EAI Endorsed Transactions
on Scalable Information Systems Research Article **EAI.EU**

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

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Abstract

INTRODUCTION: At present, the development level of industrial robots is getting higher and higher, but the research on the involvement of high-level industrial robots as well as trajectory planning algorithms in China is limited. It is increasingly important to integrate the theory of kinematics in the development of industrial robots. Some industrial robots have welding, assembly and other characteristics, and play an immeasurable role in national defence, manufacturing and other fields.
OBJECTIVES: With the development of China's industry, the manufacturing industry is changing from traditional manufacturing to intelligent manufacturing. Industrial robots have become an important tool for "intelligent manufacturing" and an important strategic emerging industry to improve the adaptability and competitiveness of the industrial market.
METHODS: This paper provides an in-depth study of the mechanical design methodology and joint simulation analysis of industrial robots based on trajectory planning algorithms and kinematics.
RESULTS: Research on intelligent observation, virtual reality flight trajectory and autonomous real-time flight trajectory design based on flight trajectory machines, which have made important contributions to the improvement of flight trajectory design. The wide application of industrial robots provides good development opportunities and broad market demand for industrial robot design.
CONCLUSION: Since the reform and opening up, China's manufacturing industry has made significant progress in machinery, standardization, automation, informatization and other aspects of industrial production, but the development of China's manufacturing industry faces the problem of labour shortage. An effective way to solve this problem is to innovate, update and modernize the manufacturing industry.

Keywords: trajectory planning algorithm, kinematics, industrial robot, mechanical design.

Received on 21 March 2023, accepted on 5 August 2023, published on 14 August 2023

doi: 10.4108/eetsis.3748

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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[1]. 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[2]. Currently, there are more than one million robots in the world. With the development of robotics, unprecedented progress has been made in industry, agriculture, services, medicine, and military industries. The development of robotics can fully reflect international power and is an important part of the national development process. This is why it has become increasingly important to invest in robotics research resources and improve capabilities. The use of robots is increasing worldwide, especially in industrial production, where they are becoming more common as machines are used to replace people. The rapid increase in labour costs has contributed to the growth of the robotics industry. Today's global machine exchange has freed labour from low-paying jobs. The industry is automated. Manufacturers use industrial robots to produce more cost-effective, efficient and faster products].

Current research on industrial robots based on trajectory planning algorithms and kinematics is focused on path design and control systems[3]. Moderate trajectory design can improve the stability and quality of the robot and extend its lifetime. The control system of a robot mainly includes data processing modules, bearings, trolleys, communication devices, and actuators[4]. A good management system can better target resources and user experience, otherwise, it can consume a lot of CPU resources and even damage the system. It is important to study the design and management of robot flight paths because of the lack of professionals in industrial robot applications in China.

From the perspective of the entire industry of industrial robots based on trajectory planning algorithms and kinematics, as countries and regions become more industrialized, their applications and needs are becoming more diverse[5]. Since 2010, the average global robot production has been 19%. Between 2005 and 2008, approximately 120,000 robots were produced globally each year. However, the credit crisis in 2009 led to a sharp decline in labour demand, which ultimately slowed the growth of the industry. The robotics market is set to boom again in 2010 as the local economy recovers. Robot sales will grow significantly over the next seven years, reaching nearly 240,000 units in 2017 and more than doubling in 2005, and the industry will grow again by 2019. Sales will increase to nearly 400,000 units. The demand for modern robots is also increasing[6].

In recent years, we have found industrial robots based on trajectory planning algorithms and kinematics in many industries, such as industrial and automotive. This robot can effectively replace manual operations for various production functions and its applications are more widespread. From the perspective of market growth, the robotics market grew very rapidly from 2013 to 2019, and according to statistics, nearly 400,000 robots were sold in the global robotics market in 2018. The sales volume exceeded $15 billion.

