Mechanical Design Method and Joint Simulation Analysis of Industrial Robots Based on Trajectory Planning Algorithm and Kinematics

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Abstract

Innovation mainly includes knowledge innovation and technology innovation. In the current study, information innovation is an attribute of thesis data and technological innovation is based on proprietary data. Industrial robots have a high level of capability and high density technology. Therefore, knowledge and technological innovation are very active in this field. The development of manufacturing industry in China is facing labor shortage. An effective way to solve this problem is to innovate, renew and modernize the manufacturing industry. Since the reform and opening up, China's manufacturing industry has made significant progress in industrial production in terms of machinery, standardization, automation, and information technology, but at the cost of cheap labor, a huge consumer market, and national policy orientation. At the same time, compared with western industrialized countries such as Japan, Germany and the United States, China's manufacturing industry as a whole is not "strong", which is mainly reflected in the fact that the development of nuclear technology has not yet begun and manufacturing enterprises do not have the ability of independent innovation. Therefore, this paper is an in-depth study of the mechanical design method and joint simulation analysis of industrial robots based on trajectory planning algorithm and kinematics.

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Keywords: Trajectory planning; algorithms; kinematics; industrial; robotics; machine design; path control

1. INTRODUCTION

At present, the development level of industrial robots is getting higher and higher, but the high level of domestic industrial robots involved and the research of trajectory planning algorithms are limited. It is increasingly important to incorporate the theory of kinematics in the development of industrial robots. The emergence and development of robotics since the middle of the 20th century is one of the most important achievements in the history of human science and technology. Global industrial robots sales and growth rate from 2016 to 2023, as shown in Figure 1.

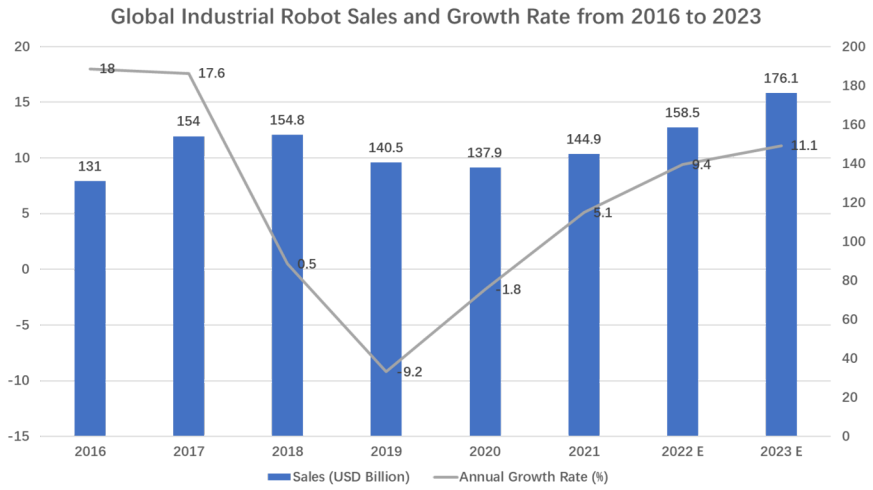

FIGURE 1 Global industrial robots sales and growth rate from 2016 to 2023

Meanwhile, compared with western industrialized countries such as Japan, Germany and the United States, China's manufacturing industry as a whole does not have an advantage, which is mainly reflected in the fact that the development of nuclear technology has not yet begun and manufacturing enterprises do not have the ability of independent innovation. Therefore, this paper delves into the mechanical design method and joint simulation analysis of industrial robots based on trajectory planning algorithm and kinematics.

2.Research Background

By 2021, the annual sales of industrial robots based on trajectory planning algorithms and kinematics in China will reach nearly 4 million units, making it the most common industrial robot market in the world. The use of robots in various countries, as shown in Figure 2.

