

Innovative Design and Optimization of Mechanical Structure Based on Visual Guidance

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Abstract: The structural design is very important in the production process of mechanical products, and the quality of structural design determines the performance of mechanical equipment. Through innovative design, we can realize the application of mature new technology, create new machinery, and optimize the mechanical structure in the optimization design to create the best machinery. As visual devices can provide enough environmental information for most robot applications, service robots are entering the visual era. Robots are more and more widely used in industrial production and human services. The integrity and accuracy of robot arm functions need to be combined with image technology, which includes complex signal processing and identification. It is necessary to detect objects, avoid obstacles and plan arm movement. Starting from the overview of mechanical innovative design, combined with visual guidance, this paper studies and discusses the innovation of mechanical structure, in order to promote the good development of mechanical industry.

1. Introduction

Mechanical design is an important part of mechanical engineering, the first step of mechanical production and the main factor determining mechanical performance [1]. Mechanical product design can help product function innovation and diversity improvement, so as to meet people's actual use needs. Mechanical design is to design high-quality machinery under the conditions of limited materials, processing capacity, theoretical knowledge and calculation means, among which innovative design and optimal design are the key [2]. Therefore, designers need to innovate all the time when designing the mechanical structure to ensure that the mechanical structure is not only highly accurate, but also innovative enough, so as to gain a firm foothold in the mechanical equipment market [3]. Mechanical structure design is an important link in mechanical design. It is necessary to fully consider the structural size, shape, position of parts, manufacturing materials and other factors of machinery in the design stage [4]. The structural design is very important in the production process of mechanical products, and the quality of structural design determines the performance of mechanical equipment. Through innovative design to realize the application of mature new technology, create new machinery, and optimize the mechanical structure in the optimization design to create the best machinery [5].

As vision devices can provide enough environmental information for most robot applications, service robots are entering the era of visualization [6]. Robots are more and more widely used in industrial production and human services. The integrity and accuracy of robot arm functions need to be combined with image technology, which includes complex signal processing and identification. It is necessary to detect objects, avoid obstacles and plan arm movement [7]. According to the hand posture measured by vision, each joint on the manipulator is guided to approach the desired posture gradually. In intelligent mechanical handling, the identification and tracking of the best grasping point of the bumper is the key to successful grasping [8]. Vision can not only provide the spatial pose and environmental state of the target, but also reflect the dynamic trajectory of the manipulator and the gripper itself. At present, the robot arm is mostly designed and planned for specific tasks or actions, and the trajectory must be recalculated and updated for different tasks, which often takes more time and manpower. This design is not suitable for the situation of high uncertainty in unknown environment [9]. Because the motion control of the manipulator is completed in the

workspace, the mutual conversion between the joint space and the workspace is avoided, thus greatly shortening the control process [10].

2. Overview of Mechanical Structure Design

Mechanical structure design plays an extremely important role in mechanical design. Mechanical structure design is that the designers show the designed mechanical products in a certain structural form, process, assemble and inspect the designed structure, and put it on the market for users. As a pillar industry in the modern production chain, the product design orientation of machinery manufacturing industry is closely related to the development direction of the industry. The mechanical structure design must first meet the functional requirements, so that the product can achieve a certain mechanical effect. The main purpose of mechanical product manufacturing is to complete technical work beyond the scope of human capacity and improve production efficiency. Therefore, functional requirements are the primary factor to be considered in the process of mechanical structure manufacturing. Mechanical structure determines the quality of mechanical performance, and the innovation of mechanical structure can be studied in the aspects of principle, shape and performance, etc., but the practicability of machinery cannot be affected when carrying out the innovation of mechanical structure. Whether the precision, hardness and structural strength of mechanical products meet the industrial production standards is an important assessment standard for mechanical structure manufacturing. By considering the raw materials, dimensions, processing methods, heat treatment methods, mechanical actions, performance, appearance, maintenance and many other factors, the qualified product structure is designed.

In the process of mechanical structure design, a variety of calculations will be involved, and the calculation is based on a certain structure. Different design formulas are applicable to specific mechanical structures. Through the combined application of mechanical working principle and the stable application of actual design scheme, it is the basic content of mechanical structure manufacturing design to meet the comprehensive requirements of mechanical products caused by relevant factors such as material mechanics, assembly mode and process performance. In the actual production process of heavy industry, the weight pressure and material toughness of products are the key points and difficulties in the manufacturing of mechanical products. Mechanical structure design requires many requirements for products, including function, reliability, manufacturability, economy, appearance, transportation and so on. Besides, mechanical structure design is also a very innovative design stage. Without a good mechanical structure design as a foundation, even the best mechanical design scheme can't be embodied. Only by correctly selecting and designing mechanical structures at the same time can the quality of mechanical design be improved. The premise of structural optimization design is to have a large number of possible schemes and optimization space, including optimizing and innovating the production process, materials, connection modes, dimensions and shapes of mechanical products. The transformation of physical properties and the optimization of design schemes are important requirements of mechanical structure manufacturing.

