

# Research on the Status Quo and Development Trend of Industrial Robots

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**Abstract.** This paper introduces the development status and application trends of industrial robots at home and abroad, as well as the economic benefits. According to the experience of robot development at home and abroad and the dynamics in recent years, the influencing factors and implementation strategies of industrial robot development in China are pointed out, and the direction and strategy of robot development in China are discussed. With the continuous development of computer science and technology, the field of industrial robot application has also been expanded and deepened. Industrial robots have become a high-tech industry and are playing a huge role in industrial automation.

## Introduction

Robotics is a comprehensive and emerging discipline involving mechanical engineering, electrical engineering, microelectronics engineering, computer engineering, control engineering, information sensing engineering, acoustic engineering, bionics, and artificial intelligence engineering. Learn many cutting-edge disciplines. [1] Industrial robots are a branch of robotics that represents the highest achievement of mechatronics. With the continuous development of science and technology, industrial robots have become automated tools for flexible manufacturing systems (FMS), automated factories (FA), and computer integrated manufacturing systems (CIMS). The widespread use of industrial robots not only improves the quality and quantity of products, but also protects personal safety, improves the working environment, reduces labor intensity, increases labor productivity, saves raw material consumption and lowers production costs, and promotes the rise of China's manufacturing industry.[2-4]

Industrial robots are high-tech integrated with computer science and technology, mechanical engineering technology, electronic engineering technology, information sensor technology, control theory, institutional science, artificial intelligence, bionics and many other disciplines. In the foreign industrial robot technology is becoming more and more mature, it has become standard equipment and is widely used in the industrial automation industry, thus forming a group of internationally influential industrial robot companies and the development level of industrial robot technology has also become an important indicator of the level of industrial automation in a country.[5]

## The Principle of Industrial Robot

In the mid-20th century, with the development of computer technology, automation technology and atomic energy technology, industrial robots began to be researched and developed in the United States, making them widely used in industrial production. The initial emergence of industrial robots is the combination of traditional institutional science and modern electronic technology. Today, industrial robots are high-tech products that are integrated into multiple disciplines and are very active research and development fields in the modern era. In order to keep up with the pace of social progress and economic development, industrial robots are gradually being applied to all walks of life in different types which plays a decisive role in the development of the national economy.

The various operating robots used in the field of modern industrial automation are the most mature ones in the current industrial robot technology. Such industrial robots are essentially one type that can be programmed in the storage device according to the program in advance, and then

the operating program is automatically executed repeatedly.

The industrial robot is a closed-loop system that can perform the functions that people need through motion controllers, servo drives, robot bodies, sensors and other components. The high-performance general-purpose industrial robots in the factory generally adopt an articulated mechanical structure, and each joint is controlled by an independent driving motor, and the power amplifying circuit of the driving unit is controlled by a computer to realize the motion control operation of the robot. The composition of the articulated industrial robot consists of a human-machine interface (teaching device), a servo drive, a motion controller (lower position machine), a robot body, etc., and different functions are realized by different jigs at the end of the robot. The teach pendant is the part that monitors the state of the robot and issues the motion command. It is the only window for the person to interact with the robot information. The servo driver is the control of the servo motor and the power source of the robot arm movement; the motion controller is the position of each joint. The posture calculation unit, the execution and operation of the positive solution and the inverse solution program are all calculated therein; the robot body is the actuator, and is the most direct component for realizing the required function.

### **The Classification of Industrial Robot**

With the continuous advancement of science and technology, China's industrial robots have embarked on the stage of independent research and development, which marks a new milestone in China's industrial automation. According to the key technology development process of industrial robots, it can be divided into three generations:

The first generation is a teaching reproduction robot, which is mainly composed of a robot body, a motion controller and a teaching box, and the operation process is relatively simple. The first generation of robots used the teaching box to teach programming online and save the teaching information. When the robot is automatically running, the stored controller teaches and executes the stored teaching program to cause the robot to perform the predetermined action. This kind of robot usually adopts the point-to-point motion, continuous track reproduction control method, and can complete the continuous trajectory motion of straight lines and arcs. However, the motion of complex curves is composed of multiple arcs and straight lines. [6] Due to the ease of operation and strong visibility, it is the most widely used in the current industry.

