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MOTOMAN NEXT
Redefining Adaptive Robotic Automation

The All-In-One Solution for Adaptive Robotic Automation

Content

01

Why do we need Adaptive Robots?

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The Demographic Change hits the European Manufacturing Industry hard.

Staff shortages have many effects such as poor machine utilization, longer delivery times, cancellation of orders, loss of know-how, high exposure risk to crises. And much more.

Shrinking Working Age Population in Europe 2020-2040 (-13% until 2040)

Year = 2020.
Europe = EU27 + UK.
Q: Calculations IGZA (2022) based on Eurostat Data.

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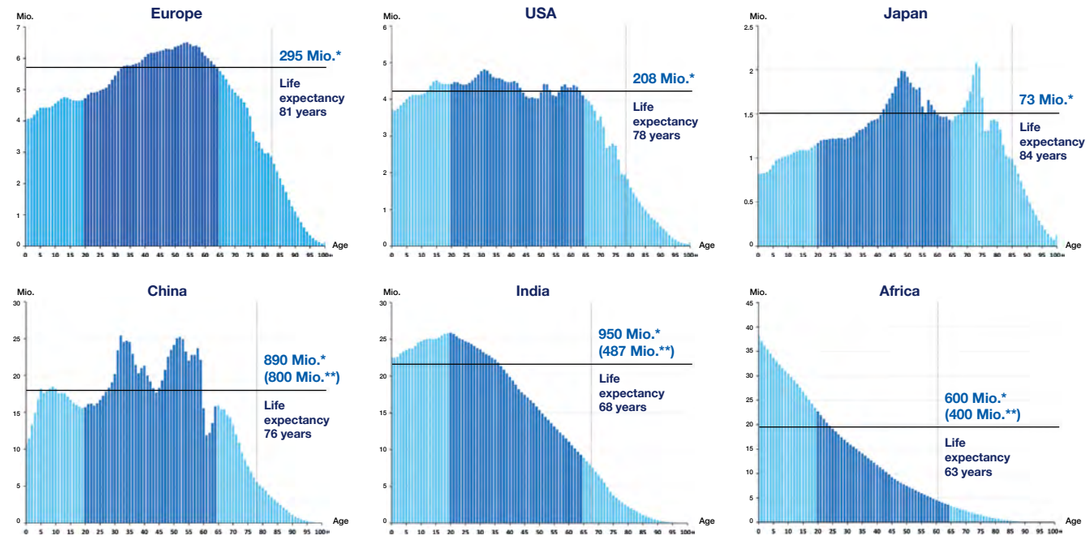
The Big Labour Shortage

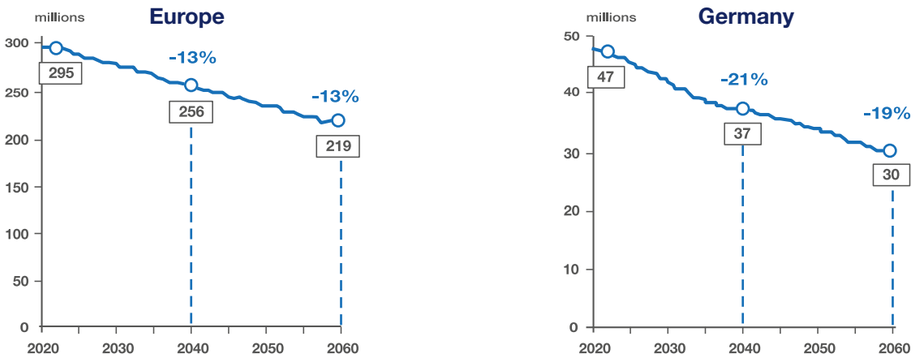
Demographic Age Distribution – Europe and the World



* The number of persons of working age (between 20 and 65)
** The number of employed persons
Year = 2020. Europe = EU27 + UK. Q: Calculations IGZA (2022) based on Eurostat Data.

The European Labour Market 2020 - 2040 - 2060

Working-age population



Year = 2020. Europe = EU27 + UK. Q: Calculations IGZA (2022) based on Eurostat Data.

Yesterday

Growth through new hires.

Today

Growth through automation.

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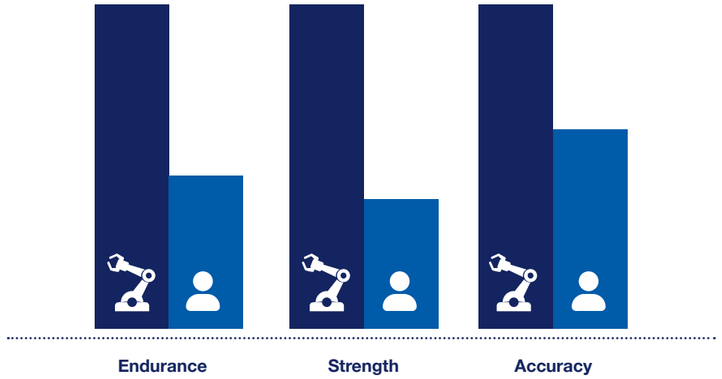
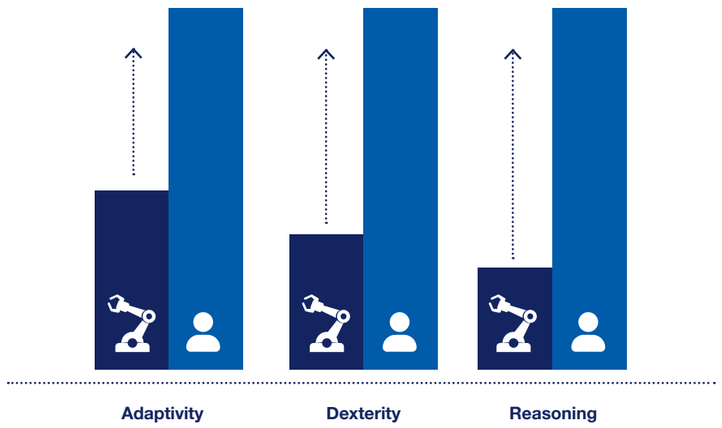
How can Robots help?