Robots based on trajectory planning algorithms and kinematics accounted for the largest share of industrial sales in the automotive industry, followed by electronics and electronics, rubber, and chemical metals. The five most commonly used robots account for more than 80% of total robot sales, with the automotive and electronics industries accounting for more than 60% of robot usage. Annual sales of industrial robots in China grew to nearly 400,000 units from 36% in 2017. The United States, Japan, South Korea, and Germany are next. Each country has a market size of about 10%. China has been the world's largest seller of robots for many years since 2013. This paper is a research topic on mechanical nail-type industrial robot fasteners. Harbin Bofu Automation Co., Ltd. has innovated and developed various rubber production robots and established many efficient and high-quality production lines[7]. At present, the company produces products sold to various regions, including Tianjin University, Delta S, Cross IV, etc. The newly developed 2-4 series of free-trade robots account for 60% of the total industrial output. They have been successfully used in many forklift and loading lines. Ltd. is a manufacturer of a full range of robots and machinery. The industry has provisionally implemented, in many applications, performance and reliability equal to those of foreign robots at a cost of at least 30% lower than foreign robots.

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 algorithms 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. With the development of robotics in modern society, the development of robotics is becoming more and more mature, which is a key criterion to measure the technological level of the manufacturing industry and the country[8]. However, the operation of industrial robots has become more complex due to the complexity of their degrees of freedom, the need for high-performance work and the high demands of the working environment, and their operating systems experience many unexpected situations where the robot collides with any or even its environment. The failure of mechanical objects or robotic arms may also endanger the safety of the user. Currently, the safety of industrial robots working with people on production lines in automotive and other companies is a challenge. The demand for safety systems for industrial robots is growing in China. As a result, the safety of industrial robot operating systems is receiving increasing attention[9]. Safety is an important indicator of robot performance and to some extent limits the development and application of robotics. To improve user safety, it is necessary to accurately evaluate and recognize the user's gestures. The study of industrial robot position data and the validation of safety systems can help to improve the safety of industrial robots and the operational efficiency of automated production lines. Studying and designing industrial robot protection paths is an important way to ensure safe operation of industrial robot systems. Assessing and identifying the position of astronauts is a basic requirement for most aircraft interactions, i.e., assessing and identifying the position of astronauts is a basic requirement for most aircraft interactions. Evaluating people's attitudes and translating them into digital abstract motion[11-13]. Identifying the original position enables industrial robot protection functions and improves user safety. Human key point recognition is the basis for evaluating and recognizing human spatial data and can be widely used in image processing and other related fields. With the development of network technology, limiting the computation of network models has become one of the most important requirements for the fast recognition of human key points. Existing face recognition network models need to be fully computed, so modification and optimization of existing face recognition networks is a research topic. Based on the existence of network models, network optimization, simplification of model parameters and complexity of model computation, more options can be provided for developing human key network models[14]. With the development of human spatial assessment and spatial exploration technologies, several forms of interaction have emerged in the market and cooperation with machines is becoming more harmonious. Industrial robots can be used more safely in different conditions. The use of robots in various countries is shown in Figure 1.

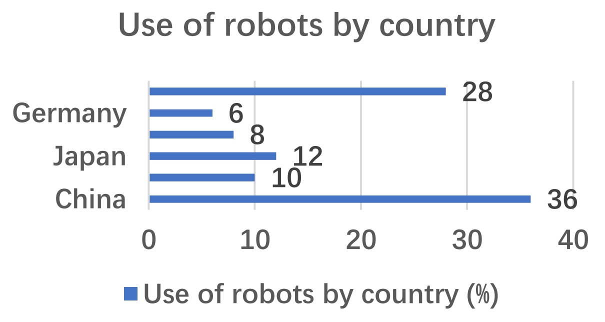

Figure 1 Robot usage by country

To ensure the safety of human-robot interaction in industrial robots for mechanical design and joint simulation analysis, visual methods such as camera depth imaging and human state position measurement are used to obtain human body information online and pre-process the image data to clarify the position of the human body. The human body position is evaluated to provide reliable information for industrial robots, avoid obstacles, and improve the safety of industrial robot operating systems. Industrial robots have the features of high versatility, high accuracy, and high speed. Reward. Today, we need robots to perform a variety of tasks from agriculture to industry in the form of "robotic solutions". In industrial production, in particular, the amount of operational data has grown exponentially as the scale of industrial equipment has increased, mechanical precision has increased, and the level of automation has become more complex. The economic impact of a sudden shutdown of a company on a given date can be as high as 20,000 euros. It is therefore particularly important to identify system anomalies or to quantify system status and to take effective measures to ensure the safety, reliability and economy of complex systems. Based on the prediction of industrial equipment maintenance, equipment maintenance management has gone through a process from monitored maintenance to planned maintenance.