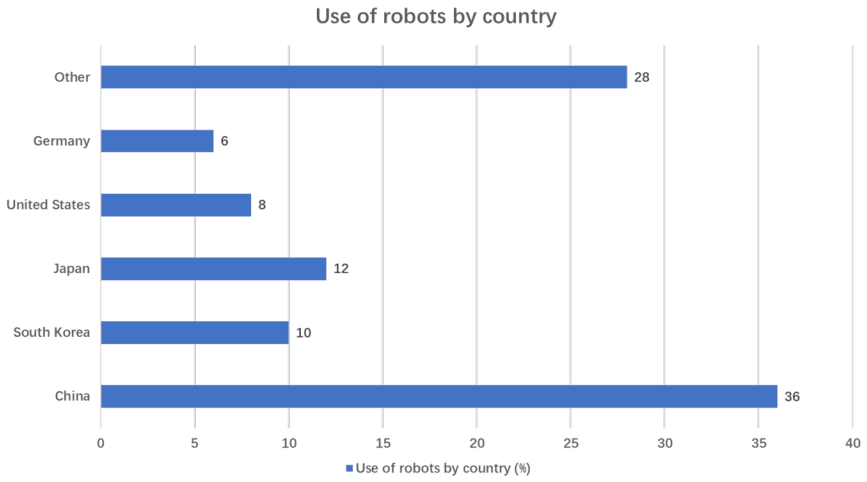

FIGURE 2 Robot usage by country

The National Congress of the Communist Party of China also emphasized the need to establish an enterprise-centered, market-oriented technological innovation system that incorporates scientific research.[1] When studying innovation and industrial development, the role of science and technology must be considered.[2] The use of robots in various industries is shown in Figure 3.

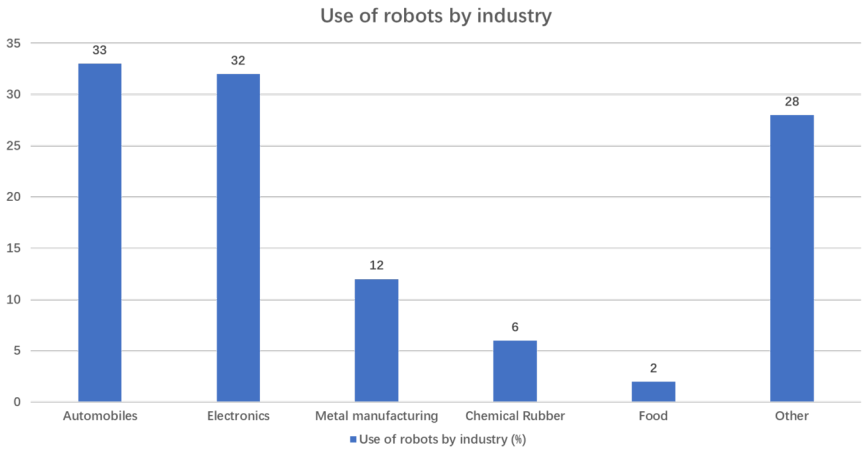

FIGURE Use of robots in various industries

3. Materials and Methods

3.1 Basic theory

The kinematics presented in this paper is the physical kinematics related to robot motion, not the physiological kinematics involved in the human body performing the body activities.

The history of the development of kinematics, as shown in Figure 4.

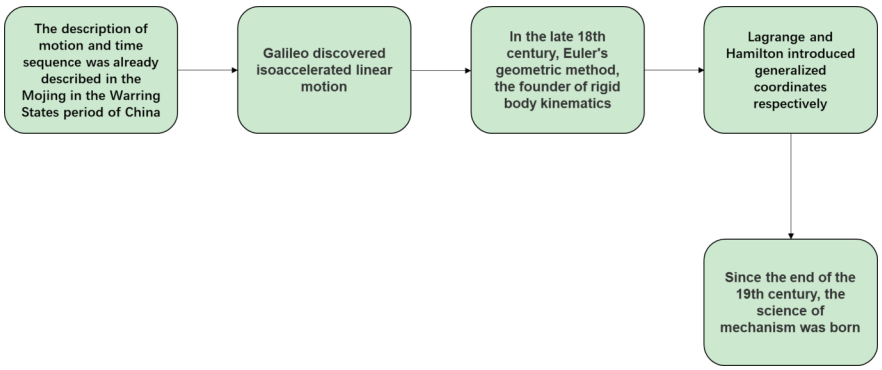

FIGURE 4 History of kinematics development

3.2 Research methods of industrial robot mechanical design in trajectory planning algorithm

Previously, project optimization was based primarily on the designer's knowledge, experience and vision. [3] With the development of new disciplines such as mechanical engineering, value optimization and systems analysis, the generation and use of technical and economic information, and the spread and application of computers, optimization relies more on scientific calculations than on subjective evaluations. The trajectory planning algorithm, as shown in Figure 5.