Skills covered by traditional robots



Skills covered by Artificial Intelligence (AI)



So many Jobs out there - waiting to be automated!

Loading/Unloading Machines

Assembly

Cleaning

Sorting

Deburring, Machining

Sand Blasting, Rack Loading

Construction

Gastronomy

Cultivation, Harvesting

Painting

Packaging, Loading (Wood & Furniture)

Welding

Cleaning, Sterilizing, Kitting

Waste Sorting

All of them require hand-/eye-coordination, dexterity and versatility of humans.

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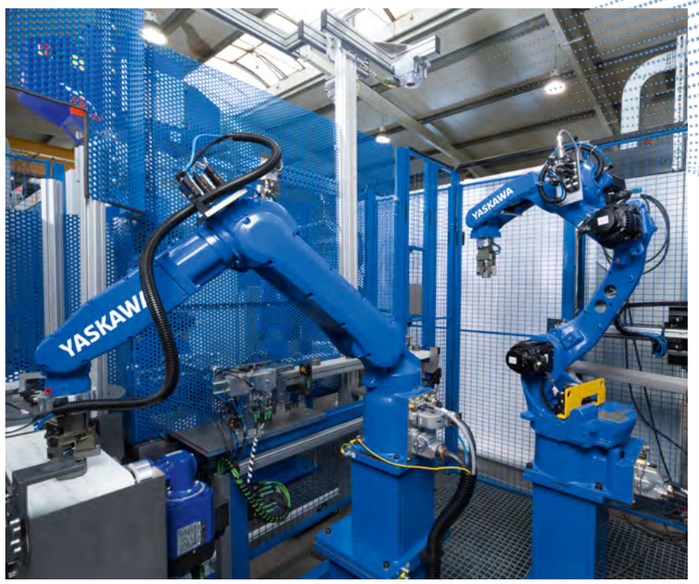
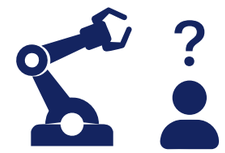
AI-driven Robotics: A New Era



Without AI

Predictable, engineered Workflows



Robot Jobs

With AI

Adapt and execute tasks autonomously

Robot Skills

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Expanding into new Areas of Robotic Automation

Mass Production ⟷ **Variable Volume**

Applications & Markets

Industrial Robots

Established Markets:
Metal, Automotive, White Goods, Food & Bev, Wood & Furniture, Electronics, Plastics, Printing, Medical, Packaging, Machinery

Collaborative Robots

New Markets:
Life Sciences, Construction, Textile, Hospitals, Logistics, Harvesting, Cleaning, Sorting, Restaurants, Remanufacturing ….

Ease of use
Low code / No code

Complex tasks
New white spots of automation

Predictable variety

Unpredictable variety

MOTOMAN YRC1000

MOTOMAN NEXT
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Low Mix ⟷ **High Mix**

Pre-coded

- Teached positions
- Jobs based on instruction code
- Communication by I/O signals

- Tasks based on (intelligent) skills
- Environment perception & AI
- Communication by data

Adaptive

Technology

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…to boost your production

MOTOMAN NEXT is a **new technology platform**, opening the stage of robotic automation, leveraging **Machine Learning** and **Artificial Intelligence**, for more **intelligent and adaptive robot solutions.**

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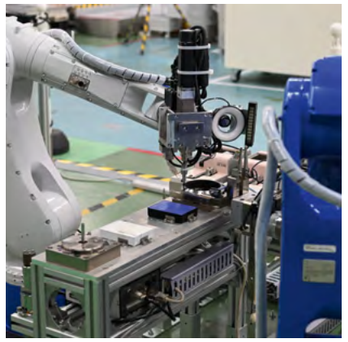
… for Robot Operators



MOTOMAN NEXT enables Robot Operators to run adaptive applications with reduced involvement of robot programmers.

… for System Integrators

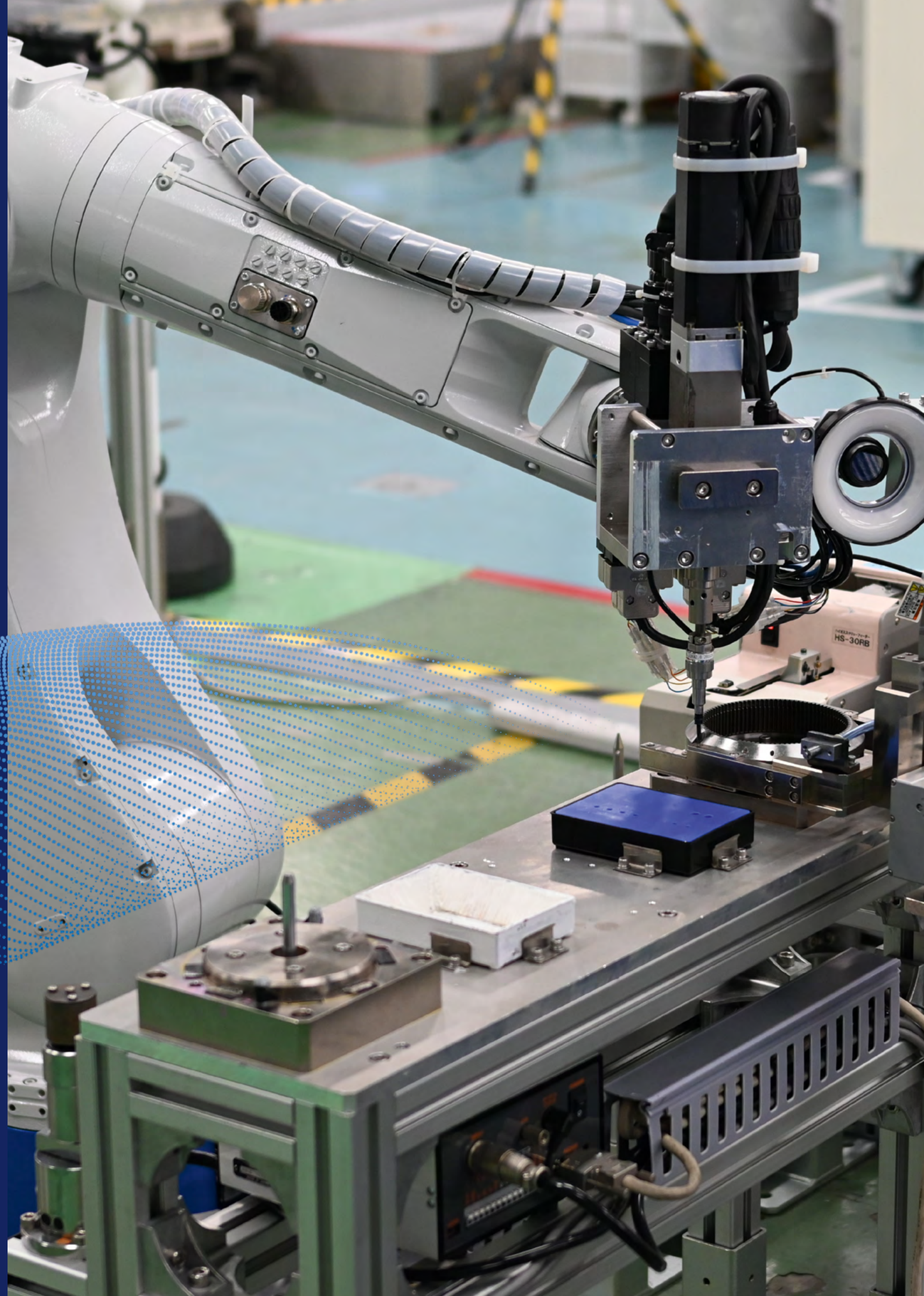
MOTOMAN NEXT enables System Integrators to deploy AI-based robot applications smoothly.

