve Industry

For the use of valve products, The application of reverse engineering technology and 3D printing technology in this field mainly includes the development and design of new products, the rapid replacement production of damaged parts, the construction of corresponding 3D digital models of products through 3D scanning data preprocessing and other forms of physical parts in the absence of original design models, and the innovation and improvement of some valuable valve cultural relics products Restore. 3D printing technology and reverse engineering technology for the valve manufacturing field to provide a way to efficiently complete the model reconstruction of existing products, combined with the actual conditions, complete the transformation of the physical object to the three-dimensional model, and then carry out the secondary innovation design, this process greatly reduces the development cycle of the product, and can improve the actual production efficiency of the working condition.

4. Conclusion

This paper is mainly based on reverse engineering technology to achieve rapid acquisition and supply of valve parts, overcome the problem of small batch and customized parts long production cycle, and greatly shorten the product production and development cycle. The forward and backward integration modeling method was used for three-dimensional model reconstruction, secondary innovative design of valve components was carried out, and 3D printing technology and other technologies were used for verification, providing corresponding

reference cases for the rapid innovative design and teaching practice of related products in the future.

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