機械與機電系統研究所

MECHANICAL AND MECHATRONICS SYSTEMS
RESEARCH LABORATORIES, MMSL.

Intelligent Robotics

Detachable Joint Robot System

For various and small-scale automated production lines, diverse types of robotic arms are required. However, the robotic arms available on the market come in fixed configurations, making customization impossible for customers. When maintenance is needed, the entire arm must be sent back to the manufacturer for repairs. The process not only involves laborious tasks but also halts production lines, leading to delays in delivery schedules.

Technical Advantages and Features

Flexible Modular Design

- Quickly replace faulty joints, reducing factory downtime from 2 days to 0.2 days.
- Easily adjust the robotic arm's degrees of freedom and arm length without being constrained by the fixed configurations.

Quick Replacement

- Similar to LEGO bricks, customized robotic arms are based on cost and requirements.
- Completing assembly within 5 minutes; setting up operation within 10 minutes.

High Performance

- Modules integrate intelligent components, such as motors, gearboxes, encoders, and drivers, for plug-and-play functionality without requiring additional configuration.
- Volume has been reduced by 15%, the high torque-to-weight ratio has been increased by 30%.

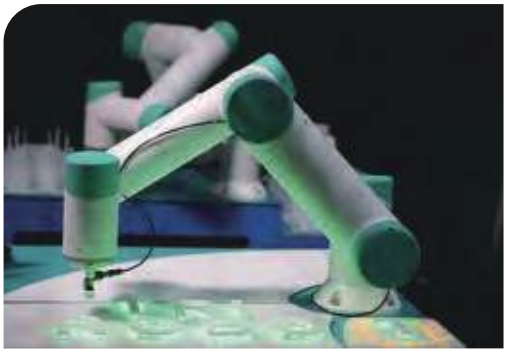
Industrial Benefits and Business Opportunities

Industry Applications:

Multi-industrial applications (Light Industry, Semiconductor Industry, Medical Industry, etc). Applied to parts assembly, material inspection, surgical assistance.

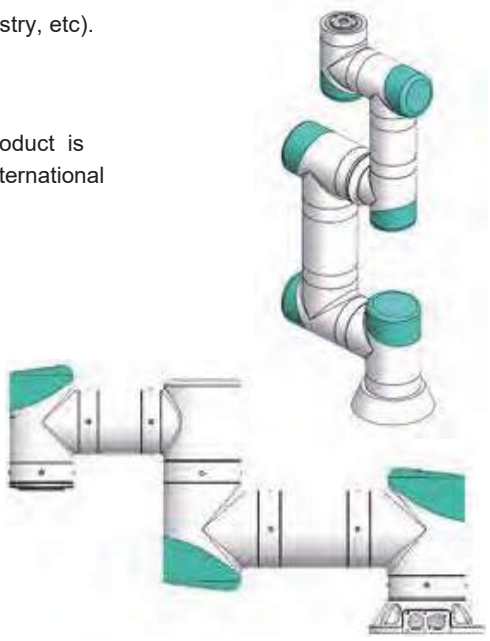
Application Examples:

In co-production with the largest domestic joint module manufacturer, the product is exported to Europe, America, India, and Southeast Asia markets through international distributors to meet the demands of collaborative and DIY requirements.



Pick-and-place

All-In-One Module



Adaptable Robot Assembly

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AMR and Intelligent Fleet Management System

Autonomous Mobile Robots (AMRs) alleviate labor shortages and enhance factory efficiency by performing tasks such as goods delivery and environmental cleaning independently. However, inconsistent communication systems across factories hinder AMRs from communicating during routine tasks, complicating the coordination and integration with equipment such as elevators and shelves, thereby limiting the use and expansion.

Technical Advantages and Features

Seamlessly Communicate Across Different Areas

- Satisfying the communication standards of the Autonomous Mobile Robot Alliance (AMRA).
- Integrating with various domestic brands of AMRs.
- Compatible with different types of mobile vehicles, such as Automated Guided Vehicles (AGVs), Autonomous Mobile Robots (AMRs), and Overhead Hoist Transporters (OHTs).

Smart Traffic Management & Dual-Module Scheduling

- Intelligent traffic management and multi-path planning algorithms with flexibly arranged tasks.
- Dual modular (simultaneously running direct routes and detour tasks)
- Smart charging and parking management for continuous 24/7 operation.