… for Software Developers

MOTOMAN NEXT takes PC Software Developers to the level of Expert Robot Programmers.

02

Concepts Behind MOTOMAN NEXT



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OT (Operational Technology)

Basic Functionality: Perfect integration of robots into automated production lines. Motion Control and Machine Safety.

Communication based on I/O Signals, Pulses, Flags.

Controlled by PLC technology

IT (Information Technology)

Advanced Functionality: HMI/Visualisation, SW Wizards, Offline Simulation, Digital Twin, Condition Monitoring, Machine Vision & AI, ROS

Communication based on Data.

Controlled by PC technology

OT

IT

MOTOMAN NEXT closes the gap between OT & IT

MOTOMAN NEXT – Platform Overview

NEXT MANIPULATORS

NEX4 .. NEX35 – Industrial Handling Manipulators 4-35kg payload

- Σ10 Servo Technology
- Absolute Position Accuracy (zero gap©)
- Lightweight Design
- Improved Responsiveness

NHC Premium Cobots 12 & 30kg payload

- Force Sensors in every joint
- Smooth Hand Guiding
- Built-in RGB-D Body Camera
- Integrated Media Cables

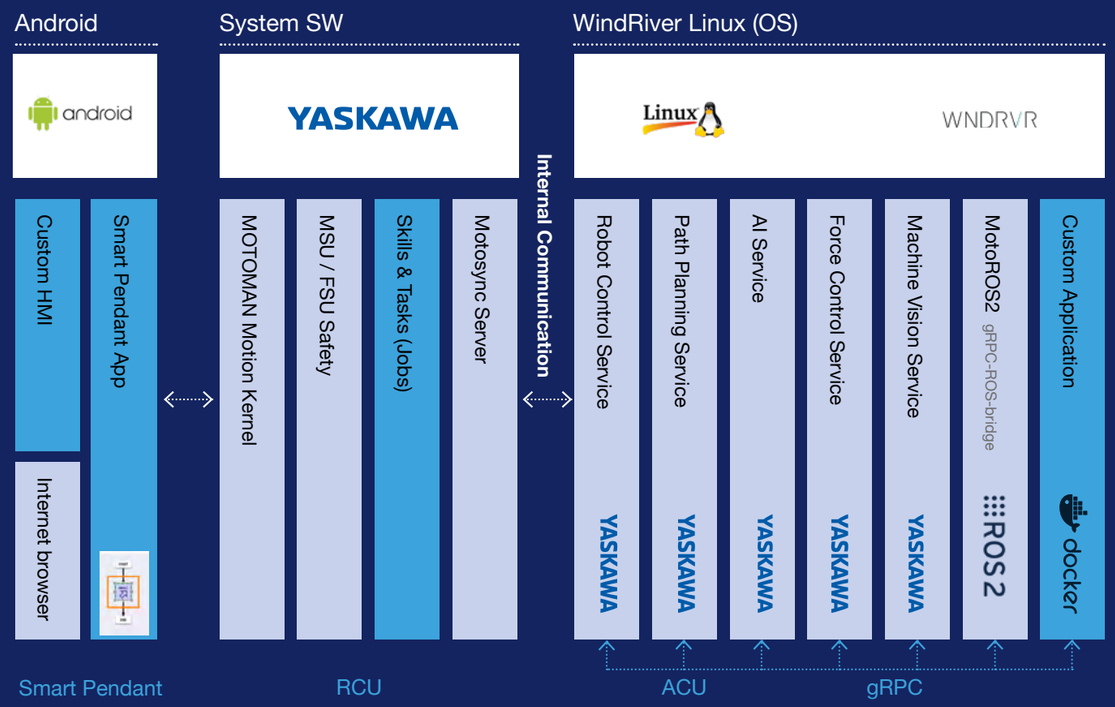
YNX1000 CONTROLLER HARDWARE

- Robot Controller (RCU)
- Autonomous Controller (ACU) (High Performance CPU & GPU
- Modular HW Design