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4. Innovative Design Mode of Mechanical Structure

4.1 Material Variable Method

The raw materials of each different part in mechanical products are also different. Parts with the same shape but different materials have different functions in the same mechanical structure. Now, material argument method has been widely used in mechanical innovative design. Innovation has originality, practicality and breakthrough, among which originality is mainly manifested in daring to put forward different opinions from predecessors and others, breaking inertia thinking and seeking more reasonable new principles, new structures, new functions and new materials. The material variable is very scientific, and each module can be optimized, combined reasonably, and finally become a new product. This change not only reflects the progress of technology, but also reflects the innovative design.

4.2 Quantitative Argument Method

Each mechanical product equipment is an integral mechanical system, and the functions and parts of the equipment are different. In the calculation and design, researchers need to carefully study different structural dimensions, and finally choose the most suitable combination and arrangement method. Generally, the structure needs to be defined and conceptual designed first to determine the general structural form, material requirements, manufacturing requirements, economic benefits, performance indicators, maintenance requirements, etc. after the conceptual design is completed, it is necessary to continuously analyze and study the conceptual design model, and then continuously optimize and adjust. There are many parts in some equipment, so researchers need to check the data patiently, and they can also find parts with consistent functions to replace them on the premise of ensuring product performance and design. In the process of constant error correction, there may be a breakthrough in the application of new technologies, which is conducive to the formation of innovative designs.

4.3 Position Variable Method

If the position of parts changes, the functions and characteristics of mechanical products with the same number and parts will also change, so as to find the most appropriate part size, so as to optimize the part application scheme. At the beginning of mechanical structure design, it is necessary to analyze and determine the relationship between various parts. On the other hand, it is also necessary to have an estimated value for the parameters of parts, including size, shape and other properties. Understand the design content of mechanical structure design. On the basis of understanding the requirements, we must also understand the mechanical manufacturing process level. In order to ensure the scientificity of the design scheme, the design drawings should reflect the complete process. Find out the structure that can meet all the requirements of the designer, and systematically generate a new scheme by changing the relationship between components. When designing the mechanical structure, designers need to reduce the size of the parts as much as possible, and then model the mechanical structure design, so that the internal parts can coordinate and run continuously, and then reduce the shape of the mechanical structure.

5. Overview of Research on Visual Guided Manipulator Control Methods

5.1 Position-Based Visual Guidance Control Method

The position based visual guidance control method is also called 3D visual guidance control method. Firstly, the input error variable of the manipulator is defined in the Cartesian three-dimensional coordinate system. Motion control needs to control the position and speed of mechanical moving parts in real time to make its motion trajectory and motion parameters reach the predetermined value. The image information collected by the camera is input into the manipulator control system, and the relative posture and position of the end effector and the target object are calculated. Finally, the relative posture and position information is transmitted to each joint in the manipulator, thus guiding the manipulator to move to the position of the target object. The flow of 3D visual guidance control method is shown in fig. 1.

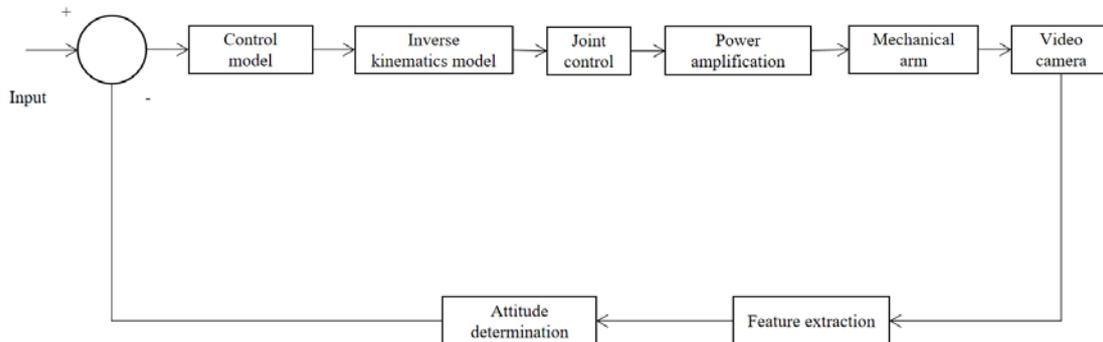


Fig.1 Position Based Visual Guidance Control Process

The basic architecture of a complete motion control system is mainly composed of motion controller, driver or amplifier, actuator, feedback sensor, mechanical components, etc. When stereo camera is used to estimate the 3D position or depth of field of an object in space, image clutter usually occurs, which makes the calculated depth of field information wrong.

