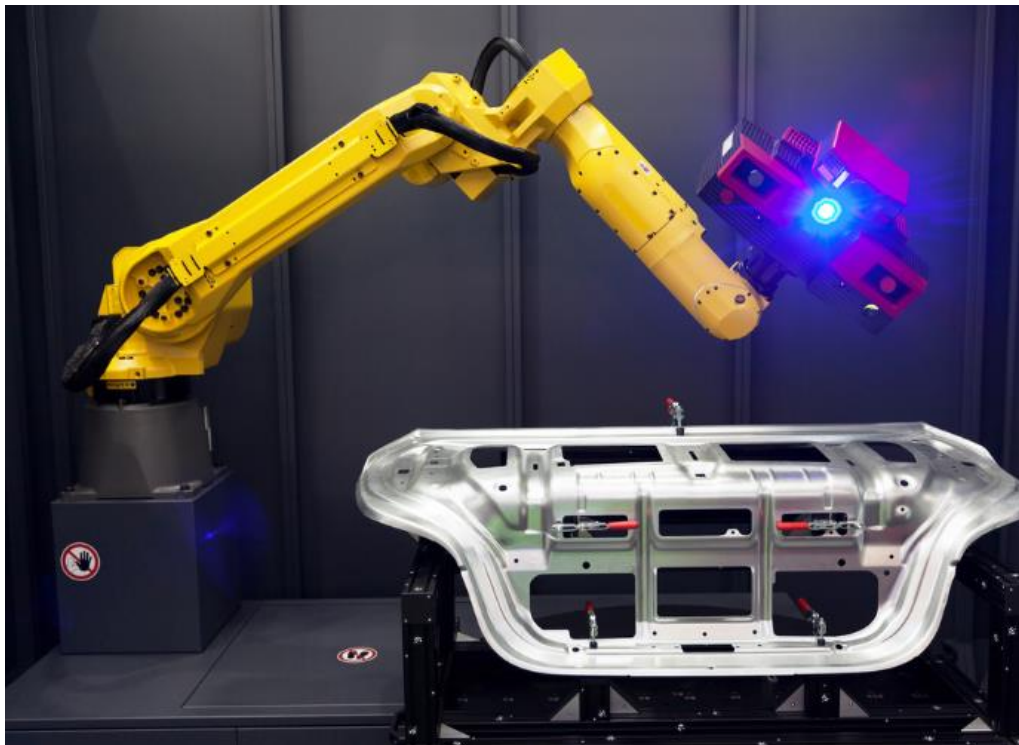


## Industrial Robots for Quality Control and Inspection



### How Manufacturers Use Robots for Quality Control and Inspection

Manufacturers in various industries, including pharmaceuticals, increasingly rely on robots for quality control (QC) and inspection due to their speed, precision, and ability to handle repetitive tasks without fatigue. In pharmaceutical manufacturing, where product safety and precision are critical, robots play an essential role in ensuring consistency and compliance with regulatory standards.

Here's how manufacturers use robots for quality control and inspection:

#### Precision and Accuracy in Inspection

Robots are equipped with high-resolution cameras and sensors, such as lasers and infrared, to detect even the slightest defects in products. This is particularly important in pharmaceuticals, where contamination, improper sealing, or faulty labels can be life-threatening.

- **Visual Inspection:** Robots use cameras to inspect drug packaging (e.g., blister packs, vials, ampoules) for defects like cracks, leaks, or mislabelling.
- **Dimensional Measurement:** Robotic systems measure the dimensions of products and packaging to ensure they meet exact specifications.

#### Automated Sampling for Testing

Robots are used to automate the process of sampling products from production lines for quality testing. In pharmaceuticals, this might involve removing samples for chemical analysis, microbial testing, or physical integrity testing (e.g., tablet hardness).

- **Automated Sampling:** Robots can select random batches for QC testing and track these samples through the testing process.
- **Consistency:** Robotic systems ensure uniformity in the sampling process, reducing human error.

### **Sterility Testing and Contamination Control**

In environments where sterility is critical, such as in the production of IV medications or injectable drugs, robots are used for sterile inspection and handling to prevent human contamination.