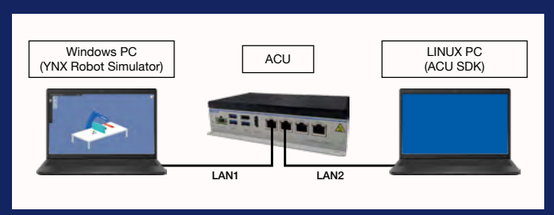
YNX SMART PENDANT

- Android Tablet
- SmartFrame© Teaching
- Web browser UIs

NEXT READY-TO-USE SOFTWARE SERVICES & APIs



YNX ACU DEV KIT



Robot Application Development Starter Package incl. ACU, Pre-configured, incl. Services & Engineering Tools, Docu

ENGINEERING TOOLS & DIGITAL TWIN

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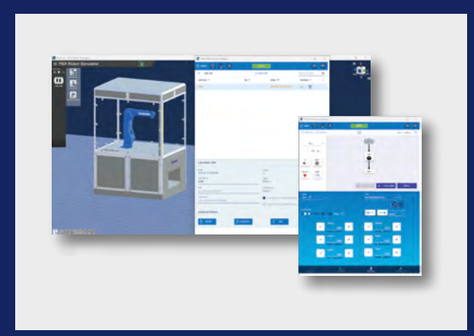
YNX Simulator

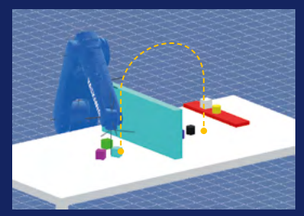
NVIDIA.

NVIDIA Isaac Sim™

NEXT USER INTERFACE & SKILLS



- Easy Composition of Workflows using Skills
- Task oriented, icon-based Block Language



MOVAUTO Skill (Collision Free Automatic Path Planning)

Item Pick Skill (AI Vision)

Four Reasons why MOTOMAN NEXT is smart

01

System Integrators:

Safe and smart entry into the fascinating world of adaptive Robots and AI.

02

Software Developers:

Standard Linux Docker Compose on professional NVIDIA® hardware for maximum freedom of code.

Pre-installed Services to cover all robot-related motion/ vision/ sensor/ AI functionality.

Professional Digital Twin Engineering Tools are included in the package without reoccuring license cost.

03

End Customers:

Can realize new robotic automation use cases solving their labour shortage trouble and cutting their costs.

04

Professional Robotic AI Application Deployment

with the backbone of Yaskawa - a worldwide leading supplier of robot, drive, automation and software technology.

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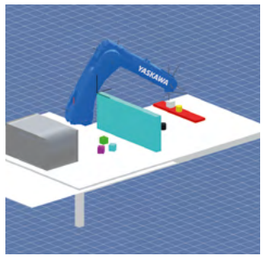
The NEXT Way to Program Adaptive Robots

Users – Instructing the Robot simply WHAT to Do

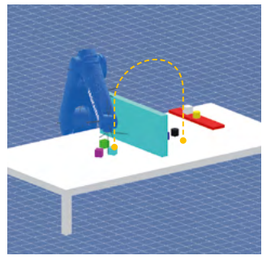
What

Workflow & Icons

Hand Guiding



Pick and place the (unknown) part

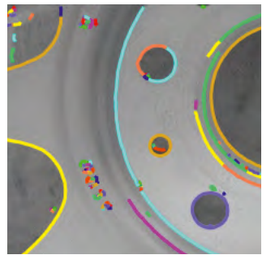


Move from A-B (avoiding collision)

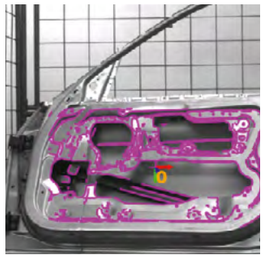
Programmers – Coding Skills defining HOW to Do

How

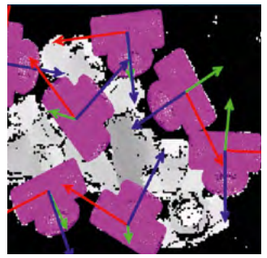
Vision & CAD



Part Recognition



Powerful Code Modules



Vision/AI - Point Cloud

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Use Case Partner Collaboration Approach

Stakeholder Team

Yaskawa	Tech Partner	System Integrator	End Consumer
(providing NEXT Technology Platform)	(providing Technology/ Sensor/Software Know-how)	(integration, commisioning, sales, support capability)	(providing market & application expertise)

Phase 1 — Use Case Definition

- Solving one real problem (labour shortage, cost-down)
- Innovative Application (Smart Solution or White Field) with high automation and sales potential
- Challenging use case requiring „intelligent“ robots
- (Vision/Sensor/AI) to cover complex applications or No-Code (Autonomous)

Phase 2 — Pilot Development

- Involving all stakeholders
- Specifications
- Prototype
- Proof of Concept

Phase 3 — Use Case Definition

- Generalizing the use case and deriving a skill or service
- Encapsulating Skills/Services
- Define Product Package and ownership
- Productification, Ready-to sell