Support the Factory Communication Protocols

- Communication among the factory's peripheral equipment, including warehouses, electronic shelves, elevators, and automatic doors.
- Supports Universal Communication Protocols, including Modbus, AMQP, REST API, and SECS, ensuring high compatibility with enterprises.

Industrial Benefits and Business Opportunities

Industry Applications:

Semiconductor Industry, Manufacturing Industry, Medical and Service Industry.

Application Examples:

- Applied at the semiconductor packaging and testing plant, Siliconware Precision Industries, the Intelligent Fleet Management System commands and dispatches multiple autonomous mobile robots to transport wafer carriers (FOUPs and Magazines) in the cleanroom, achieving flexible scheduling. This technology has successfully reduced manpower by 15%, increased production capacity by 50%, and achieved a production line utilization rate of 95%.
- Applied at the screw mold factory, San Shing Fastech Corp, the "Intelligent Task Scheduling" achieves dual-module operation of detour and direct transport between workstations. The "Fleet Management System" communicates with peripheral automatic, enabling AMRs to have the capability of transporting goods across floors and buildings. After implementation, it saved 3 manpower in each area.

For Different Guiding Type Magnetic Guidance & SLAM

SANSHING

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RoboTwin Integrated Virtual-Real Robot Control Unit

Virtual-real integration is not commonly implemented in all factory lines due to a lack of big data and reliable verification platforms. This increases the risk of failure in the actual implementation of products and requires more time to be spent on the production line.

Technical Advantages and Features

Advanced Factory Deployment

- Rendering a 3D scene from 2D static images without Computer-Aided Design (CAD) models.
- Simultaneous remote immersive interaction with three units helps overcome cross-factory limitations.
- Completed advanced simulation and dynamic verification within a week to enhance implementation confidence.

Robots Equipped with Smart Vision

- Fully automated database generation by using AI-powered vision database automation tools.
- Completed the visual recognition system within 3 days, with general machine adjustment taking about 10 days.
- Visual-guided robot for loading, unloading, and processing operations.

Digital Twin Fast-Learner

- Generative AI robots equipped with learning and decision-making capabilities.
- Non-engineers can easily get started.
- Optimize configurations and adjust paths within one day.

Industrial Benefits and Business Opportunities

Industry Applications:

Manufacturing Industry, such as electrical machinery factories, steel industry, powder metallurgy, metal processing industry, and other Processing Industries.

Application Examples:

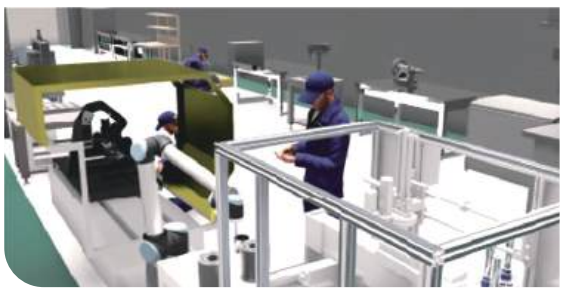
- Successfully entered the Horizon Europe research project, collaborating with European partners such as Fundacion TEKNIKER in Spain, DFKI in Germany, and Philips Consumer Lifestyle in the Netherlands.
- Introduced to the top 10 hand tool factories in Taiwan, the system is used for high-difficulty assembly (e.g., ratchet wrenches), resolving high-contact-rich issues and increasing productivity by 30%.

Horizon Europe

Practical Applications in Electrical Manufacture

Virtual War Situation Room / Virtual-Reality Integration / Remote Maintenance and Operation

Human-Machine Collaboration / Robot Automation / AI Intelligence



High-Fidelity Bidirectional Connectivity

Production Line AI Database

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HolonOS | Core Robotic Software Integrating AI, Sensing, and Control Technologies

Small-batch, multi-variety manufacturing leads to labor shortages and complex equipment operation. Traditional robotic arms require diverse sensors, communication protocols, algorithms, brand-specific support, and expert programming, limiting production line flexibility, increasing downtime, reducing efficiency, and demanding high investment from system integrators. HolonOS integrates AI, sensors, and control, enabling 1-hour mastery, 15-minute path setup, and 3-minute tuning to boost efficiency.

Technical Advantages and Features

Built-in Multiple Application Modules

- Supports communication with 6 major robotic arm brands, including top brands from Japan, Europe, and Taiwan.
- Supports up to 7 global sensor brands and algorithms.

Automated Path Generation

- Scans and creates paths in 15 minutes.
- User-friendly interface for quick process adjustments in 3 minutes.