In industrial robots for mechanical design and joint simulation analysis, the development of the Chinese manufacturing industry faces the problem of labour shortage. An effective way to solve this problem is to innovate, update 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 labour, a huge consumer market, and national policy orientation. Promoting industrial change and modernization through technological innovation is an important way to achieve a high level of economic development in the new era. The structure of the world economy is currently undergoing dramatic changes[15]. The impact of the 2019 coronavirus outbreak is uncertain. The international situation is complex. Globalization and international competition are changing. Technological innovation is the key to the transformation and upgrading of Chinese industry, to the construction of a modern industrial technology system that is digital, connected, intelligent, and environmentally friendly, and to the promotion of technological innovation and the improvement of industrial innovation capacity. In the 21st century, innovation is the key to change and improve Chinese industry. Information and technology are the most innovative players. At the beginning of the 21st century, Vice Premier Li Lanqing emphasized that we should use knowledge and technology as a source of innovation to keep pace with the world's technological development. Compared to traditional factors such as capital and labour, technology and knowledge have become important competitive and strategic resources for economic innovation and development. The innovation development strategy is the basis of China's future development strategy. From developing existing innovation resources to innovation and development, it has become one of the main topics of research in Chinese economic geography. Many studies consider patents as evidence of industrial innovation capacity. However, from an epistemological point of view, technological innovation must be based on scientific discoveries. Technological progress is a process of selection, inheritance and change of knowledge on the one hand, and technological review based on experience on the other[16]. To study the development of industrial innovation, we need to examine the current state of knowledge and technology. Scientific knowledge can, to some extent, represent theoretical innovations in the application of technology. The development of industrial innovation is best reflected by the combination of these two factors. 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. When studying innovation and industrial development, the role of science and technology must be considered. The use of robots in various industries is shown in Figure 2.

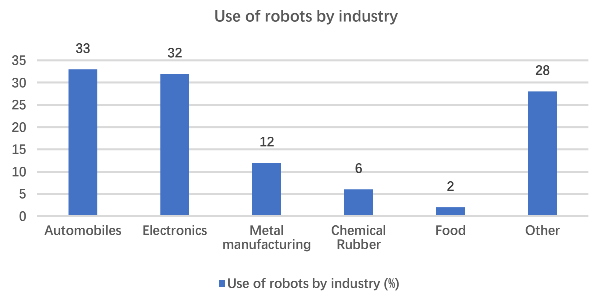

Figure 3 Use of robots in various industries

3. Materials and Methods
3.1 Basic theory
3.1.1 Kinematics

Kinematics focuses on the study of points and laws of stationary motion. A point is a geometric point that has no size or mass and has a specific position in space[15]. A solid is an object that has no mass or deformation but has a specific shape and position in space. Kinematics includes point kinematics and stationary kinematics. The study of these two types of motion helps to study deformation motion (elastomers, liquids, etc.). During deformation detection, the rigid displacement and tension of the body microsphere must be separated. They vary depending on the chosen frame. Stationary kinematics is used to study more complex motion properties such as rotation, angular velocity, angular acceleration, etc. Depending on the nature of the stationary motion, it can be classified as planar motion, fixed-axis rotation, planar motion, fixed rotation, and total stationary motion.
The kinematics presented in this paper is the physical kinematics related to robot motion, not the physiological kinematics involved in the human body performing body activities.

The history of the development of kinematics is shown in Figure 3.