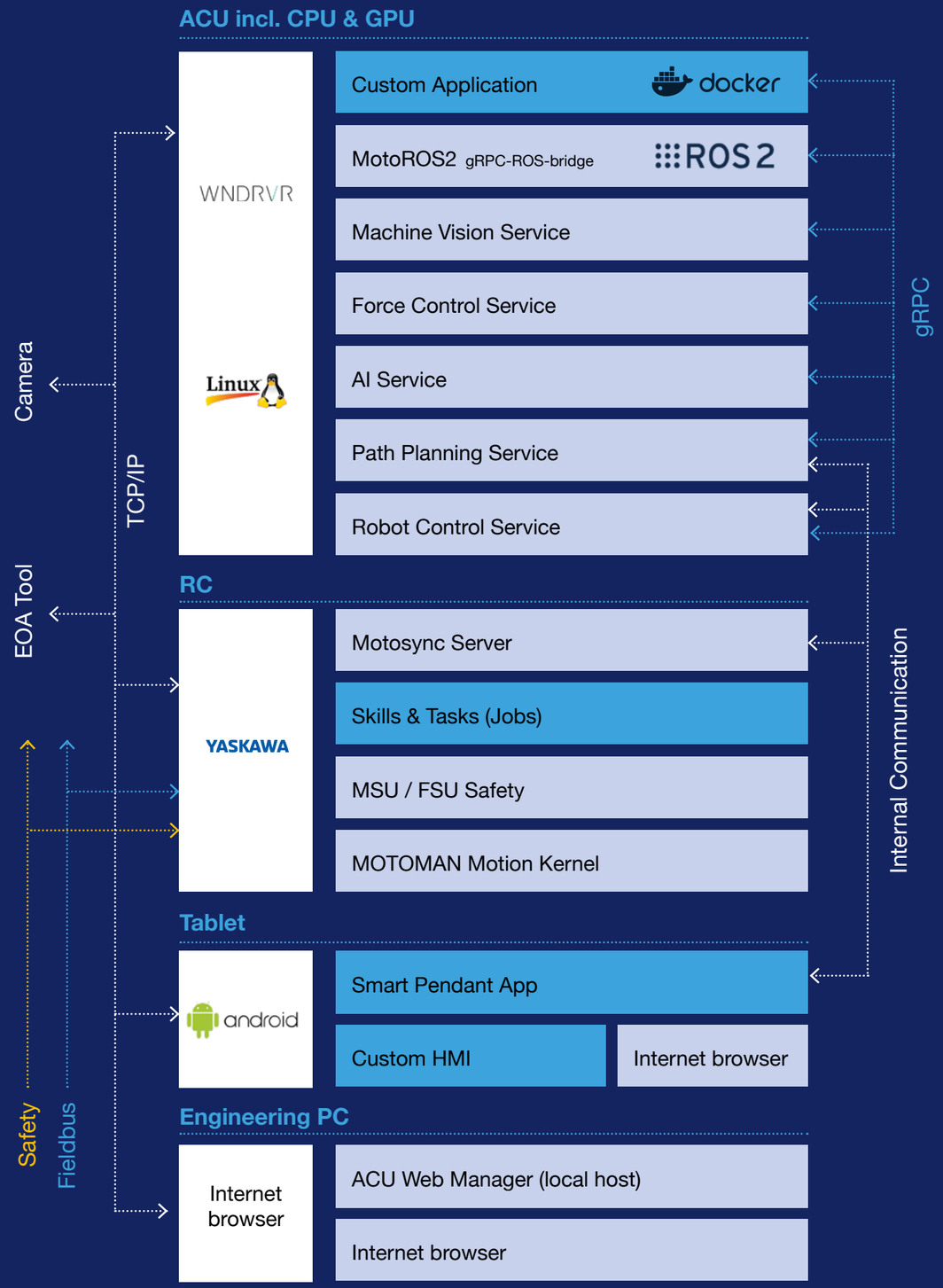
Phase 4 — Use Case Definition

- Sales Channel definition (Roles and product responsibilities of each partner)
- Business model to scale up (Mass deployment) sales growth by occupying a high volume market segment

03

MOTOMAN NEXT Technology Deep Dive

The Architecture



Path Planning Service real-time generation of motion trajectories for MOTOMAN Robots, automatically avoiding collision with obstacles, corresponding 1:1 to the real robot's motion, incl. behavior on singularities, re-orientations, trajectory overlapping at different speed and position levels.

Robot Control Service – access to OT functions, controller status, variables, registers, files, torque and position values, monitor positions and trigger motion.

Machine Vision Service 2D/3D image processing capabilities and workflows, camera calibration, including HALCON library and visual programming tool.

Force Control Service guiding and correcting the TCP of a robot based on manipulator-internal and external force information, pushing and following geometries with constant force (e.g. polishing), servo-float sensitive precision assembly.

AI Service Runtime for Alliom© core functions of AI picking, AI inspection and processing.

MotoROS2 Supports the ROS2 framework, including a gRPC bridge to include NEXT services into ROS applications.

gRPC (Google Remote Procedure Calls) widely used universal communication protocol, open-source, low latency & bidirectional streaming, supports multiple programming languages, universal remote procedure call framework. Easy to setup (no need to set up ICP/IP or UDP socket).

One Controller for All.

MOTOMAN NEXT resolves the OT/IT hardware gap and brings a powerful Edge device NVIDIA® Jetson Orin™ NX module into the robot controller, adding GPU & CPU Power for AI applications like and autonomous Path Planning and AI Machine Vision.

YNX1000

RCU

ACU

NVIDIA

ACU UNIT WITH NVIDIA® Jetson Orin™ NX

CPU: 8-core Arm Cortex-A78AE v8.2 64-bit (2MB L2 + 4MB L3)
GPU: 1024-core NVIDIA Ampere architecture, 32 Tensor Cores
AI Performance: Sparse: 100 INT8 TOPS (for AI Inference),
Dense: 50 INT8 TOPS (for AI training)
Memory: 16 GB 128-bit LPDDR5 DRAM
Storage: 256 GB NVMe SSD, 100 GB available for application

Path Planning System

The Path Planning Service can be called by a user application docker, or the MOVAUTO skill from a block language icon. It provides motion trajectories, automatically avoiding collision with obstacles. The collision model incorporates all geometries incl. robot arm, end-of-arm-tool and any object in the workcell. Further obstacle shapes and geometries can be uploaded via CAD data, or perceived as a point cloud by a 3D camera.

Benefits

- **EASY:** Simplifies robot programming dramatically. You just tell the robot to move from A to B – and don't worry about deeper and tricky robot-specific programming know-how
- **SPEED:** In many cases, the MOVAUTO statement provides better cycle times than classical MOVJ sequences with waypoints.
- **COST:** System Integrators can really save days and weeks of tricky commissioning and robot trajectory tuning in projects.

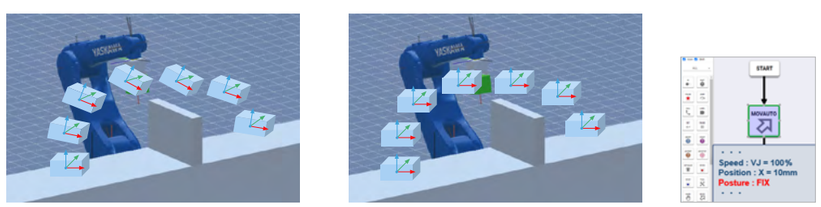
Environment Recognition using a 3D camera

Recognize the environment by vision sensor

Update environment models in Path Planning service

Generate paths avoid obstacles.