- **Closed Systems:** Robotic systems like RIVA (Robotic IV Automation) ensure that inspection and compounding take place in a sealed, sterile environment, reducing the risk of contamination.

### **Non-Destructive Testing (NDT)**

Robots equipped with NDT technologies, such as ultrasonic or X-ray systems, can inspect pharmaceutical products without destroying them. This is essential for ensuring that tablets, capsules, and injectable vials meet safety standards without compromising the product.

- **Ultrasound Inspection:** Used to check the integrity of packaging or liquid-filled products without opening them.
- **X-ray Scanning:** Detects foreign particles, cracks, or density irregularities inside products.

### **The Types of Robots Used for Quality Control and Inspection**

In quality control (QC) and inspection across industries, including pharmaceuticals, various types of robots are used based on the specific needs of the inspection process. These robots are designed to handle tasks such as visual inspection, dimensional measurement, non-destructive testing, and defect detection. Below are the main types of robots used for QC and inspection:

- ❖ Articulated Robots
- ❖ Cartesian (Gantry) Robots
- ❖ SCARA (Selective Compliance Assembly Robot Arm) Robots
- ❖ Delta Robots
- ❖ Mobile Robots

#### **Articulated Robots**

- **Structure:** These robots have rotary joints, typically ranging from 4 to 6 axes, giving them flexibility and a wide range of motion.
- **Applications in QC:** Articulated robots are commonly used for tasks requiring complex movements, such as inspecting products from different angles or handling multiple parts. They are often equipped with cameras and sensors for visual inspection and defect detection.
- **Example:** FANUC and KUKA's articulated robots are frequently used for QC in industries like automotive and pharmaceuticals.

#### **Cartesian (Gantry) Robots**

- **Structure:** Cartesian robots operate on linear axes (X, Y, Z), moving in straight lines rather than rotating.
- **Applications in QC:** These robots are ideal for high-precision tasks that require repeatable, linear movement. In pharmaceutical manufacturing, they are often used for sampling, picking, and placing products for inspection.
- **Example:** Used in automated optical inspection (AOI) and X-ray inspection systems.

### **SCARA (Selective Compliance Assembly Robot Arm) Robots**

- **Structure:** SCARA robots have a horizontal-axis design that is excellent for precise lateral movements and high-speed operations.
- **Applications in QC:** SCARA robots are widely used in automated visual inspections and for packaging inspection in assembly lines, especially in high-speed production environments. They can also perform tasks like barcode and label verification.
- **Example:** Epson SCARA robots are used for high-speed inspection of small parts or components in industries like electronics and pharmaceuticals.

### **Delta Robots**

- **Structure:** Delta robots are fast, spider-like robots with three arms connected to a single base, allowing them to perform high-speed, precise movements.
- **Applications in QC:** Delta robots are excellent for lightweight, high-speed applications, such as inspecting small products on a conveyor. They are commonly used for picking, sorting, and inspecting fast-moving products in industries like food, electronics, and pharmaceuticals.
- **Example:** ABB's Flex Picker is a popular delta robot used for high-speed inspection tasks in packaging and sorting.

### **Mobile Robots**

- **Structure:** Mobile robots are autonomous or semi-autonomous systems that can move across the factory floor, usually equipped with cameras and sensors for inspection.
- **Applications in QC:** These robots are used for QC inspections across large manufacturing plants, especially where flexibility is required. They can inspect multiple stations or production lines, transporting samples or conducting real-time monitoring of products as they move through different stages of production.
- **Example:** MiR (Mobile Industrial Robots) are used for factory inspections and quality control in dynamic environments.

### **Technical Specifications for Quality Control and Inspection**

- ❖ Automated Optical inspection
- ❖ X-ray inspection systems
- ❖ MiR (Mobile Industrial Robots)
- ❖ Cognex vision-guided