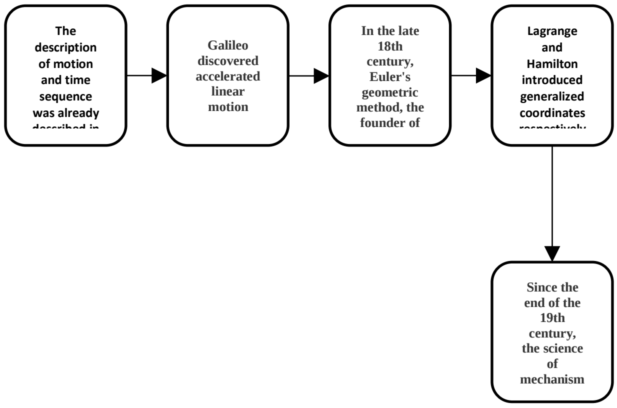

Figure 3 History of kinematics development

3.1.2 Industrial robots

Industrial robots are generally composed of three parts and six subsystems. Mechanical design industrial robots can be divided into tandem and parallel robots[17]. The standard function of a robot is to move one axis to change the origin of coordinates on another axis while moving one axis does not change the origin on the other axis. In the past, industrial robots used switching devices. A parallel mechanism is a parallel drive with two or more free tires, where the moving chassis and the fixed chassis are connected by at least two independent circuits. The parallel mechanism consists of a wrist and a shoulder. The shoulder has a great influence on the movement space, while the wrist is the connection point between the knife and the body. Depending on the energy, there are four types of use: hydraulically operated, pneumatically operated, electrically operated, and mechanically operated. The early industrial projects were water protection projects. The hydraulic system has the characteristics of leakage, high noise, low-speed instability, heavy drive technology and high cost. However, pneumatic devices work at low pressure and are difficult to position accurately. It is designed to transport the latest industrial robots. Pneumatic clamps, rotary cylinders and pneumatic suction cups are used as an end use for fixing and mounting loads on small and medium-sized parts. Currently, the most common driving mode is electric operation. The advantages include easy power supply, fast response time, high propulsion, signal detection, easy signal transmission and processing, and flexible control methods. In addition to detecting the robot's own state and mechanical variables (e.g., motion, speed, and force), vision observation techniques are an important component of industrial robots. Image processing systems are also widely used in quality control, product identification, food sorting, packaging, and other fields. It can be multiple robots embedded in functional modules to perform complex tasks. Human-robot interaction systems are devices that allow people to communicate with and participate in the management of robots. Examples include general computer terminals, consoles, data displays, emergency alarm systems, and other control systems. The function of the controller is to control the activation of the robot based on its commands and sensor response signals to achieve the necessary movements and actions. If the robot does not have feedback, it is an open control system. If the robot has feedback, it is a closed-loop control system. Based on the guiding principles, it can be classified as an industrial control system, an adaptive control system, and an artificial intelligence system. According to the form of Motion control, can be divided into point control and continuous flight trajectory control.

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

In the industrial robot for mechanical design and joint simulation analysis, including mechanical design, working principle, structure, motion, power and transmission mode, material, shape and size of parts, lubrication mode, etc[18]. The lubrication status is examined, analyzed and calculated according to the requirements of the machine, and the working process of the machine is translated into a concrete description of the machine production base. Mechanical engineering is an important part of the machine manufacturing industry and is the main factor determining its performance. Mechanical engineering design is the design of the best machine under various conditions, such as materials, properties, theoretical knowledge and calculation methods, i.e. the design of the best machine to meet the customer's needs. It is used for optimal planning. The optimal design must take full account of the best efficiency, the lowest production costs, the smallest dimensions and weight, the most reliable operation, the lowest consumption and the lowest environmental impact. The developer's task is to make trade-offs, design holistically and balance both sides according to the actual situation. Previously, project optimization was based primarily on the designer's knowledge, experience and vision. 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 is shown in Figure 4.

