

# The Application of Industrial Robots in Automated Production Lines

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**Abstract:** Elaborate on the definition, structure, and characteristics of industrial robots, their application in automated production lines, and provide suggestions for balancing and optimizing industrial robots in automated production lines.

**Keywords:** Industrial robots; automation; production line.

## 1. Introduction

With the advancement of the strategic planning of "Industry 4.0" and "Made in China 2025", various new technologies are widely applied in various fields of industrial production in China. Among them, emerging technology industries such as industrial control systems with industrial robot technology as the core are showing a rapid growth and prosperity trend [1]. Industrial robots play an increasingly important role in industrial production. They can perform various tasks in various production environments, improve production efficiency, reduce labor costs, and also improve product quality, ensuring work safety.

## 2. Introduction to Industrial Robots

### 2.1. Definition of industrial robots

Industrial robots are modern manufacturing automation

equipment that are controlled by computer programs and typically integrate advanced technologies from multiple disciplines such as machinery, electronics, control, computers, sensors, and artificial intelligence [2]. The basic composition of industrial robots is that the world's first industrial robot was born in 1956 in the United States, using CNC machine tools to produce automotive parts. After decades of effort, competitive institutions and enterprises have been established in the field of industrial robots. Then industrial robots were developed for welding, welding, assembly, transportation, loosening, printing ink or painting systems.

### 2.2. The structure of industrial robots

Industrial robots are mainly composed of three parts: mechanical part, control part, and sensing part. It is divided into six systems in detail, including drive system, mechanical structure system, human-machine interaction system, control system, sensory system, and robot environment interaction system [3]. As shown in Figure 1:

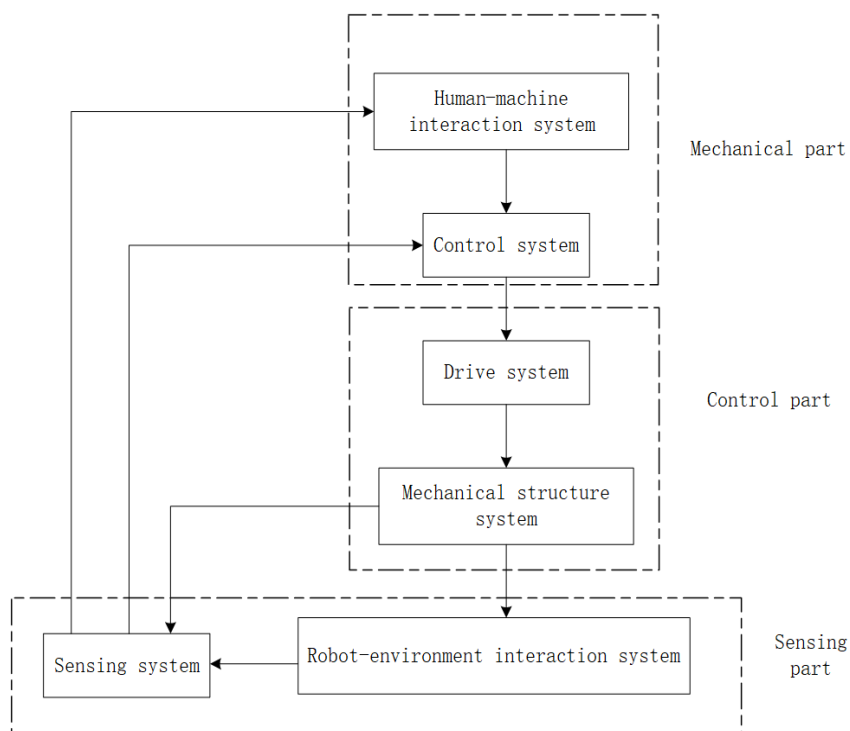


Figure 1. System structure of industrial robots

### 2.3. The characteristics of industrial robots

#### (1) High production efficiency

During heavy and monotonous repetitive labor, prolonged manual operations can lead to fatigue and a decrease in production efficiency. But industrial robots can replace humans, and their efficiency is much higher than humans because no matter how many hours they work, they can still drill holes in the same position and tighten them with the same force.

#### (2) High security

In harsh environments such as high temperature, low temperature, toxicity, and narrow spaces, people may face direct or indirect hazards. However, industrial robots continue and expand the functions of human hands, feet, and brain, replacing dangerous work, reducing losses in work accidents, and ensuring the safety of workers.

#### (3) Accurate positioning

Industrial robots can achieve precise operation and positioning control, with high-precision sensors and actuator equipment. When faced with precise and meticulous operations, they possess incredibly precise dexterity, making it easy to assemble a tiny microchip, ensuring product consistency. In addition, there are also automatic detection and calibration operations to maintain the stability of product quality.

