Industrial Robots for Robotic Lab Automation

How Manufacturers Use Robots for Robotic Lab Automation

Manufacturers utilize robots for robotic lab automation to enhance efficiency, accuracy, and productivity in various laboratory processes. Here's a breakdown of how robots are integrated into lab environments:

Sample Handling and Preparation

- **Automated Sample Processing**: Robots can automate the handling, sorting, and storage of samples. This includes tasks such as pipetting, aliquoting, and mixing samples, reducing human error and improving throughput.
- **Consistent and Reproducible Results**: Robots ensure that sample handling is performed consistently, which is critical for experiments requiring precision.

High-Throughput Screening (HTS)

- **Drug Discovery**: Robots are used in drug discovery to rapidly test thousands of compounds against biological targets. They can perform complex assays more quickly and accurately than manual methods.
- **Assay Development**: Automation speeds up the development and optimization of assays by allowing simultaneous testing of multiple conditions.

Data Management and Analysis

- **Integrated Data Systems**: Robots can be integrated with software that collects and analyses data in real-time, allowing for immediate adjustments to experiments based on results.
- **Machine Learning and AI**: Advanced robotic systems use machine learning algorithms to analyse experimental data, leading to faster insights and discoveries.

Quality Control and Assurance

- **Automated Testing**: Robots can conduct routine tests to ensure product quality and compliance with standards, reducing the risk of contamination or errors.

- **Traceability**: Automated systems maintain detailed logs of sample handling and test results, ensuring traceability and regulatory compliance.

Inventory Management

- **Automated Stock Management**: Robots can monitor inventory levels, reorder supplies, and track sample locations within the lab, minimizing waste and preventing shortages.
- **Efficient Storage Solutions**: Robotic systems can manage complex storage systems, including temperature-sensitive materials, ensuring optimal conditions for each sample.

The Types of Robots Used for Robotic Lab Automation

Robotic lab automation employs various types of robots to enhance efficiency and accuracy in laboratory processes. Here are some common types of robots used in robotic lab automation:

- ❖ Liquid Handling Robots
- ❖ Robotic Arms
- ❖ Collaborative Robots (Cabot's)
- ❖ Automated Storage and Retrieval Systems (ASRS)
- ❖ High-Throughput Screening Robots
- ❖ Microplate Robots

Liquid Handling Robots

- **Function**: These robots are designed for precise pipetting and liquid dispensing tasks. They can perform tasks like sample preparation, reagent addition, and dilutions.
    - **Examples**: Automated pipetting systems, multi-channel liquid handlers.

Robotic Arms

- **Function**: Flexible robotic arms can perform a wide range of tasks, including sample manipulation, sorting, and assembly. They can be equipped with different end effectors (grippers, suction cups) for various applications.
    - **Examples**: Articulated robotic arms for automated sample processing.

Collaborative Robots (Cabot's)

- **Function**: Cabot's are designed to work alongside human operators. They are equipped with safety features that allow them to operate near people without barriers.
    - **Examples**: Robots that assist with repetitive tasks, such as sorting and organizing samples.

Automated Storage and Retrieval Systems (ASRS)

- **Function**: These systems use robots to manage the storage and retrieval of samples or supplies within a laboratory. They help optimize space and ensure quick access to materials.
    - **Examples**: Robotic shelves and automated carts for inventory management.

High-Throughput Screening Robots

- **Function**: Used primarily in drug discovery, these robots can quickly test many compounds or samples against biological targets. They automate the setup and execution of assays.
    - **Examples**: Robotic platforms for automated assay preparation and analysis.

Microplate Robots

- **Function**: These robots are specifically designed for handling microplates, commonly used in biological assays. They automate tasks such as loading, unloading, and transferring samples between plates.
    - **Examples**: Plate readers and handlers for ELISA or cell culture assays.