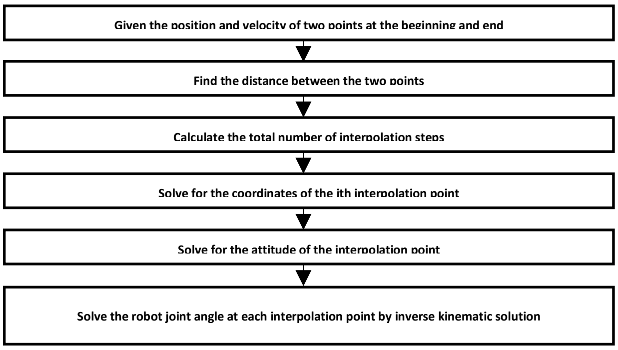

Figure 5 Trajectory planning algorithm

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.

$$f = \sum_{t=1}^{TP} f_l^t + \sum_{t=TP+1}^{TP+TC} f_S^t \qquad (1)$$

$$f_l^t = \sum_{c=1}^{c} \sum_{p} w(p).\left\| L_c^t(p) - L_c^*(p) \right\|^2 \qquad (2)$$

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.

The kinematically improved trajectory planning based on the kinematics is shown in Figure 5.

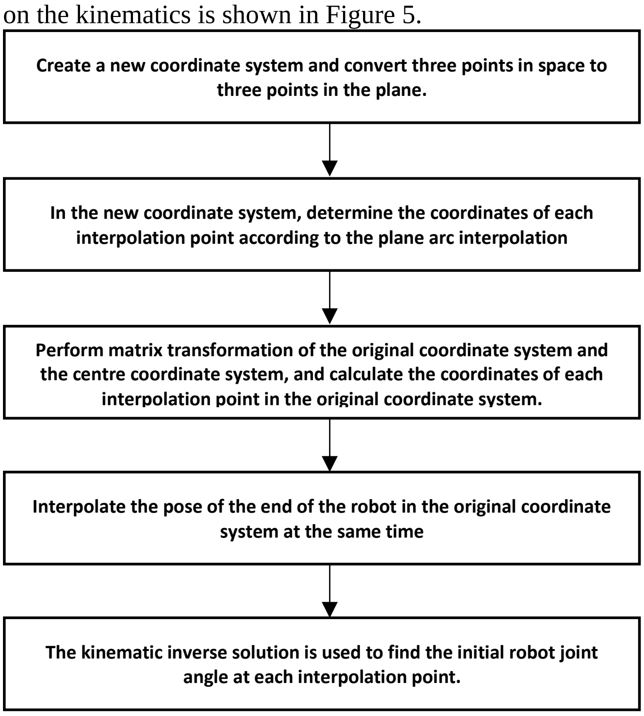

Figure 6 Kinematically improved trajectory planning based on kinematics

4. Results and Discussion

4.1 The current development status of industrial robots in

4.1.1 The main status of domestic industrial robots

An industrial robot based on trajectory planning algorithm and kinematics is a system technology developed based on modern advanced technology, which mainly includes machine interface, motion control and operation, and mechanical body of the robot[19]. The machine interface is a control system that translates the user's will into the actual operation of the robot. Command centre. The function of the motion control is to coordinate certain functions of the components after receiving commands from the machine interface to ensure that the robot operates correctly according to the interface commands and requirements. The main task of the actuator is to supply power to the motion controller, i.e. power supply; this mechanism is the participant of the behaviour, responsible for the execution of the human-machine interface commands, and is the most direct factor in the execution of the various activities, including the different participants. In addition, some sensors help the robot detect workplace, forces, temperature, light and other auxiliary devices. These components are closely linked to form a closed system. Thus, the components of an industrial robot are a complex system that coordinates with each other in the execution of relevant instructions and ultimately meets the user's expectations by coordinating human movements and performing the correct functions.

In traditional practice, the classification of industrial robots based on trajectory planning algorithms and kinematics depends mainly on the development of key technologies and process improvements. Industrial robots are usually classified into three generations: intelligent robots, replicating robots and autonomously programmed robots. The continuous updating of industrial robots can bring more functions and optimization to better serve people's production and life. Industrial robots can be classified as very large, large, medium, small and micro enterprises according to their capabilities. During operation, the maximum nominal weight of the robot must be properly analyzed, and then the right type of robot must be selected according to the maximum load capacity specified in the manual to avoid wasting resources or damaging the robot. At the national level, the development of intelligent robots is crucial: industrial robots will soon have more effective development strategies and opportunities that will provide more space for the diffusion and application of intelligent robots and will give new impetus to the development of different sectors and departments. The development of industrial robots should focus on the analysis of their main properties, such as application areas, key technologies, maximum load capacity, etc. The centralized link is confidential. Although the range of applications is considered to be the basis for separating industrial robots, industrial robots are already widely used in social and economic sectors such as medicine, mining, cargo handling and, increasingly, in military sectors where they can replace soldiers in dangerous military tasks on the battlefield.