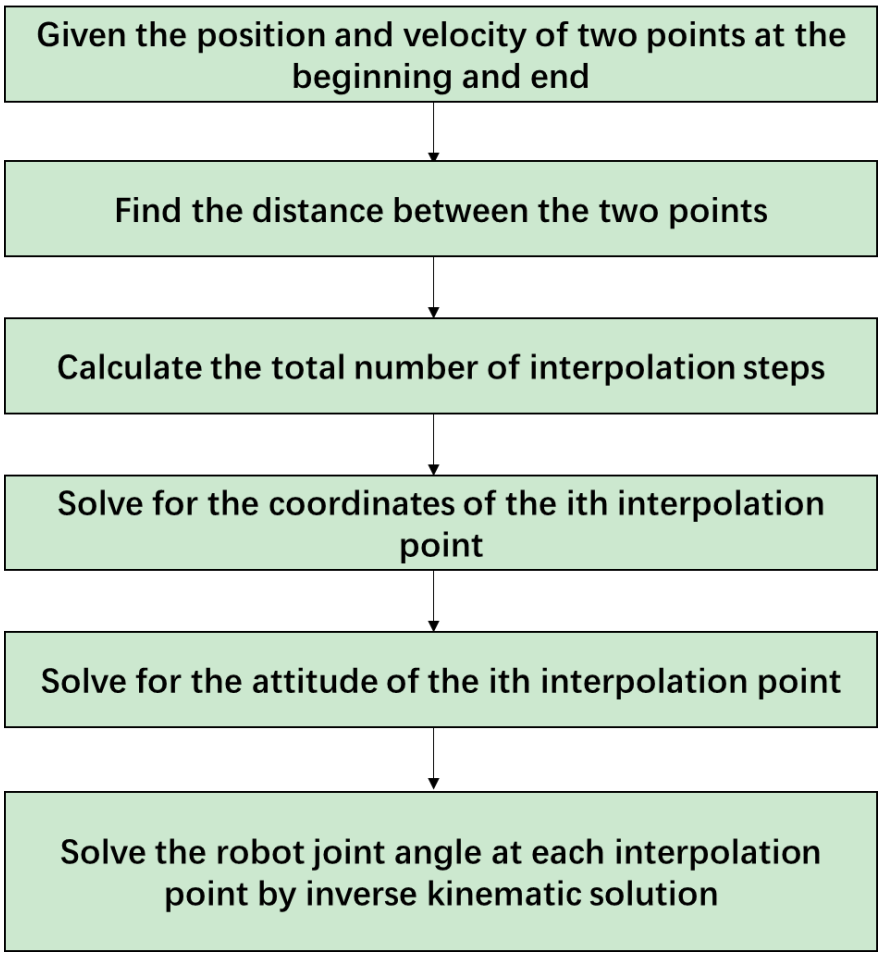

FIGURE 5 Trajectory planning algorithm

Industrial robot path control methods can be divided into two parts: path planning for mobile robots usually shows the amount of traffic, for example, which path the robot will follow if it has a map or not; in industrial robots, it represents the flight profile of the head of the robot arm or the flight profile in both directions, i.e., the velocity and acceleration of the robot motion. [4]

Equation (1) is designed to calculate the vector of weighted mean values, while equation (2) enables a better calculation of the overall value of the error.[5]

The kinematically improved trajectory planning based on the kinematics is shown in Figure 6.