The second generation is the offline programming robot. The robot programming system adopts the offline computer entity model simulation technology. Firstly, the physical model of the robot and its working environment is established, and then the actual forward and inverse solution algorithm is adopted to control the solid model. Operation, path planning is performed offline, and then the 3D animation of the solid model is simulated by programming to verify the correctness of the programming. Finally, the correct code is passed to the robot control cabinet to control the robot movement and complete offline programming.

The third generation is an intelligent robot. It has various sensors in addition to the characteristics of the first and second generation. These robots not only have sensory ability to the external environment, but also have the ability to judge, remember, reason and make decisions independently. It can adapt to external objects and work in harmony with the environment, and can complete more complicated actions. At work, external information is obtained through the sensor, and information feedback is performed, and then the working state is flexibly adjusted to ensure that the work is completed while adapting to the environment. This robot is used in arc welding and handling work.

In China, due to the backwardness of robotics and R&D, industrial robots are mainly used in manufacturing, such as automobile manufacturing and construction machinery, mainly for spraying, welding and handling of automotive and engineering machinery.

### **The Development Status of Industrial Robots**

Since the introduction of the world's first Unimate and Versatra industrial robots in the United

States in 1962, robots have grown rapidly in industrialized countries. According to the predictions of the International Federation of Industrial Robots (IFR) in the past few years, the total number of industrial robots worldwide will reach 820,000 by the year 2000, an increase of 24% over 1996. Among them, Japan will have 420,000 units, accounting for about 50% of the total number of robots in the world, and continue to maintain the status of “robot kingdom”. In addition to Japan, there are many industrialized countries in the world, such as the United States, the former Soviet Union and some countries in Western Europe, the robot industry has also developed rapidly. For example, in the United States, the number of robots increased by more than 20 times between 1970 and 1980. Although the number of robots owned by the United States is not as good as that of Japan, its technical level is relatively high and it has certain advantages. By 1998, the United States had more than 80,000 robots, and Germany had more than 70,000 units, accounting for 15% and 13% of the world's total robots, ranking 2nd and 3rd in the world. In Asia, Korea's robot industry is growing rapidly and is currently ranked 5th in the world. The robot density in Japan, Korea and Singapore (the number of industrial robots per 10,000 employees in the manufacturing industry) ranks 1st to 3rd in the world. In Western Europe, Italy, France, the United Kingdom, and Eastern Europe, Hungary, Poland, Yugoslavia, and North America, Canada, the development of robot manufacturing and application robots has greatly improved.

China's industrial robots started in the early 1970s. After more than 30 years of development, they can be roughly divided into three stages: the germination period of the 1970s, the development period of the 1980s, and the practical period of the 1990s. Driven by the development of high technology, with the implementation of the reform and opening up policy, the development of China's robotics technology has received the government's attention and support. In the mid-1980s, the state organized industry research on the demand for industrial robots. The results showed that the demand for the first generation of industrial robots was mainly concentrated in the automotive industry (60% to 70% of total demand). Under the advice and planning of many experts, during the "Seventh Five-Year Plan" period, the Ministry of Electrical and Mechanical Services presided over, the central ministries and commissions, the Chinese Academy of Sciences and local scientific research institutes and universities participated. The state invested considerable funds to carry out industrial robot basic technology and basic components. After five years of research and development, the development of teaching regenerative industrial robot complete sets of technology (including manipulator, control system, drive rotary unit, test system design, manufacturing, application and small batch production process technology) was completed, and spray paint was developed. The main performance indexes of several types of special and general control systems and several key components of arc welding, spot welding and handling have reached the level of similar foreign products in the early 1980s, and formed small batch production capacity. After the efforts of the 1980s and especially the last five years, China's industrial robot technology development can basically be based on the domestic. In the mid-1990s, the state had chosen to focus on the engineering application of welding robots, so as to quickly master the welding robot application engineering complete development technology, key equipment manufacturing, engineering support, field operation and other technologies. At present, there are about 500 welding robots distributed in the automobile, motorcycle, construction machinery and other manufacturing industries in major cities in mainland China, of which about 55% are arc welding robots, about 45% are spot welding robots, and the built robots are welded. There are 5 flexible production lines and 300 robot welding stations. In the second half of the 1990s, it was the period of realizing the commercialization of domestic robots and laying the foundation for industrialization. At present, the number of industrial robots in China (referring to mainland China, excluding Hong Kong, Taiwan, and Australia) is only about 2,500, which has not reached the level of Singapore (more than 3,000 units) in 1997 and Taiwan Province (more than 5,000 units).