"Tool posture" parameter to define the tool orientation during robot motion



The posture of the tool is not fixed

The posture of the tool is fixed

Force Control Service

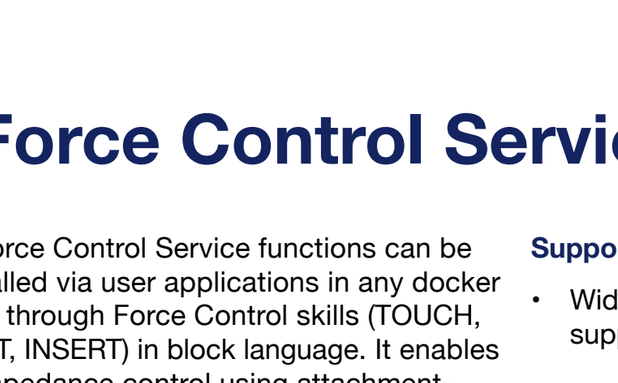
Force Control Service functions can be called via user applications in any docker or through Force Control skills (TOUCH, FIT, INSERT) in block language. It enables impedance control using attachment-type force sensors or built-in torque sensors to monitor and adjust robot actions. The service supports force sensors which are attached to the robot flange, and built-in joint sensors of MOTOMAN NHC Series cobots.

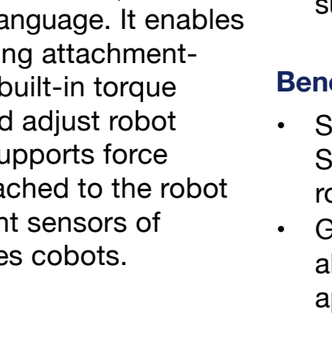
Supported Sensors

- Wide range of Sensor Products supported (e.g. ATI)

Benefits

- Sensitive Assembly (Servo-float, SCARA Selective compliance assembly robot arm) with tight tolerances
- Grinding/Polishing – moving along a geometry with defined application force





- Motor-Current (Servofloat)
- Force Sensor
- Built-In Torque Sensors

Machine Vision Service

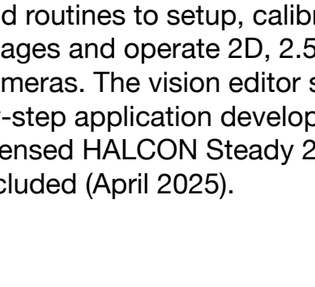
The Machine Vision Service Provides tools and routines to setup, calibrate, capture images and operate 2D, 2.5D or 3D cameras. The vision editor supports step-by-step application development. A fully licensed HALCON Steady 20.11 library is included (April 2025).

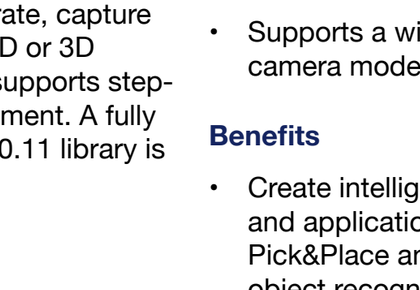
Supported Cameras

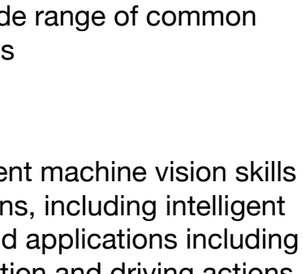
- Supports a wide range of common camera models

Benefits

- Create intelligent machine vision skills and applications, including intelligent Pick&Place and applications including object recognition and driving actions on the result.
- Realize adaptive assembly, handling, packaging, finishing applications.

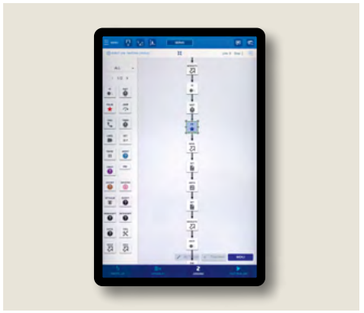






Smart Pendant (Tablet)

YNX Smart Pendant



- Tablet with Android OS – an intuitive way to operate a robot.
- Emergency Stop Button, Operation mode switches and 3-position Dead-Man-Switch (Safety DIN-ISO 13850, 10218-1 and DIN-EN 60204)

SmartFrame Teach-In

In order to teach positions to the robot, users can jog a manipulator to a target pose and then save the position, without deep knowledge of cartesian coordinates. MOTOMAN NEXT Smart Pendant Tablet makes use of the built-in gyro sensor, supporting inclination and relative position of the tablet towards the manipulator.

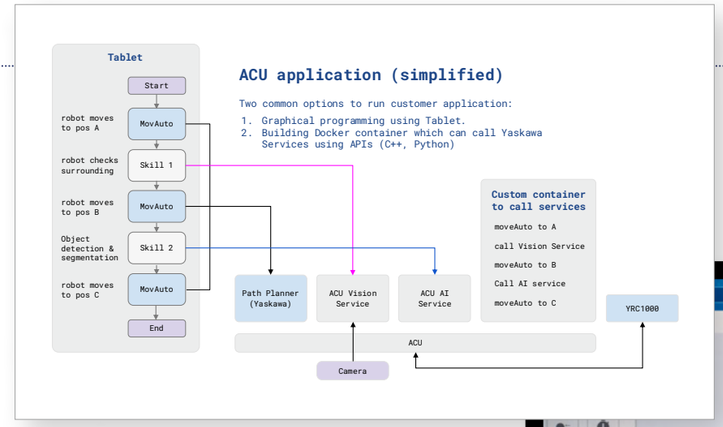
User Interfaces

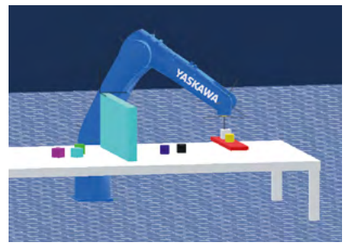
The modern and intuitive way of today is using a tablet. Operating an Android-based Tablet is not a challenge for users today. Web Browsers or apps are commonly used as a control interface for all kind of equipment provide excellent possibilities to design user specific HMIs.