## Technical Specifications for Automated Optical inspection



Specification	Details
Camera Resolution	5 MP to 25 MP (megapixels)
Inspection Speed	Up to 70 cm <sup>2</sup> /s
Inspection Types	- Surface defects (scratches, cracks) - Solder joint inspection - Label, barcode, and packaging inspection
Lighting System	Multi-angle LED (red, green, blue, white)
Inspection Modes	2D and 3D inspection
Defect Detection Accuracy	99.9% or higher
Resolution Accuracy	± 10 μm to ± 30 μm
Handling System	Conveyor or robotic handling
Maximum PCB Size	50 mm x 50 mm to 500 mm x 500 mm
Software	Machine vision algorithms with AI/deep learning for defect detection
Integration	MES, ERP, SCADA
User Interface	Graphical User Interface (GUI) with real-time visualization
Operating Temperature	15°C to 35°C
Power Supply	100-240V AC, 50/60 Hz
Dimensions	Typically 1.5 m x 1.0 m x 1.8 m
Weight	300 to 800 kg

## Technical Specifications for x-ray inspection systems



Specification	Details
X-Ray Source Type	Sealed tube, microfocus, or flat-panel detector
Energy Range	30 kV to 300 kV (depending on application and material)
Detection Resolution	100 µm to 500 µm (depends on the system configuration and source)
Inspection Speed	Up to 120 parts per minute (varies based on object size and inspection complexity)
Field of View	Typically ranges from 50 mm x 50 mm to 600 mm x 600 mm
Image Processing Software	Advanced algorithms for image enhancement, defect detection, and 3D reconstruction
Material Penetration	Capable of penetrating various materials (e.g., metals, plastics, glass)
Image Storage	Digital storage with the ability to save, retrieve, and analyze images
User Interface	Graphical User Interface (GUI) with real-time visualization and analysis tools
Compliance	CE certified, FDA approved for medical applications
Power Supply	100-240V AC, 50/60 Hz
Operating Temperature	10°C to 40°C
Dimensions	Varies by model, typically 1.2 m x 1.0 m x 2.0 m
Weight	300 to 700 kg
Safety Features	Shielding, interlocks, and safety alarms to protect operators

## Technical Specifications for MIR (mobile industrial robots)



Specification	Details
Robot Type	Autonomous mobile robot (AMR)
Payload Capacity	Up to 1,500 kg (varies by model)
Navigation System	LIDAR (Light Detection and Ranging), camera, and sensor-based navigation
Speed	Up to 3.5 m/s (varies depending on load and environment)
Battery Life	Up to 12 hours of continuous operation (depending on load and application)
Charging Time	Approximately 2-3 hours for a full charge
Communication	Wi-Fi, Ethernet, and various communication protocols (e.g., MQTT, REST API)
Dimensions	Varies by model, typically 800 mm x 600 mm x 300 mm
Weight	Varies by model, typically 200 kg to 400 kg
Control Interface	Web-based user interface for configuration, monitoring, and control
Safety Features	Emergency stop buttons, obstacle detection, and collision avoidance systems
Load Handling	Capable of transporting pallets, carts, and various materials
Integration	Compatible with Warehouse Management Systems (WMS) and Manufacturing Execution Systems (MES)
Operating Environment	Indoor and outdoor environments, depending on model specifications

## Technical Specifications for Cognex vision-guided



Specification	Details
Camera Resolution	1 MP to 12 MP (megapixels)
Field of View	Up to 160 mm x 120 mm (varies based on lens and application)
Image Processing Speed	Up to 60 frames per second (FPS)
Lighting	Integrated or external lighting options (e.g., LED, ring lights)
Communication Interfaces	Ethernet, USB, RS-232, and digital I/O for integration with other systems
Supported Protocols	TCP/IP, HTTP, MQTT, and various industrial protocols
Supported Image Formats	JPEG, BMP, PNG, TIFF, and custom formats
Software Compatibility	Cognex Vision Software, In-Sight Explorer, and other third-party software
Vision Tools	<ul style="list-style-type: none"> <li>- OCR (Optical Character Recognition)</li> <li>- 2D and 3D inspection</li> <li>- Blob analysis and pattern matching</li> <li>- Measurement and alignment</li> </ul>
Operating Environment	Suitable for industrial environments with IP ratings for dust and water resistance
Power Supply	12V DC to 24V DC
Operating Temperature	0°C to 50°C
Dimensions	Varies by model; typically around 150 mm x 120 mm x 80 mm
Weight	Approximately 1 kg to 3 kg, depending on configuration
Safety Features	<ul style="list-style-type: none"> <li>- Emergency stop capabilities</li> <li>- Integrated safety features for secure operation around human workers</li> </ul>