## 3. The Application of Industrial Robots in Automated Production Lines

### 3.1. Welding operations

Most automated production lines require welding tasks, while traditional manual welding wastes time and labor costs, and cannot guarantee the stability of product quality. Industrial robots are used instead of welders for welding operations. Currently, welding robots are mainly divided into arc welding robots, laser welding robots, and spot welding robots, usually composed of robot arms, welding equipment, control systems, and sensors. Robot arms typically adopt a multi joint structure, giving them flexible motion capabilities and the ability to perform various welding actions in three-dimensional space. Firstly, the operator uses computer-aided design (CAD) software to design the welding path and parameters. Then, input these data into the robot control system, and the robot moves and welds according to the program. During the welding process, robots are usually equipped with sensors that can monitor the welding process in real time and adjust parameters as needed.

### 3.2. Automatic assembly

In the electronic product assembly production line, assembly tasks bear the brunt of the manufacturing process. Assembly robots mainly consist of robotic arms, control systems, sensors, and mechanical tool hands. Assembly robots complete the work of identifying parts, grasping parts, aligning parts, assembling, and monitoring in automated assembly production lines. Through the information transmitted by the recognition system, industrial robots accurately grasp the required workpiece and correctly assemble it to the corresponding position of the reducer[4]. At present, the most installed industrial robots in the world are SCARA type four axis robots, followed by series joint type vertical 6-axis robots.

### 3.3. Handling

With the development of the logistics industry and the increase in labor costs, the application of material handling robots in the physical manufacturing industry is becoming increasingly widespread. In the production line, industrial robots can be equipped with various types of fixtures and tools to grasp, move, and place materials of different types and sizes. This can be used to handle and transport parts and semi-finished products on the assembly line, and more importantly, to transport qualified finished products to the warehouse to complete the task of warehousing. The emergence of industrial robots for handling has made workplaces more concise and clear, making it easier to find and retrieve materials. Among them, palletizing robots are more common. Palletizing is based on the idea of integrated unitization, stacking materials one by one in a certain pattern to achieve logistics activities such as storage, handling, loading and unloading, and transportation of materials in the unitized stacking[5]. Stacking robots are widely used in various industries such as food, beverage, animal husbandry, medical, chemical, building materials, and automotive manufacturing.

## 4. Suggestions for Promoting Industrial Robots in Automated Production Lines

### 4.1. Optimizing human-machine collaboration in automated production lines

The development of industrial robots is not a complete replacement for manual operations or humans, but rather a replacement for humans to complete specific tasks in certain special scenarios, reduce the frequency of hazards, and complete high difficulty and high-risk tasks. In practical work scenarios, there are many work processes that industrial robots cannot handle, and it is necessary to rely on the work experience of employees to collaborate and complete. Therefore, human-machine collaboration plays a crucial role in the application of industrial robots in automated production lines. In human-machine collaboration, relevant personnel are responsible for setting task goals, supervising and guiding the work of industrial robots, making decisions, and solving complex problems, while robots perform specific tasks, handle heavy and repetitive work, provide data support, and provide real-time monitoring feedback. This involves the design of anthropomorphic industrial robots, human-machine interfaces, human-machine linkage control, etc., in order to improve the humanization standards in the production process and accelerate the efficiency of employees using industrial robots.

In the production line, collaborative work is usually arranged based on the quantity of order requirements, with technical staff adjusting parameters and setting the robot's motion trajectory for operation. If there are new order requirements, the robot's operation route needs to be adjusted again. Inappropriate adjustments or other hidden dangers may lead to accident risks for industrial robots. Ensure that industrial robots share workspaces with employees, including using sensors and visual systems to detect personnel approach, implementing safety braking or deceleration functions, and designing mechanical structures to prevent collisions.

## 4.2. Process optimization in automated production lines

In automated production lines, optimizing the process layout can maximize the flexibility and adaptability of the production line. The following are some principles for optimizing the process layout of automated production lines: (1) Workstation design. Considering the range of motion and safety distance of the robot, determine the position and layout of each workstation, arrange the work area of personnel and industrial robots reasonably, so that industrial robots can most effectively complete tasks and coordinate with other workstations and equipment. (2) Process program optimization. In automated production lines, allocate different tasks reasonably to industrial robots and personnel to complete. In addition to employee standardization, more detailed optimization is also needed for industrial robots, including speed, acceleration, attitude control, and the path trajectory of robotic arm operation. By optimizing parameters, industrial robots and employees can achieve maximum balance and reduce errors in the production line. (3) Material flow and workpiece transfer. Design material flow and workpiece transfer systems to ensure smooth transfer of materials and workpieces from one workstation to another, minimizing waiting and pause times. Consider using automated equipment such as conveyor belts, robot grippers, and AGVs (Automatic Guided Vehicles).

## 5. Conclusion

Industrial robots are a system technology based on the integration of mechanical technology, electronic technology, electronic computers, and automation control. It can also be said to be a knowledge and technology intensive,

interdisciplinary and comprehensive high-tech. The combination of industrial robots and automated production lines improves production efficiency and quality, while reducing manpower. At present, it is widely used in the manufacturing and production of automotive, electronic products, pharmaceutical production and other fields. As a new type of industrial equipment in a comprehensive discipline, if enterprises want to maintain their advantages in market competition, they must increase investment in technology to reduce production costs, improve production efficiency and economic benefits, and ultimately lay the foundation for the long-term and stable development of the manufacturing industry while ensuring product quality.

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