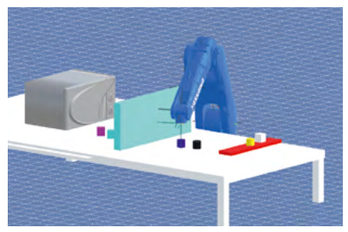
Workflows with Blocks and Skills

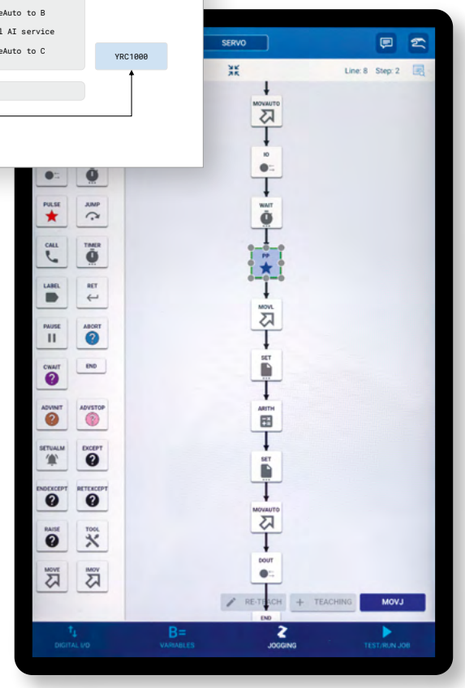
A block programming language is intuitively understandable for many persons. Workflows are created by dragging and dropping blocks into sequences or loops.

Behind every block there can be a motion, logic or actuator statement. Something what the robot can do – a skill. A tap on an instruction icon opens the detailed settings dialog box for details and parameters. Some skills are simplistic (e.g. move linear), some can be more complex requiring path planning functionality (move from A to B by avoiding an obstacle). Some skills may look simple, but the execution requires complex CPU/GPU calculation logic or even AI neural networks behind (e.g. open a bottle, pick a part out of a pin). Blocks are perfect for modular code (skills).









NEX Series Robot Manipulators

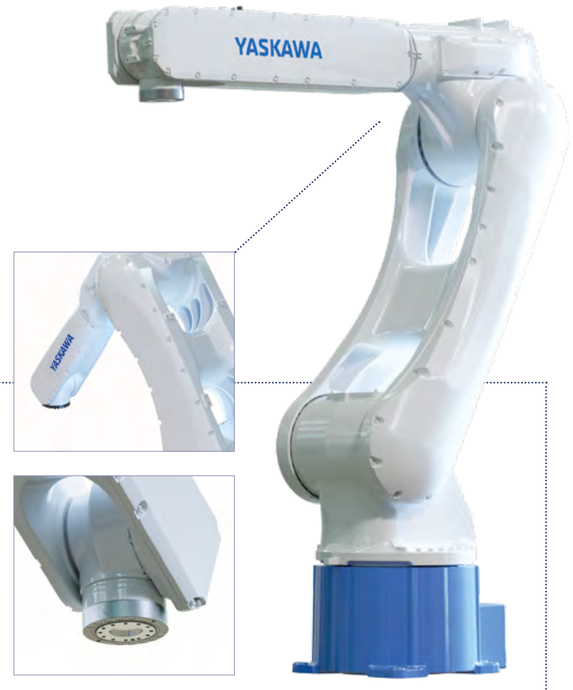
Manipulators which are particularly designed for intelligent applications, featuring:

Loss Reduction – realized by new low speed/high torque servo motors (Σ10). Motor optimized inertia and gear reduction ratio. Original Yaskawa Grease excluding ambiguity in lubrication status. High speed encoder signal processing for agile motion with short control loops.

Absolute Accuracy (Precision of Positioning the end effector at specific points relative to a coordinate system) – mandatory to align precision of control system and algorithms between virtual and real world, as well as for calibration of vision systems.

Lightweight Design – stiff and compact design, low vibration, noise reduction, aluminium casted housings.

Built-in media cables – incl. Ethernet Cat6 line. No undefined dress packs.



Model	NEX4	NEX7	NEX10	NEX20	NEX35
Payload (wrist)	4 kg	7 kg	10 kg	20 kg	35 kg
Reach	550 mm	927 mm	1100 mm	1550 mm	2060 mm
Mass	30 kg	48 kg	58 kg	250 kg	380 kg
Repeatability	< 0,01 mm	< 0,016 mm	< 0,015 mm	< 0,02 mm	< 0,03 mm
Power Supply	230V/1-phase	230V/1-phase	230V/1-phase	230V/1-phase	400V/3-phase

NHC Series Cobot Manipulators

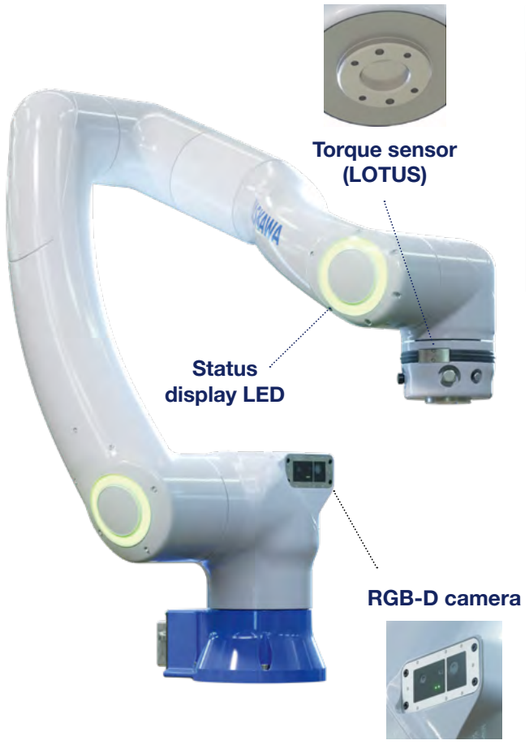
Manipulators for Human-Robot-Collaboration, particularly designed for intelligent applications, featuring:

Smooth Hand Guiding – realized by new Lotus-type torque sensors in all axes.

