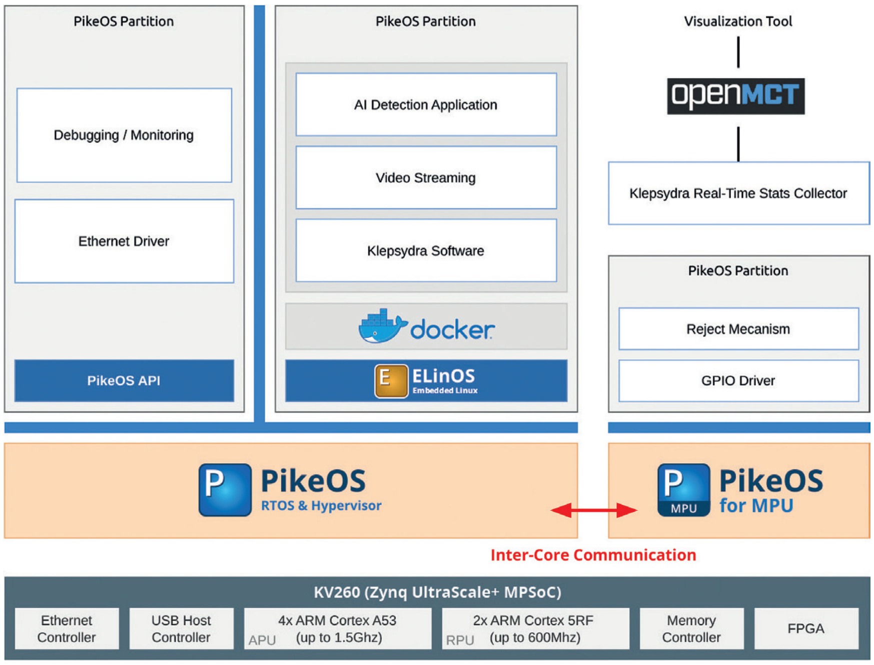
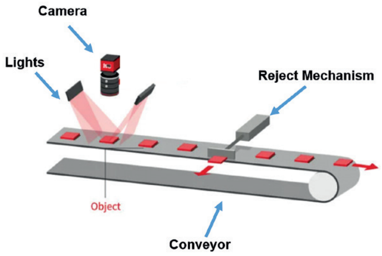
SYSGO
EMBEDDING INNOVATIONS



Industrial Edge Demo

Our industrial virtual quality control demo illustrates the integration of Edge architecture for real-time quality assessment. Utilizing AI-driven image classification in a non-critical partition and a deterministic rejection mechanism in a PikeOS-critical partition, this demonstration showcases secure, mixed-criticality processing for Industrial Automation.



Demo Overview

This demonstrator features a conveyor-based quality control system where an industrial-grade camera captures images of work pieces. The AI model, running in a Docker environment on PikeOS, analyzes these images in real-time. A rejection mechanism in the critical partition is triggered to remove faulty items, ensuring efficient and secure quality control.

Key Features

- Real-time image classification using AI by Klepsydra
- Deterministic rejection mechanism in PikeOS-critical partition
- Edge and Cloud integration for monitoring and scalability
- Screen visualization with live classification and system analytics

Real-Life Industrial Use Cases

Overview

A leading automotive parts manufacturer needed a faster and more accurate way to ensure product quality on a high-speed assembly line. Manual inspection was causing delays and errors, leading to increased costs.

Solution

An AI-powered vision system to automate quality control:

- **Visual Inspection:** Cameras capture images of parts on a conveyor. An AI model running on PikeOS analyzes these images in real-time to detect defects.
- **Real-Time Decision Making:** Based on the AI analysis, parts are classified as “Good” or “Defective”. A rejection mechanism immediately removes defective parts without stopping the line.
- **Data Visualization:** A consolidated dashboard displays real-time metrics, allowing operators to monitor quality and adjust quickly if needed.

Benefits

- **Higher Accuracy:** Reduced human error
- **Improved Efficiency:** Continuous inspection at high speed
- **Cost Reduction:** Minimized waste through early defect detection

Conclusion

This solution showcases how AI and edge computing can transform manufacturing by enhancing speed, accuracy, and efficiency in quality control.

Customer Benefits

- **Improved Quality:** Detects and removes defects in real-time
- **Increased Efficiency:** Keeps production fast without manual checks
- **Cost Savings:** Reduces waste and rework
- **Real-Time Insights:** Live data for better decisions
- **Consistency:** Ensures high-quality products every time
- **Scalability:** Adapts to different production lines

Our Demonstrator Partner

KLEPSYDRA TECHNOLOGIES

About Klepsydra Technologies

Klepsydra Technologies is a leading provider of high-performance data processing and AI software acceleration for onboard and embedded systems. With a commitment to innovation and excellence, Klepsydra team of experts develops cutting-edge AI software for various industries, including space exploration, robotics, automotive, and more..

www.klepsydra.com

More Solution Insights

Detection Algorithm

- The detection algorithm is based on YOLOX with optimizations for seamless operation on Klepsydra.
- This model was chosen due to its reliability, flexibility, and ability to cover multiple use cases efficiently.

Detection Pipeline Overview

Pre-Processing:

- The image is downscaled to improve performance, as processing a full HD image does not provide additional benefits.
- The detection area is cropped to the conveyor belt's position, reducing false positives and enhancing efficiency.

Model Inference:

- Runs inference on the entire image.
- Defines an "activation zone" where the network output translates into servo actions. This zone is configurable to adjust for different activation delays.
- Collects system performance statistics (CPU, memory, latency, etc.).
- Outputs activation signals along with bounding box locations.

Post-Processing:

- Implements Non-Maximum Suppression (NMS) to refine detections, a standard step in YOLOX-based models.
- Reconstructs the video feed by overlaying detection boxes on the video and transmitting it via a web socket.
- Various approaches are being tested for video feed reconstruction.

Core Utilization During Inference

- The model utilizes as many CPU cores as available.
- Currently, inference is limited to two cores, balancing acceptable performance with uncertain CPU requirements for video processing.
- There is an almost linear correlation between the number of cores and model latency.

Optimization for Efficiency

- A proprietary network optimizer (autotuning + SDO) automatically configures operations for target hardware.
- Further optimizations could involve modifying the network itself, but expected gains do not justify the effort due to ongoing work on video encoding.

Input Data and Performance

- Handles any RGB image input.
- Two resolutions are relevant:
  - **Video resolution:** Not critical as long as it meets a minimum threshold (downscaled before processing).
  - **Inference resolution:** Balances accuracy and performance (currently 640x160, downscaled by a factor of 3 and cropped to the conveyor belt).

- Estimated performance:
  - At full utilization (4 cores, no video output), the system could reach 15-20 FPS.
  - The current goal is 2 FPS using 2 cores, with inference taking approximately 150 ms per image.
  - Inference is expected to use ~40% of two cores, leaving room for video encoding.

Real-Time vs. Batch Processing

- The model supports both real-time and batch processing.
- In Klepsydra's context, inference runs in real time (one of the few companies operating on RTEMS).
- The demo's final approach depends on ongoing work related to video output.

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