### **The Development Trend of Industrial Robots**

The introduction of agile manufacturing strategies has provided new opportunities for the development of industrial robots. The basic idea of agile manufacturing is that companies can

quickly reorganize their organization and equipment, respond quickly to market changes, and produce personalized products that meet the needs of users. Agile manufacturing requires the production equipment at the bottom of the enterprise to be flexible and dynamically reconfigurable. The robot is a highly flexible automated production facility. [7] This will put forward higher requirements for the development of industrial robots.

Increased speed and motion accuracy, reduced weight and reduced installation footprint will inevitably lead to standardization and modularization of industrial robot functional components (which can be divided into mechanical modules, information detection modules, and control modules) to reduce manufacturing costs. And improve reliability. In recent years, countries around the world have paid attention to the development of modular robots. It is assembled using standardized assemblies. At present, various standard components have been developed and produced abroad. In addition to various servo motors and sensors for robots, the structure of the arms, wrists and body has been standardized, such as arm telescopic shaft, arm lifting shaft, arm pitch axis, arm swing axis; wrist rotation axis, swing axis, fixed Table body, base, moving shaft, etc.

With the improvement of the precision of industrial robots and the complexity of the working environment, new micro-motion mechanisms should be developed to ensure the accuracy of motion; the development of multi-joint, multi-degree-of-freedom arms and fingers, the development of new types of walking mechanisms, etc. to meet the needs of complex operations.

In the flexible manufacturing automation technology of multi-variety and small-volume production, especially in the robot automatic assembly technology, the industrial robot is required to have an adaptive ability to the external environment and the object, that is, it has certain "intelligence", and the intelligentization of the robot means The robot has a feeling, a perception, etc., that is, it has a strong detection function and a judgment function. To this end, sensors similar to human sensory organs (such as tactile sensors, vision sensors, ranging sensors, etc.) must be developed to develop multi-sensor information fusion technologies. Through various sensors, information about the working object and the external environment, as well as data, experience, and planning data stored in the information base are obtained to complete pattern recognition, and the intelligent system such as "expert system" is used to solve the problem and plan the action.

The development of advanced manufacturing technology plays an active role in promoting the research and development of collaborative robotics. With the development of advanced manufacturing technology, industrial robots have become the production equipment in highly flexible, efficient and reconfigurable assembly, manufacturing and processing systems from the original flexible loading and unloading devices. On such a production line, robots work as a group, and no matter what role each robot plays on the production line, it always exists as a member of the system. Therefore, it is necessary to study the further development of industrial robots from the viewpoint of forming an agile manufacturing system. In the robotic flexible assembly system and robot processing system for advanced manufacturing environments, not only the integration of multiple robots, but also the integration of robots with production lines, peripheral equipment, production management systems, and people. Therefore, to develop a new robot control system from a systematic point of view, there is a lot of theoretical and practical work to be done.

## **Conclusion**

The birth of industrial robots and the establishment of robotics are undoubtedly major achievements of human science and technology in the 20th century. To shorten the gap between the application and research of industrial robots in China and foreign countries, we must use our own advantages to take the road of industrialization. At the same time, in the rapid development of modern manufacturing technology, it is necessary to track the development trend of robotics in research and development. The development of industrial robot industry and technology will greatly accelerate the rise of China's manufacturing industry.

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