PAQi Architecture

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System Architecture & Scalability

Technical breakdown of PAQi system's overall architecture and scalability at the unit, plant, and enterprise levels

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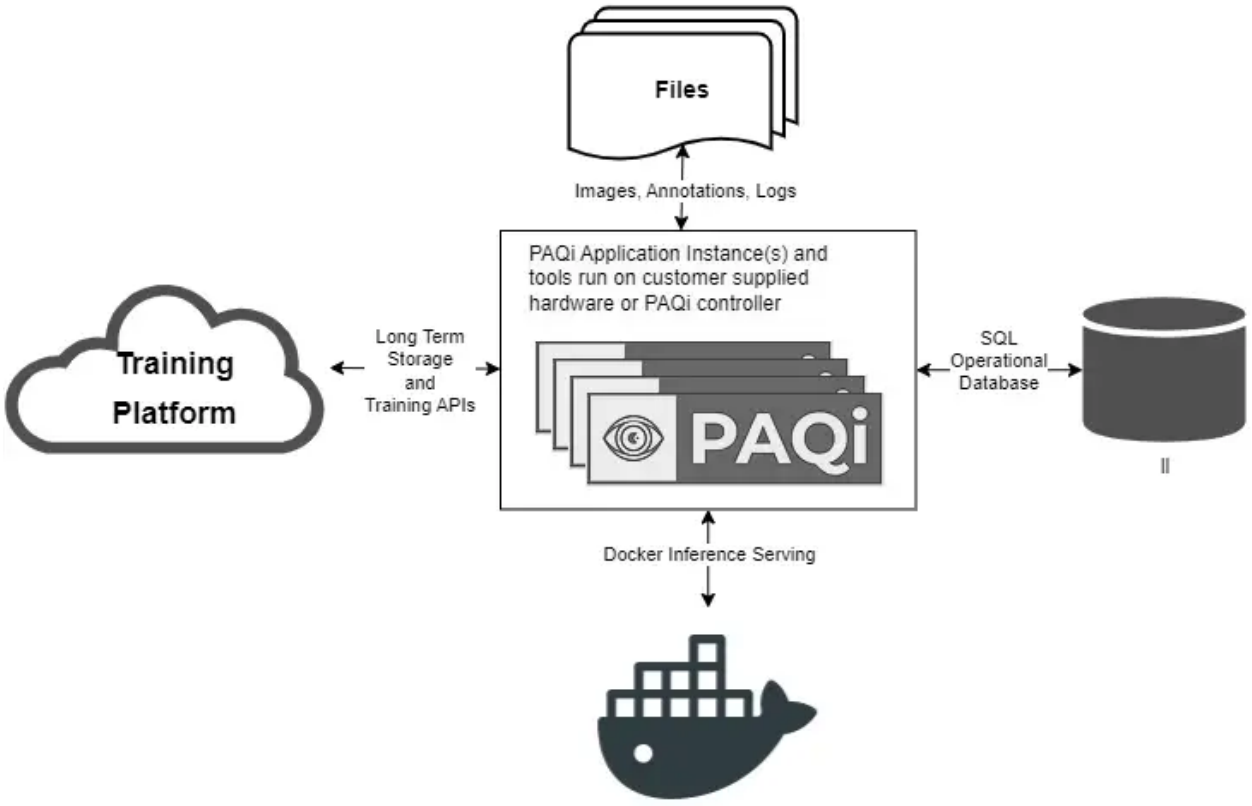
System-Level Architecture (Single System)

A single PAQi system functions as an AI-powered, self-contained inspection unit that integrates into manufacturing environments for real-time defect detection, dimensional verification, and process optimization. It is designed to function as a standalone unit or within a fully automated production system, ensuring high precision and adaptability.



1.1 Key Components

Each PAQi unit is built with several essential components to ensure robustness and efficiency in industrial applications.

Industrial PC with PAQi AI Software

- ⇒ Ruggedized industrial PC optimized for real-time processing.
- ⇒ Windows-based OS with pre-installed PAQi software.
- ⇒ AI-powered inference engine for defect detection and quality control.
- ⇒ Multiple industrial connectivity options for seamless automation integration.

Camera & Sensor Suite

- ⇒ Configurable for a wide variety of camera and sensor types.
- ⇒ Adjustable field of view (FOV) and resolution based on application needs.
- ⇒ Multi-camera support, allowing a single PAQi unit to operate with up to six cameras.

Lighting Systems

- ⇒ High-intensity LED arrays with adjustable brightness.
- ⇒ Structured light for surface depth inspection.
- ⇒ IR/UV options for specialized material analysis.

Industrial Communication Interfaces

- ⇒ Supports Ethernet/IP, Modbus, PROFINET, and OPC UA.
- ⇒ Seamless PLC and SCADA integration for automated workflows.
- ⇒ Custom API support for Manufacturing Execution System (MES) compatibility.

Data Storage & Reporting

- ⇒ Local storage via SSD with optional cloud connectivity.
- ⇒ SQL database support for long-term defect tracking.

HMI & Operator Interface

- ⇒ Intuitive touchscreen UI with role-based access control.
- ⇒ Real-time defect visualization and manual override functionality.
- ⇒ Customizable alerts and notifications for production monitoring.

1.2 Scalability Features

PAQi's modular architecture ensures it can be easily scaled based on production demands. It can operate as an independent inspection system or as part of a larger, networked AI-driven quality control system.

Flexible deployment

- ⇒ Can be integrated inline within automated production lines or function as a standalone workstation.
- ⇒ Compatible with existing factory networks for remote monitoring and diagnostics.