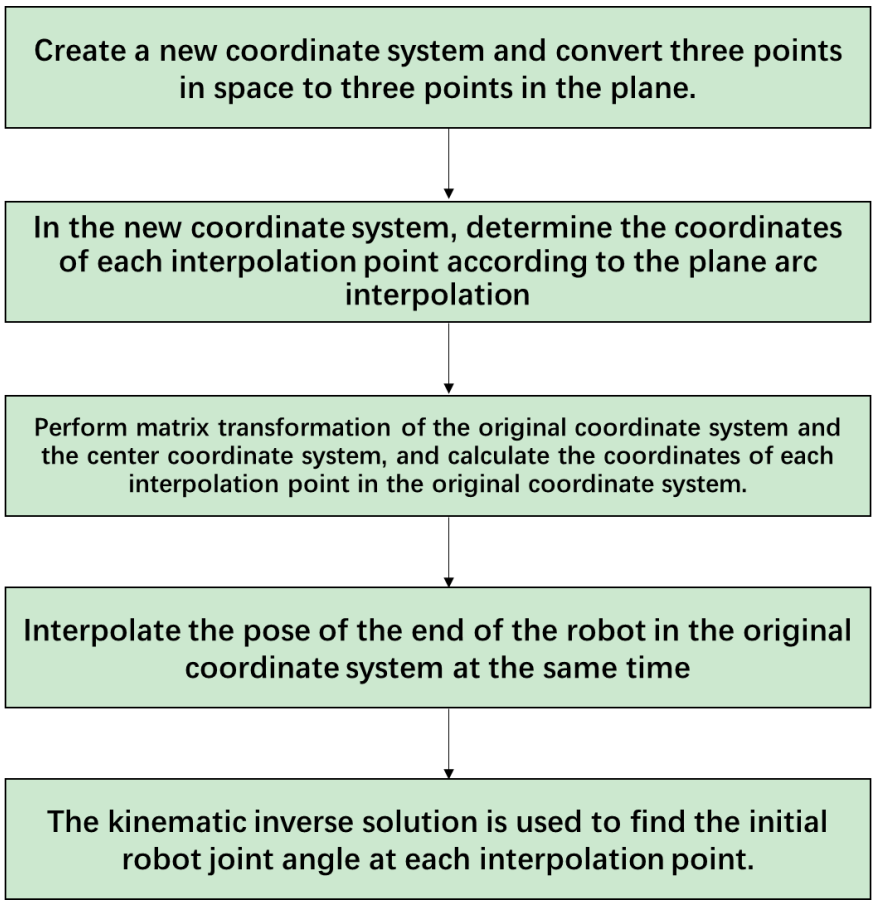

FIGURE 6 Kinematically improved trajectory planning based on kinematics

4. Results and Discussion

4.1 The current development status of industrial robots in

4.1.1 The main status of domestic industrial robots

Industrial robots based on trajectory planning algorithms and kinematics account for more than 20% of the high-end electronics market and are mainly used for welding, processing, assembly, sorting, and cleaning of electronics.[6] The application levels of various trajectory planning algorithms in industrial robots at home and abroad are shown in Figure 7.

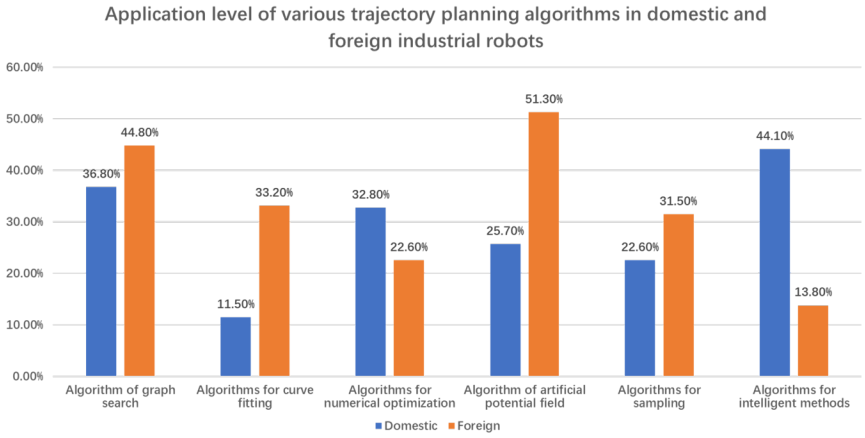

FIGURE 7 Application levels of various trajectory planning algorithms in industrial robots at home and abroad