AI-Assisted Control Assistant

- Generates precise code from documents and manuals.
- AI-based object recognition, user instruction, and troubleshooting.

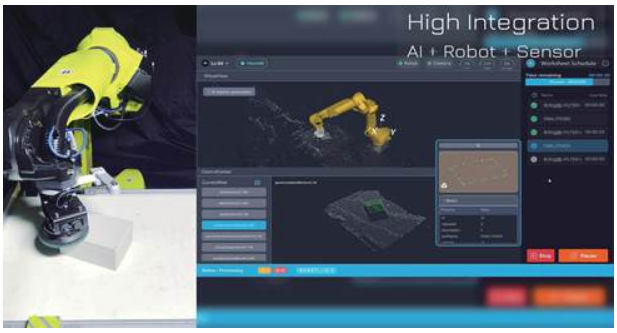
Industrial Benefits and Business Opportunities

Industry Applications:

Adopted in 13 cases across 9 industries, including plumbing, kitchenware, automotive parts, semiconductor components, sports equipment, shipbuilding, bicycles, military supplies, and medical devices.

Application Examples:

Partnering with a leading domestic cutlery manufacturer to introduce HolonOS with laser line modules and algorithm, automating size measurement and compensation. This enables robotic arms to grind automatically, successfully mass-producing 10+ products, increasing output by over 30%, addressing labor shortages, and maintaining product quality.



HolonOS offers High-Level Integration of AI, Robotics, and Sensor-Based Applications

Intuitive and User-Friendly HMI (Human-Machine Interface)

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Wafer Handling Robot

Wafer robots previously faced challenges integrating into Equipment Front End Module (EFEM), including low space efficiency, large footprint, maintenance difficulties, limited stability and electromagnetic interference affecting precision. With the growing demands of the semiconductor industry, the performance requirements for wafer transfer robots have also increased.

Technical Advantages and Features

Embedded Design

- Integrates electronic control components and robots into a single unit.
- High space utilization, easy maintenance, and no electromagnetic interference.

High-Speed and Low-Vibration

- High-speed control technology, capable of transferring 250 wafers per hour.
- Low-vibration control, with vibration value under 0.3G.

Vibration Monitoring Function

- Embedded vibrating fork sensor for effective vibration monitoring.
- Flexible motion path planning and control.

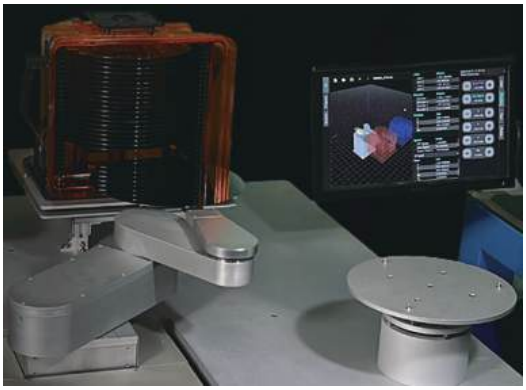
Industrial Benefits and Business Opportunities

Industry Applications:

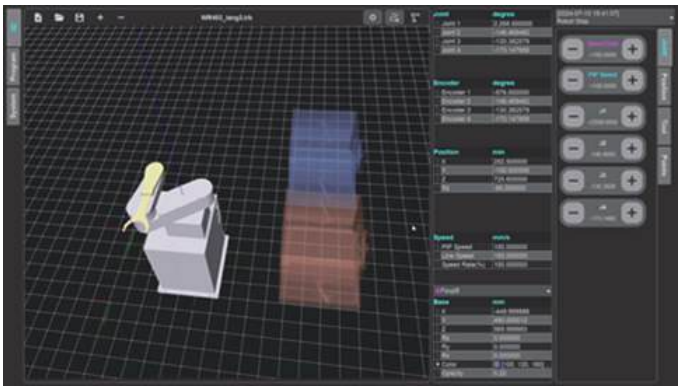
Semiconductor, LED, and Panel Industry.

Application Examples:

This technology was transferred to a well-known Taiwanese automation equipment supplier to develop a high-speed, low-vibration wafer transfer robot with an embedded control system. The system integrates electronic components and robots to improve space utilization, solves maintenance and electromagnetic interference issues when integrating robots into EFEM, and successfully boosts production capacity.