Technical Specifications for Robotic Lab Automation

- Automated pipetting systems
- Multi-channel liquid handlers' systems
- Articulated robotic arms

Automated pipetting systems

Specification	Details
Models Available	Various models (e.g., single-channel, multi-channel, portable systems)
Pipetting Volume Range	Typically from 0.1 µL to 1,000 µL; specific models may handle larger volumes
Accuracy	±0.5% to ±5% depending on model and volume range
Precision	Coefficient of variation (CV) < 5% at standard volumes
Speed	Up to 96 wells per minute for multi-channel systems
Number of Channels	Single-channel or multi-channel (e.g., 8, 12, 96 channels)
Software Compatibility	Compatible with various laboratory information management systems (LIMS)
User Interface	Touchscreen or computer-controlled with customizable settings
Connectivity	USB, Ethernet, or wireless options for integration with laboratory systems
Operating Conditions	Temperature: 15°C to 30°C (59°F to 86°F); Humidity: 20% to 80% RH
Calibration	Automated calibration routines; some models offer self-calibration
Safety Features	Leak detection, software interlocks, and error notifications
Maintenance Requirements	Regular cleaning and occasional recalibration recommended
Dimensions	Varies by model; typically compact for laboratory bench use
Power Requirements	100-240V AC; power consumption varies by model
Noise Level	Typically ≤ 50 dB during operation
Customization	Modular designs available for specific applications and configurations

Multi-channel liquid handlers' systems

Specification	Details
Models Available	Various models (e.g., 8-channel, 12-channel, 96-channel systems)
Pipetting Volume Range	Typically from 0.1 µL to 1,000 µL; specific models may handle larger volumes
Accuracy	±1% to ±5% depending on model and volume range
Precision	Coefficient of variation (CV) < 5% at standard volumes
Speed	Up to 96 wells per minute for 96-channel systems
Number of Channels	8, 12, 16, 24, 48, or 96 channels, depending on the system
Software Compatibility	Compatible with various laboratory information management systems (LIMS)
User Interface	Touchscreen or computer-controlled with customizable settings
Connectivity	USB, Ethernet, or wireless options for integration with laboratory systems
Operating Conditions	Temperature: 15°C to 30°C (59°F to 86°F); Humidity: 20% to 80% RH
Calibration	Automated calibration routines; some models offer self-calibration
Safety Features	Leak detection, software interlocks, and error notifications
Maintenance Requirements	Regular cleaning and occasional recalibration recommended
Dimensions	Varies by model; typically designed for bench-top use
Power Requirements	100-240V AC; power consumption varies by model
Noise Level	Typically ≤ 55 dB during operation
Customization	Modular designs available for specific applications and configurations

Articulated robotic arms

Specification	Details
Degrees of Freedom (DOF)	Typically 4 to 7 DOF, allowing for complex movements
Payload Capacity	Ranges from a few grams to over 100 kg, depending on model
Reach/Working Radius	Varies by model; typically ranges from 0.5 m to 3 m or more
Precision	Positioning accuracy of ±0.1 mm to ±0.5 mm depending on model and application
Speed	Maximum joint speed can range from 100 to 1000 mm/s or more
Control System	Compatible with various controllers (e.g., PLC, PC-based control)
User Interface	Touchscreen or software interface for programming and operation
Connectivity	USB, Ethernet, and wireless options for integration with other systems
Operating Conditions	Temperature: 0°C to 50°C; Humidity: 20% to 80% RH
Power Requirements	100-240V AC; power consumption varies by model and usage
Safety Features	Collision detection, emergency stop buttons, and safety enclosures
Programming Languages	Support for various programming languages (e.g., C++, Python, specific proprietary languages)
Maintenance Requirements	Regular maintenance recommended; lubrication and calibration based on usage
Dimensions	Varies by model; typically compact for flexibility in workspace
Customization	Modular components and end effectors available for specific applications
Weight	Varies widely; lightweight models available for easy maneuverability