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. In 2018, domestic and foreign investments in China's industrial robotics market, automotive, electronics, and other high-tech sectors accounted for significantly more than 50% of the market, with metal processing, plastics and chemicals, and food and beverage at relatively average technology levels. At a lower level, industrial robots have a high internal performance. It is worth noting that the production of robots made in China is concentrated at low levels. In the automotive electronics industry, advanced research and application technologies and market share are relatively limited, and there is still much room for development. The application levels of various trajectory planning algorithms in industrial robots at home and abroad are shown in Figure 6.

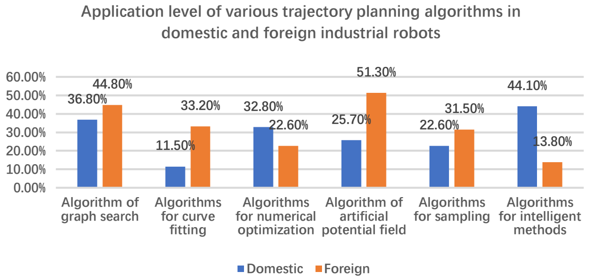

Figure 7 Application levels of various trajectory planning algorithms in industrial robots at home and abroad

4.1.2 The main status of domestic industrial robots

According to the history of the development of industrial robots based on trajectory planning algorithms and kinematics, it was first applied in the automotive industry. As early as the 1960s, American automobile manufacturers began to use industrial robots in the production process. This marked the beginning of industrial robots in the service of humans and a milestone in the history of robotics. Over time, as researchers have continued to improve and enhance, the United States has become the most developed country in the field of robotics, establishing the United States as a leader in industrial robotics and providing the technical support to establish the United States as a long-term industrial power. Since the 1980s, Japan, Russia, and other Western industrialized countries have made great strides in developing industrial robots. Many industrial robots are as effective in some regions as they are in the United States.

Industrial robots based on trajectory planning algorithms and kinematics can reduce production costs, labour intensity and safety. As the most industrially productive country in the world, China has made more urgent demands for the marketing and promotion of industrial robots. In the 1970s, during the Seventh Five-Year Plan, we increased R&D efforts in electronics, intelligence, machinery, nuclear components, and industrial robots, opening up new paths for the development of a robotics industry with Chinese capabilities. In the 1990s, domestic industrial robots were gradually integrated into production. Especially during the Ninth Five-Year Plan, based on the 863 programs, nine R&D centres for intelligent robots were established in the late 20th century, including Siam Robotics Automation and the Beijing Institute of Mechanical Automation. When it entered the market, the robotics industry was developing rapidly. Since 2000, the domestic industrial robot market has grown 15.20% annually. It is mainly used for automotive assembly, including welding, inspection, machining, grinding, and polishing. From a market perspective, domestic industrial companies are mainly focused on the domestic market, with low export volumes. However, China, the United States and Japan have shortcomings in the field of robotics, but in some areas, they have narrowed down or even surpassed these countries. In particular, China has an advanced technology system in the field of quantum research and development and is a leader in the field of industrial robotics development.

The 21st century is an era of knowledge explosion. With the acceleration of economic globalization and rising labour costs, robots based on trajectory planning algorithms and kinematics are widely used in future industries. According to the law of time, industrial robots must meet the basic requirements of flexibility, low cost, safety and reliability in future industrial applications. According to these requirements, robotics research institutes should pay attention to the scientific allocation of functional modules to meet the individual needs of different customers, optimize the structure of parts, and give full play to their functions. In addition, due to the unique precision characteristics of robots, it is particularly important to prevent damage during transportation and operation. This is because its maintenance and upgrade costs lead to increased production costs for the company. Therefore, the application economy should be an important factor in the development of industrial robots. Through the symbiosis and integration of global cultural trends, many general-purpose electronics fully meet individual needs and optimize the corresponding adaptations. The focus is usually on feasibility and portability. For example, computers have become increasingly portable, while cell phones have evolved from the early large cell phones. As the environment in which industrial robots work changes, search and production organizations need to focus on various types of underwater robots, explosive ordnance disposal robots, space robots, search and rescue robots that can adapt to extreme environments and even medical robots. You can get people to do surgery. For example, in body design, more attention should be paid to the ability of search and rescue robots to get through complex environments. Medical robots can be designed according to the characteristics of microsurgery, as small and complex as possible to minimize damage to human tissue. Therefore, personal needs are an important direction for the future development of industrial robots.