4.1.2 Future prospects for domestic industrial robots

Industrial robots based on trajectory planning algorithms and kinematics have established a national employment front. Foshan Automotive saves more than 60% of its labor force by using robotic production.[7] This is an assembly line with 15 people that requires only two operators. Robots are used for packaging and processing in the ceramics industry. More than 90% of the labor force has been replaced. [8] At the same time, the widespread use of industrial robots will inevitably lead to the emergence of new labor-intensive technologies, including manufacturing technology, design technology, installation and commissioning technology, marketing and maintenance technology, and technical personnel. [9]The performance levels of various types of industrial robots at home and abroad are shown in Figure 8.

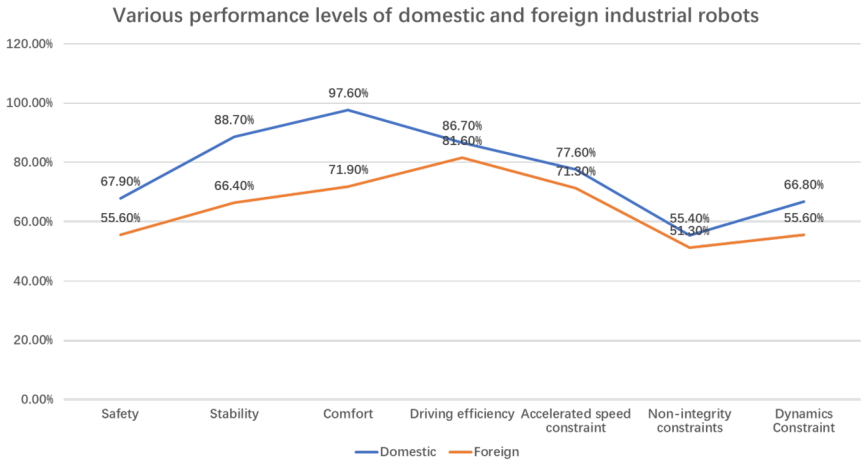

FIGURE 8 Various performance levels of domestic and foreign industrial robots

4.2 Analysis of the current situation and problems in industrial robot trajectory planning

At present, route planning is mainly for specific tasks. When there are many different tasks in a factory, a lot of manual route planning is required. Due to partial tolerance, the same task often leads to direction changes, which seriously affects the efficiency of SMEs in using products flexibly. Adaptive intelligent path planning is one of the current path planning problems. [10]

5.CONCLUSION

The development level of industrial robots based on trajectory planning algorithms and kinematics is getting higher and higher, but the involvement of high-level industrial robots and the research of trajectory planning algorithms in China is limited. With the development of Chinese industry, the manufacturing industry is changing from traditional manufacturing to intelligent manufacturing. Industrial robots have become an important tool for "smart manufacturing" and an important strategic emerging industry to improve the adaptability and competitiveness of industrial markets. Innovation is the first driving force of industrial development. The innovation potential of the industrial robotics industry can reflect the competitiveness and sustainability of the industry. Innovation mainly includes knowledge innovation and technological innovation. In the current study, information innovation is an attribute of thesis data and technological innovation is based on patent data. Industrial robots have a high level of capability and high density technology. Therefore, knowledge and technological innovation are very active in this field. The development of manufacturing industry in China is facing the problem of labor shortage. An effective way to solve this problem is to innovate, renew and modernize the manufacturing industry. Since the reform and opening up, China's manufacturing industry has made significant progress in industrial production in terms of machinery, standardization, automation and information technology, but at the cost of cheap labor, a huge consumer market and national policy orientation. At the same time, compared with western industrialized countries such as Japan, Germany and the United States, China's manufacturing industry as a whole is large but not strong, which is mainly reflected in the fact that the development of nuclear technology has not yet begun and manufacturing enterprises do not have the ability of independent innovation. Therefore, this paper delves into the mechanical design method and joint simulation analysis of industrial robots based on trajectory planning algorithm and kinematics.

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