Absolute Accuracy (Precision of Positioning the end effector at specific points relative to a coordinate system) – mandatory to align precision of control system and algorithms between virtual and real world, as well as for calibration of vision systems.

Built-in media cables – keep a defined geometry same as digital twin

Built-in RGB-D Body Camera – 2D camera including depth information, at the robot base (S-axis), can be used to monitor the work area in front of the robot, identify workpieces, react live on events or obstacles or simply for inspection purposes.



Model	NHC12	NHC30
Payload (wrist)	12 kg	30 kg
Reach	1250 mm	1900 mm
Mass	46 kg	t.b.d.
Repeatability	< 0,05 mm	< 0,05 mm
Power Supply	230V/1-phase	230V/1-phase

YNX Robot Simulator – Engineering Tool

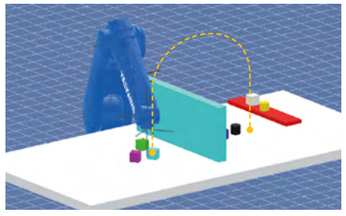
YNX Simulator is a comprehensive Engineering Tool to develop Robot applications in a Digital Twin Environment, including Offline Simulation and Offline Robot Programming (OLP). It provides extended features like simulated camera views, and supports automatic live path planning in combination with the ACU.

01

Virtual Camera view of a part on a conveyor

02

Live Automatic Path Planning with collision avoidance

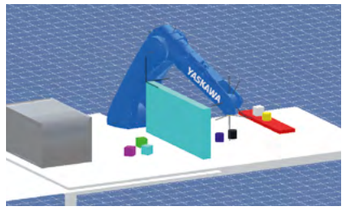


03

Jogging the virtual robot

04

Simulation of Picking objects with variable geometry



05

Gripper Parameter Setup

06

I/O and Error simulation

Sim2Real (NVIDIA Isaac Sim™)

Simulation to Reality and Robotics

- transfers knowledge and skills learned in a simulated environment to real-world applications.
- useful to train robots and AI systems because it allows extensive testing and learning in a controlled, risk-free, not time-critical environment before deploying the systems in the real world.

For Sim2Real we need software environments which are capable to deal with physical phenomena like gravity, friction, surface structures, inertia and lighting.

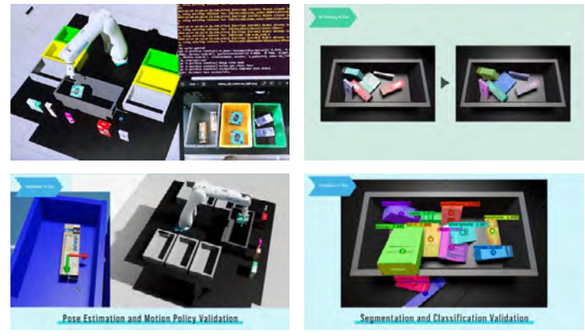
Such software tools (here: **NVIDIA Isaac Sim™**) have originally been developed for the gaming industry, and are now transferred to simulate robot motion and robotic workcells. To be as close as possible to reality, they include a pathplanner (cuMotion/cuRobo) or integrate 3rd party path planners (e.g. NEXT Path Planning Service, MoveIt). Yaskawa provides an embedded kinematic model and a Virtual Robot Controller (VRC) of robots, to realize an exact 1:1 virtual twin of the MOTOMAN robot and it's path and motion.

Training of Neutral Networks

In the robotics world, Sim2Real technology is a method to train neural networks automatically. A good example is to let robot arms grasp random parts from randomly filled bins.

The hard way is to train the robot on real scenes, where you manually fill the bin over and over again by hand, and take hundreds of pictures of different scenes until you have a critical mass of training data. This heavy training effort of neural networks can easily kill amortization when you have large quantities of products to be picked.

The smart Sim2Real way is to let the system randomly generate scenes virtually and let the machine train itself, using available 3D data of the products, or data sets which themselves have been automatically generated by another AI (e.g. randomly generated defects).



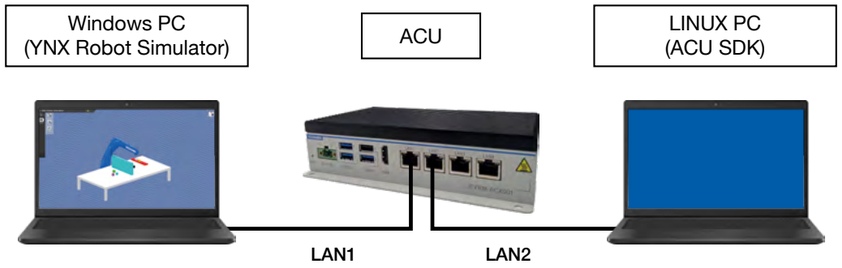
ACU Development Kit

Application Development

With the ACU Development Kit, Technology partners can start to develop their applications today, even before having a robot manipulator available.

The YNX Simulator Engineering Tool, which is included in the ACU Dev Kit package, provides everything required to develop complex AI based software, deploy and run dockers on real hardware.

The NX Simulator supports specialities of the Yaskawa services as well, e.g. the MOVAUTO statement (Path Planner, collision-free motion) or virtual cameras (Vision Service).



The ACU Development Kit includes:

- a complete ACU hardware unit (NVIDIA® Jetson Orin™ NX inside and interfaces), pre-installed Windriver OS (licensed), pre-configured by Yaskawa, ready-to-use.
- licenses of Yaskawa Path Planning, Robot Control & Vision Services
- the YNX Robot Simulator Engineering and Simulation Software and License

What's your NEXT case?

Waste Sorting

Cleaning of Medical Instruments

Robot gripping unknown Bottle Portfolio

Automatic Cabinet Wiring & Inspection

Cultivation and Harvesting

Food Picking

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