Solution Brief

Red Hat x intel

Modular AI-Vision Robotic Control at the Edge

Powered by Intel® AI Edge Technologies and Red Hat® Enterprise Linux®

Smarter Robotics at the Edge. Real-time Precision. Flexible Integration.

Authors

Intel
www.intel.com

Dario Russo
Matthias Seidel
Candy Wei
Ralph Wittmann

Red Hat
www.redhat.com

David Rapini
Fabien Dupont

Introduction

In the fast-evolving world of smart industrial automation, achieving scalable, secure, and intelligent automation is a critical advantage. Intel® AI Edge Technologies [1] combined with Red Hat® Enterprise Linux® (RHEL) [2] for Real-Time offer an advanced, adaptable platform for high-precision robotic control. For manufacturing and automation engineers and leaders, system integrators, and edge Artificial Intelligence (AI) developers, the ability to deploy flexible, intelligent robotics is a growing competitive advantage.

The Robot Vision and Control (RVC) demo is based on Robot Operating System 2 (ROS2) and unifies AI-powered perception and precise robotic control at the edge. RVC demonstrates seamless integration of vision, motion, and automation. It showcases the consolidation of multiple workloads with different timing requirements. It is running real-time (RT) as well as non-real-time (Non-RT) applications like RT Control, Human-Machine Interface (HMI), AI inferencing, computer vision, and automation control.

System Architecture and Technologies

Figure 1 presents the system architecture diagram of the RVC Demo. It runs on Intel® Edge Control Nodes and Red Hat® Enterprise Linux® (RHEL) for Real-Time. It uses OpenVINO™ [3] to optimize AI vision workloads across Intel® Central Processing Unit (CPUs), Graphics Processing Unit (GPUs), Neural Processing Units (NPUs).

Key architectural highlights include:
- **Plugin-based vision pipeline:** Easily swap 2D/3D AI models.
- **Hardware abstraction:** Replace robots or Intel® RealSense™ cameras with minimal reconfiguration.
- **Container-ready:** Runs in Docker, and virtual machine environments.

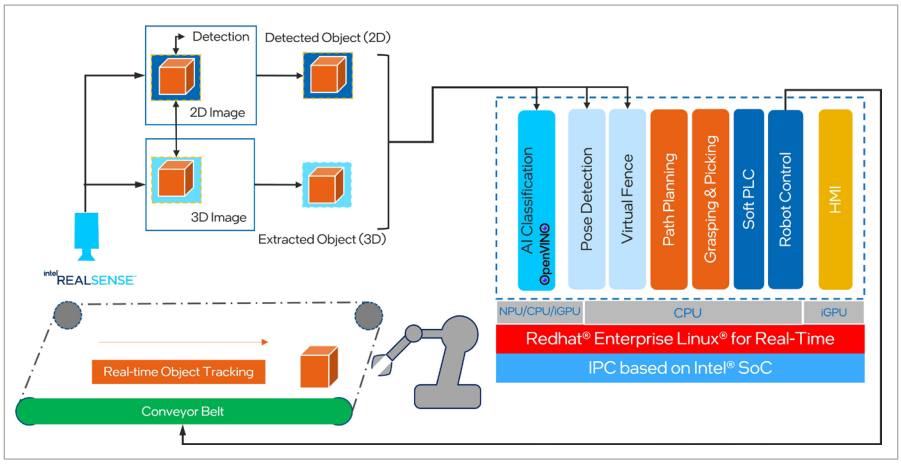

Figure 1. System Architecture Diagram

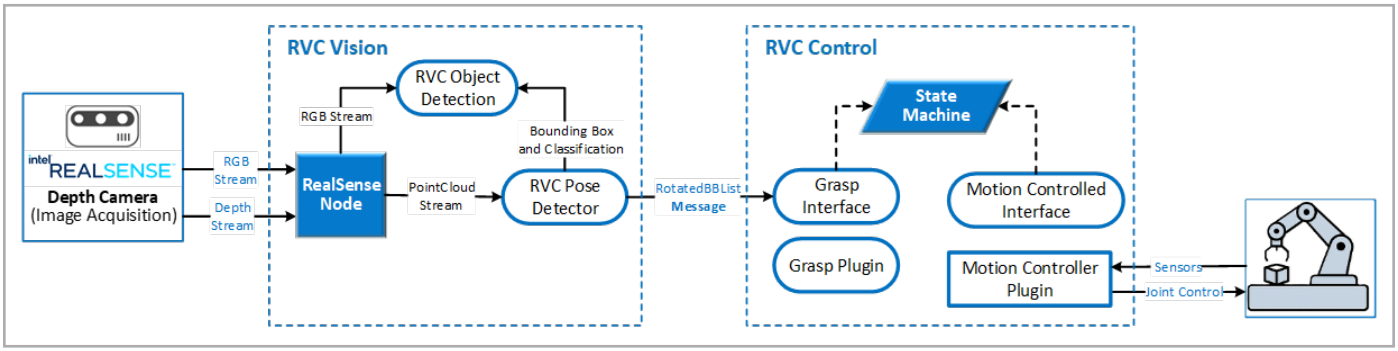

Figure 2. System Block Diagram and Workflow

Intel AI Acceleration: RVC takes full advantage of the various AI capabilities offered by Intel® Edge platforms [1]:

- **Intel® CPUs:** Leverage built-in instruction sets for efficient AI inference on all Intel® Core™ Ultra processors.
- **Intel® GPUs:** Integrated Intel® Arc™ and Xe GPUs deliver parallel AI processing with OpenVINO™ acceleration.
- **Intel® NPUs:** Enable power-efficient, dedicated AI inference — ideal for always-on edge workloads.
- **OpenVINO™ Runtime:** Dynamically distributes inference workloads across CPU, GPU, and NPU for optimal performance, offering seamless scalability, enhanced energy efficiency, and cross-platform deployment flexibility.

System Workflow

As illustrated in Figure 2, RVC features two core subsystems: the RVC Vision and Control subsystems. The system block diagram integrates these components to deliver real-time perception and intelligent robotic actuation—working together to enable dynamic, high-precision automation at the edge.

The RVC Vision subsystem is responsible for accurately detecting and localizing target objects. It continuously tracks moving objects using a deep neural network in 2D space, then estimates their full 6 Degrees of Freedom (6DoF) pose in 3D space through depth-based PointCloud matching.

The RVC Control subsystem uses the pose of the object to determine the optimal path for moving the robot arm toward the target position. It needs to update the robot in a deterministic way to ensure smooth and precise movement of the robot arm.

In parallel with AI vision and robot control, RVC also runs additional workloads such as:

- Software-based programmable logic control (Soft PLC) for managing conveyor belts, laser breaks, and indicator lights.
- Integrated safety logic immediately halts robot operation upon human detection in the work area based on computer vision.

Red Hat® Enterprise Linux® (RHEL) for Real-Time ensures secure, deterministic performance for mission-critical automation and AI workloads.

Conclusion

The RVC demo is a great example of how mixed-criticality workloads—like real-time control, non-real-time and AI workloads—can be consolidated on a single Intel silicon-based edge platform. It is designed to empower manufacturing and automation engineers, system integrators, and edge AI developers to accelerate deployment, adapt more easily, and reduce time-to-market (TTM).

References

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[4] Intel White Paper, Mar. 2025, "Intel® AI Edge Systems Verified Reference Blueprint with Supermicro – Vision AI"

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