In the future, robots based on trajectory planning algorithms and kinematics should be able to master 18 different martial arts. Based on the analysis of threat elimination in robotics and the deep application of robotics, artificial intelligence technologies are introduced to ensure that robots can think independently and respond to work needs in complex environments.

4.1.3 Prospects for domestic industrial robots

"Human-robot integration fundamentally changes the relationship between humans and robots based on trajectory planning algorithms and kinematics, ensuring close coordination and natural interaction in the work environment. In other words, robots can combine the logic of thinking, analysis and decision-making with the precision and cycles of machines to achieve flexible work[20]. Nowadays, many robot manufacturers are working on the concept of "machine integration". AGV robots made their debut at the Nanjing Software Exhibition and introduced AGV carriers based on laser autonomous navigation technology. The laser scanning system does not require navigation markers. The navigation map can be repaired within 15 minutes. Computer systems can be integrated into seamless systems, such as WMS, MES and ERP. With the rapid development of artificial intelligence, the coordination and collaboration between robots and humans is increasing.

Industrial robots based on trajectory planning algorithms and kinematics has established a national employment front. Foshan Automotive saves more than 60% of its labour force by using robotic production. 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 labour force has been replaced. At the same time, the widespread use of industrial robots will inevitably lead to the emergence of new labour-intensive technologies, including manufacturing technology, design technology, installation and commissioning technology, marketing and maintenance technology, and technical personnel. The performance levels of various types of industrial robots at home and abroad are shown in Figure 7.

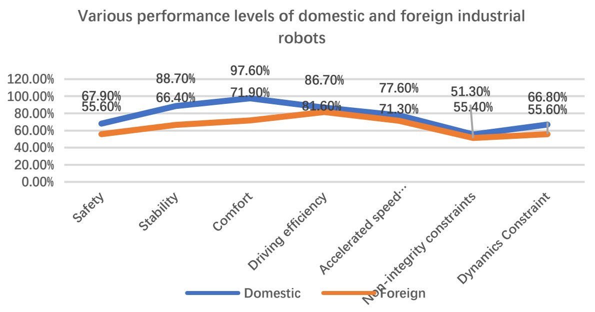

Figure 8 Various performance levels of domestic and foreign industrial robots

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

4.2.1 Analysis of problems in trajectory planning of industrial robots

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[14].

Previous research on industrial robot path design based on trajectory planning algorithms and kinematics have focused on the construction of interpolation curves and the application of non-interpolation algorithms. The more interpolated curves (classical and cubic curves), the more difficult it is to find the robot's path during motion to meet the robot's performance requirements, but this is complicated and reduces efficiency. Many scientists have studied higher-order curves. Although the correct flight paths have been obtained, further analysis and research is needed to determine which curve is best suited for different flight paths. Most design paths focus only on local objectives and constraints, such as time, energy, impact, etc., without considering other factors, such as load, deformation, etc. Using the weighted coefficient method to optimize multi-objective metrics based on one objective often leads to the weakening of some objectives and shortening of the actual execution process. For the improved genetic algorithm improves the global search capability and speed, however it cannot meet the requirements of global convergence, accuracy and real-time. These problems affect the efficiency and effectiveness of industrial robots in practical applications.