Wafer Handling Robot



Control Interface for Wafer Handling Robot

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Dual Arm Robot System

Dual-arm robots previously faced challenges like low precision, limited payload capacity, restricted degrees of freedom, and inadequate grasping ability for soft or irregular objects. In addition, poor integration of structural design and control systems made it difficult to perform complex and diverse tasks.

Technical Advantages and Features

29 Degree of Freedom

- The dual-arm robot features two 7-axis arms, two 6-axis anthropomorphic hands, and a 3-axis torso.

Handles Diverse Objects

- Anthropomorphic hands can grasp objects of various shapes and hold human tools without customization.

User-Friendly Development Environment

- Supports Robot Operating System (ROS).
- Provides simulation software for users to develop applications.

Industrial Benefits and Business Opportunities

Industry Applications:

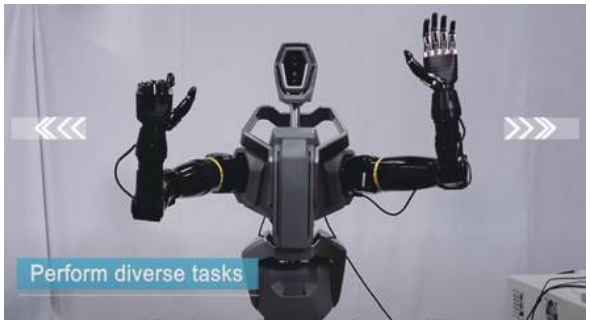
Smart Manufacturing, Professional Services (Industrial Services), Hazardous Environment Operations and Entertainment Industry.

DARS Concept Design

Application Examples:

The Dual Arm Robot System (DARS), developed by ITRI, features two robotic arms and anthropomorphic hands, offering high degrees of freedom, high load capacity, and high precision.

The arms are made of composite materials, and the control system integrates various robotic software functions, providing human-like capabilities for grasping diverse objects, such as soft paper or irregularly shaped hand tools. DARS is widely used in industrial processing, home services, and healthcare applications.



DARS Prototype

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AI-driven Self-Navigating Miniature Serpentine Robotic System for Natural Orifice Transluminal Endoscopic Surgery, AiSNMSR

Traditional endoscopic surgery depends on visual inspection and instrument handling, making it prone to disorientation. Prolonged radiation exposure also increases risks for doctors. Additionally, percutaneous procedures may cause bleeding, pneumothorax, and infections, leading to complications and longer recovery times. This technology allows doctors to control the instruments precisely through the system panel.

Technical Advantages and Features

Multi-Degree-of-Freedom Robotic Hose

- Integrated bending section with a minimum outer diameter of 2.9mm and an inner diameter of 1.2mm.
- Omnidirectional bending up to 210°.

AI Self-Navigation

- Pre-rendered 3D modeling in 10 min.
- AI air pocket recognition guides the instrument through the oral cavity into the lungs, covering over 90% of the lung area.

Detachable Module, Plug-and-Play

- Quick disassembly in 30 seconds and setup in 1 minute.
- Compatible with multiple medical disciplines, plug-and-play.
- Reduces sterilization procedures and lowers the risk of secondary infection.

Industrial Benefits and Business Opportunities

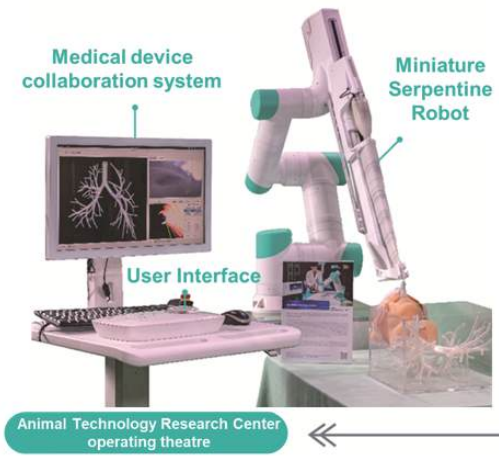
Industry Applications:

Medical Device and Equipment Manufacturing Industry (e.g., minimally invasive surgical instruments, endoscopes, and medical imaging devices).

Application Examples:

This technology meets IACUC, IEC 60601, and ISO 10993 standards and has undergone preclinical validation with NTU Hospital Zhubei and ATIT, providing clinical feedback and optimizing treatment outcomes. It has been recognized with prestigious awards, including the 2024 R&D 100 Awards and ITRI's Outstanding Research Award.

Miniature Serpentine Robotic System



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