Expandable AI Model Deployment

- ⇒ New AI models can be updated or trained dynamically for evolving quality control requirements.
- ⇒ AI inference is containerized using Docker, allowing up to 30 models per processing server.
- ⇒ AI models run on premise, providing additional security.

Future-proofing capabilities

- ⇒ Modular hardware design ensures upgrades can be implemented without replacing the entire unit.
- ⇒ Supports White labeling of QC Hero pipeline, allowing customer-managed AI training pipelines.

1.3 Software & AI Processing

PAQi runs a Windows-based AI vision software suite designed for easy configuration and powerful AI-driven inspections.

PAQi OS Features

- ⇒ AI-powered defect detection, data collection, and multi-camera synchronization.
- ⇒ Custom defect classification and tolerance settings for different product lines.
- ⇒ Preloaded with automated training tools for continuous AI model improvements.

AI Model Training Acceleration

- ⇒ Google TPU-based training ensures AI models can be trained in under two hours.
- ⇒ Continuous self-improvement from production feedback via cloud or local model adjustments.

Remote Support & Troubleshooting

- ⇒ TeamViewer integration allows offsite monitoring, updates, and troubleshooting.
- ⇒ Real-time AI model adjustments and system recalibration without disrupting production.

Plant-Level Scalability & System Architecture

Deploying multiple PAQi systems across a plant enables centralized defect tracking, data sharing, and predictive maintenance. This approach ensures consistent quality control across multiple production lines, optimizing overall efficiency.

2.1 Key Components

For large-scale manufacturing, PAQi systems are deployed at multiple production stages, integrating with plant-wide automation and quality control systems. Each PAQi unit serves as an independent AI-powered inspection station, but when networked together, they provide a comprehensive, real-time defect detection ecosystem that optimizes production efficiency.

Multiple PAQi Units

- ⇒ Installed at different production stages for line-by-line inspection and verification.
- ⇒ Ensures early defect detection, preventing quality issues from progressing further.
- ⇒ Can be configured with unique AI models per production zone.

Centralized Data Server or SQL Database

- ⇒ Aggregates all inspection data for cross-line defect tracking and reporting.
- ⇒ Enables real-time AI-driven adjustments to production parameters.
- ⇒ Integrates with MES and ERP systems for seamless factory-wide data flow.

Automated Defect Handling

- ⇒ AI-powered rework and reject station integration.
- ⇒ Triggers automated corrective actions, such as sorting and scrap removal.

2.2 Scalability Features

To effectively scale across a facility, PAQi integrates with existing PLCs, MES, and SCADA systems, allowing for seamless communication between inspection stations. AI models deployed plant-wide ensure standardized quality control, while predictive analytics enable proactive maintenance and defect prevention.

Shared AI Model Deployment:

- ⇒ Ensures consistent defect detection across multiple lines.
- ⇒ AI models continuously improve based on plant-wide defect patterns.

Automated Process Optimization:

- ⇒ AI-driven insights help predict and prevent potential manufacturing defects.
- ⇒ Adjusts production line parameters in real-time to minimize waste.

2.3 AI Model Synchronization & Training

AI models need to be uniformly deployed and updated across all PAQi units in a facility to maintain consistency.

QC Hero AI Model Management:

- ⇒ Allows clients to manage their own AI training pipelines while ensuring quality compliance.
- ⇒ Custom AI models can be deployed factory-wide while maintaining centralized oversight.

Automated AI Model Updates:

- ⇒ AI models are pushed plant-wide, ensuring standardized defect recognition.
- ⇒ Factory-wide synchronization eliminates inspection inconsistencies.

Company-Level Scalability & Enterprise Deployment

Scaling PAQi across multiple manufacturing plants enables global AI standardization, enterprise-wide defect tracking, and centralized model deployment.

3.1 Scaling Across Multiple Facilities

Enterprises with multiple manufacturing plants require a standardized AI inspection framework to ensure uniform quality control across all sites. PAQi enables cross-plant AI model deployment, real-time data synchronization, and comparative analytics to enhance operational efficiency at a global scale.

Company-wide AI standardization:

- ⇒ Ensures all facilities operate under unified AI model parameters.
- ⇒ Cross-plant defect tracking for enterprise-wide process improvements.

3.2 White Labeling & Security

White Label AI Pipeline:

- ⇒ QC Hero white label allows corporations to manage and utilize a built-out internal pipeline.
- ⇒ Ensures standardized inspection criteria across all plants.

3.3 Licensing & Software Management

PAQi's licensing framework is designed for flexible, scalable deployment, allowing enterprises to expand their AI-powered inspection capabilities without excessive overhead costs. Licensing options include per-unit, per-plant, or enterprise-wide solutions to align with business needs.

Flexible Licensing Models:

- ⇒ Per-unit licensing for small-scale implementations.
- ⇒ Enterprise-wide licensing for multi-plant deployments.

3.4 Centralized AI Model Management

To ensure consistent performance across all facilities, PAQi utilizes a centralized AI model management system that allows for automated model distribution, remote training, and adaptive learning based on aggregated defect data from multiple plants.

Automated Model Deployment:

- ⇒ AI models are updated across all facilities without manual intervention.

Cross-Plant AI Training:

⇒ AI learns from global defect patterns, improving detection across all plants.

3.5 Enterprise Data Infrastructure & Reporting

Enterprise-wide deployment of PAQi requires a centralized data management system to collect, analyze, and report quality metrics across all facilities. This enables data-driven decision-making, helping corporations improve production efficiency, reduce waste, and optimize AI-powered quality control.

Global Manufacturing Dashboard:

⇒ Provides real-time defect analysis from all plants worldwide.

⇒ Ensures predictive quality control for enterprise-wide efficiency.