4.2.2 Prospects of machine path planning algorithms for industrial robots

Hybrid optimal orbits considering time, energy and impact is a subject of research and application in the existing orbit design literature[18]. Most approaches create simplified optimization models of track design based on key factors to find the correct optimal solution. However, practical factors such as robot motor performance (engine speed, torque, load, etc.) should not be ignored in the actual route planning process. Operating conditions (to extend the robot's life in high temperature, low temperature, underwater, etc., often affect the performance of motors, reducers, etc.). To ensure high reliability of the planned flight path, detailed and comprehensive planning must be carried out based on the different tasks, operating conditions and needs of the target audience of the industrial robot. For example, when optimizing route planning when the machine is running at high speeds, it is necessary to keep acceleration strictly at a relatively low level to reduce the maximum load on the engine to reduce the effects of vibration. Under the given actual operating conditions, multi-objective optimized flight path design can ensure the quality of robot work and improve the service life of industrial robots.

Intelligent observation-based autonomous real-time trajectory planning algorithm and kinematics-based path is planning for industrial robots. Flexible production is the trend for SMEs. To perform various tasks (e.g., painting robots and painting different products), tracks must be handled manually several times, which seriously affects work efficiency. On the other hand, even in the same task, industrial robot automation usually has gaps between different workpieces and handles, so the predicted trajectory is slightly different from the actual required trajectory. As machining accumulates, some machining defects can lead to product quality degradation. To adapt to different tasks and different working environments of the same task, autonomous real-time path planning is needed. In recent years, it has been a good method for task detection and path planning due to the rapid development of intelligent detection methods such as image processing and laser. The real-time path planning task of the robot is completed with the help of intelligent detection technology, and the path of the robot is formed according to the established algorithm to realize the real-time autonomous path planning of the robot. The flexibility and anti-interference capability of industrial robots will be improved.

For industrial robots, commuting is only possible as part of a specific plan. A major introduction is usually required before formal work begins. The feasibility of the route is ensured by pre-processing and adjustments are made based on the results of the trials to ensure the reliability of the route. This process not only leads to unemployment but also reduces the efficiency of network design. Although some major robot manufacturers have developed robot modelling software, such as ABB's Robo Studio, it is currently unsuitable for complex trajectory design and relatively weak in intuitive trajectory design. Virtual reality technology provides good technical support for user-friendly interaction and is used in product design, technical training, and entertainment games. A new path-planning model is proposed. Using virtual reality, users can easily build an industrial robot scheduling simulation platform, perform flight path design in a virtual environment, monitor flight path results and adjust parameters in real-time. Even a virtual reality route planning simulation system can be directly connected to a factory robot for remote control of the robot. This has harmed the trajectory design of industrial robots and has contributed significantly to their development. The program is based on the study of aircraft paths. In recent years, machine learning has been widely used in many fields with the development of artificial intelligence technologies such as machine learning. The algorithm achieves the prediction of unknown data and avoids subjective interference by automatically analyzing samples. Although a lot of work has been done in the construction of curve functions and path-planning algorithms, most of the work has been done by different researchers according to different needs. Optimal route planning has not been analyzed, nor has a complete train planning system been created. On the one hand, a machine learning program can independently learn and support methods for constructing optimal curves, and on the other hand, it can avoid adjusting parameters for human intervention during the solution process. The machine research-based design aims to ensure the generality of the design. Research on route guidance and machine learning has only just begun. The introduction of artificial intelligence techniques such as machine learning has greatly improved the intelligence of route planning.

Despite the many successes of industrial robot design methods based on trajectory planning algorithms and kinematics, challenges remain. Since interpolation functions are different from intelligent algorithms, there is no universal path system to meet all job requirements, but they can be selected and designed based on task requirements and the merits of various additive functions and intelligent algorithms. There are still many aspects to be optimized in terms of practicality, real-time, visibility, comfort and objectivity. This paper presents research on intelligent observation, virtual reality flight trajectory and autonomous real-time flight trajectory design based on flight trajectory machines, which have made important contributions to improving flight trajectory design. The wide application of industrial robots provides a good development opportunity and a broad market demand for industrial robot design.

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 the manufacturing industry in China is facing the problem of labour 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 labour, 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 algorithms and kinematics.

6. Acknowledgements

Tianshi College -“Electronic technology practice” quality course construction-JP20150005

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