5.2 Image Based Visual Guidance Control Method

Image-based visual guidance control method is also called 2D visual guidance control method. This control method does not need to solve the pose and position of the manipulator, and does not need to consider the calibration error of the camera model. It directly uses the image information as the input error variable of the manipulator control. The whole operation mode: the user controls the operation behavior of the robot arm through the computer, the computer sends and receives the information from the digital signal processor through Ethernet, and the digital signal processor controls the operation of the robot arm and receives the information from the sensor through the digital and analog input and output of the programmed logic gate, Human computer interaction is

controlled through the upper computer interface written by labview8.6 and ni-imaq. As shown in Figure 2.

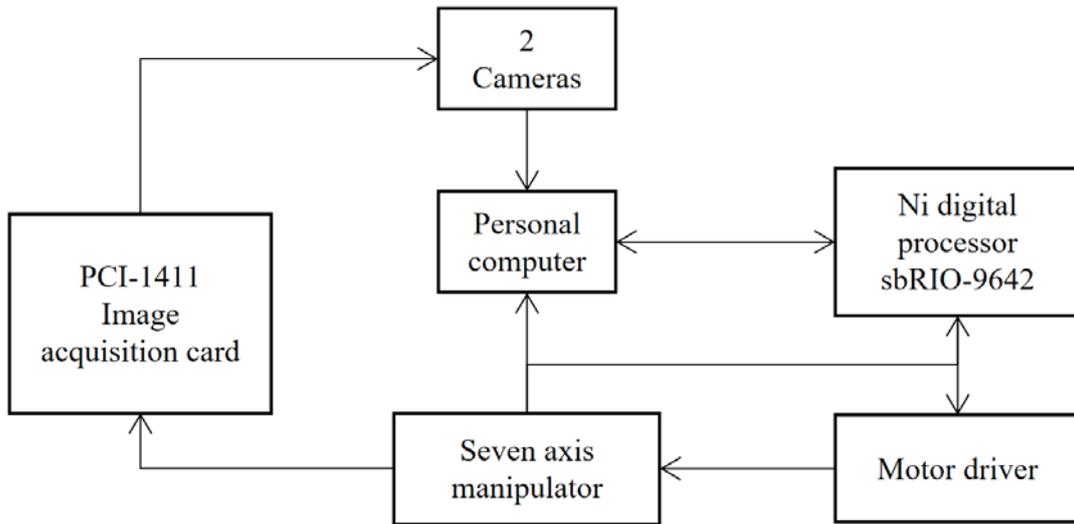


Fig.2 System Hardware Composition

The hardware composition of the system is robust to the calibration errors of the manipulator model, the camera model and the target object model. The flow of 2D visual guidance control method is shown in fig. 3.

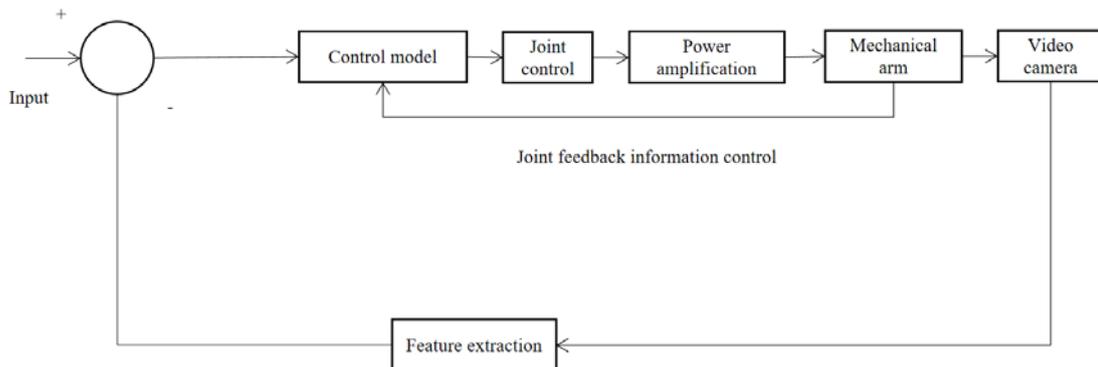


Fig.3 Image Based Visual Guidance Control Flow

Compared with 3D visual guidance control method, 2D visual guidance control method has a wider application range.

6. Conclusions

To sum up, the quality of mechanical structural design is directly related to the use quality of mechanical products, and good structural design is usually characterized by originality, practicality and humanization. Mechanical structure innovation is an important link in the process of mechanical development, which can ensure the effective combination and use of parts, improve the mechanical quality and efficiency, and thus promote the stable development of China's national economy. General robot arm motion planning is only suitable for specific environments, or can be used in complex environments, but it takes too much time to calculate and cannot interact with the environment immediately, and there is no detection method for judging the position of environmental objects. The variable method is an ideal innovation and optimization design method. In the practice of mechanical structure design, through the variable design of quantity, process, material and position, the innovation and optimization are carried out on the basis of inheriting some excellent structural design thinking. In structural design, designers need to effectively combine professional theoretical knowledge with practical experience to stimulate their strong

innovation ability.

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