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Revolutionizing High-Mix/Low-Volume Production

with Machine Learning-Based Robotic Innovations

Introduction

Traditional robotics and machine tools often struggle with the high-mix/low-volume (HMLV) production needs due to the rigidity of pre-programmed tool paths, dedicated part fixtures, and fixed production flows.

PAR Systems has developed a cutting-edge machine learning (ML) based vision mapping and planning system that delivers high-accuracy automation. Our innovative solution addresses common high-mix/low-volume challenges by delivering enhanced flexibility, efficiency, and cost reduction.

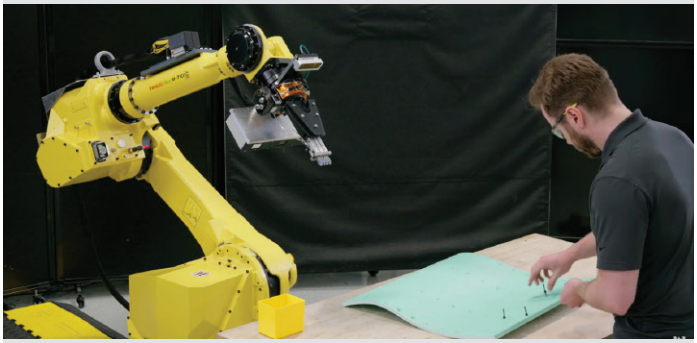
How It Works

The PAR vision mapping and planning system leverages machine learning to autonomously identify, map, and process parts arbitrarily placed within the robot's work envelope. The advanced ML algorithm functions without knowledge of the overall assembly, which eliminates the need for costly, pre-programmed setups and fixtures.

The system uses a 2D camera to capture images from multiple positions across the work area. These images are processed by the ML algorithm, which calculates the 6D pose (position and orientation) of each target and generates an efficient tool path based on the different processes required by each target type. For higher-accuracy tasks, the initial camera-based calculations are refined using a 3D structured light scanner.

About Us

PAR Systems is an industry leader in designing and implementing small parts handling systems and has a long history of automating processes and designing first-of-a-kind innovations in our research and development laboratories. We help companies solve complex issues with intelligent manufacturing solutions.



Key Components

- **Tool Changer:** Automatically switches between tools to perform a range of operations
- **2D Camera:** Captures images from multiple angles for target detection and pose estimation
- **3D Structured Light Scanner:** Provides high-resolution scanning for accurate target location and post-process inspection
- **Machine Learning Algorithm:** Detects, identifies, and locates each target's 6D pose, autonomously generating tool paths

Benefits of Machine Learning Vision Mapping

Our machine learning-based system offers several advantages over traditional, rigid pre-programmed setups:

Increased Flexibility:

Objects can be placed anywhere within the robot's work envelope, making the system adaptable to various target types and part configurations.

Improved Efficiency:

Automated tool path generation and elimination of pre-programmed setups reduce overall setup times.

Enhanced Accuracy:

The 3D scanner provides highly accurate location data for process precision and post-process inspection, providing quality control and automated reports.

Cost Reduction:

The flexible system architecture reduces the need for dedicated part fixtures and custom tool paths.

Scalability:

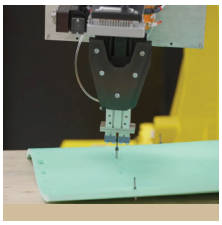
The system can be easily adapted to accommodate various operations and part types, expanding the capabilities of robotic automation.

Mobility:

When integrated with collaborative robots and mobile stations, the system can be transported across the production floor to where it's needed most, working alongside operators.

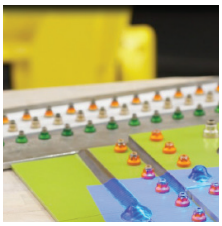
Automation Technologies in HMLV Production Environments

These examples highlight how automation technologies can adapt in HMLV production environments.



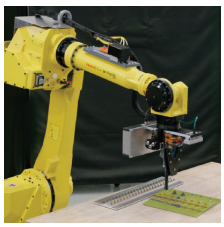
Fastening Systems:

Automation revolutionizes manufacturing by enabling robotic systems to install a variety of fastener types—including rivets, screws, and bolts—with unmatched precision and efficiency. These systems integrate features like tool-changing capabilities, real-time sensor feedback for quality monitoring, and robotic arms capable of navigating complex geometries and hard-to-reach areas. In aerospace applications such as wing panels, fuselage sections, and landing gear assemblies, automated fastening enhances accuracy, accelerates production rates, improves quality control, and reduces operator fatigue.



Automated Fastener Removal:

Robotic systems streamline the removal of both temporary fasteners used during assembly and installed fasteners during upgrades or repairs. Using advanced vision technology and adaptive tooling, these systems precisely locate and remove fasteners without damaging surrounding structures. Whether disassembling temporary fixtures or extracting high-stress fasteners for maintenance, automated removal reduces manual effort, improves efficiency, minimizes errors, and shortens downtime, ultimately enhancing productivity and quality across the manufacturing and repair lifecycle.



Automated Sealant Application to Fuselage Fasteners:

Automation ensures consistent, high-quality sealant application to fuselage fasteners, a critical step in aerospace manufacturing. Robotic systems equipped with vision technology and machine learning dynamically adjust sealant application paths and quantities based on fastener type and placement. This precision minimizes material waste, guarantees uniform results, and maintains high standards even with varying fastener designs and locations.

➔ **Visit our website for more examples of PAR automation technologies in HMLV production environments.**

Conclusion

PAR Systems is leading the charge in modern automation with our machine learning-powered vision mapping and planning system. By combining the latest in ML, 2D and 3D imaging, and versatile hardware, we deliver a solution that redefines efficiency, flexibility, and precision in high-mix/low-volume production environments. Whether in aerospace or other industries, our system not only streamlines operations but also sets new benchmarks for cost-effectiveness and process control.

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