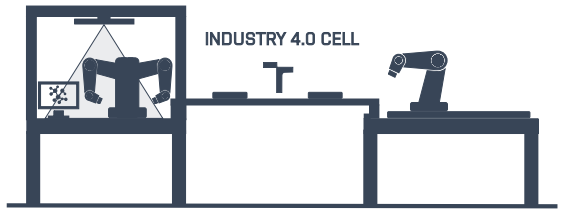
INSTITUTE OF AUTOMATION AND COMPUTER SCIENCE

Industry 4.0 Cell (I4C): A Brief Overview

Roman Parak

NETME Centre



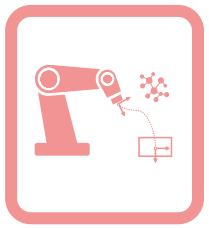
FACULTY institute
OF MECHANICAL of automation
ENGINEERING and computer science

Brno, 2023

Content

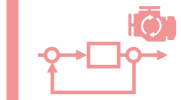
IACS

Institute of Automation and Computer Science

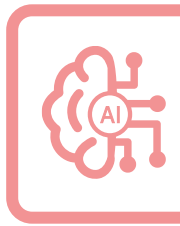


Cybernetics and Robotics Division (NETME Centre)

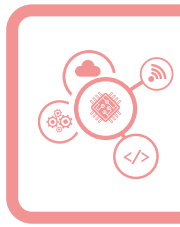
Dept. of Automation



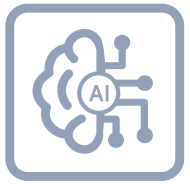
Dept. of Applied Computer Science



Dept. of Computer Networks



Research Activities



Artificial Intelligence
Machine Learning

Advanced Robotics
Industry 4.0

Computer Vision
Image Processing

Augmented / Virtual
Reality

Optimization
Logistics

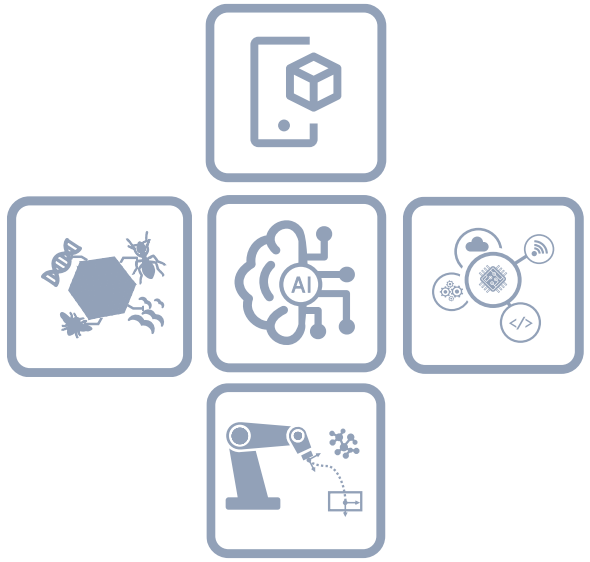
Cloud Computing and
Cybersecurity

Educational Activities

The Institute of Automation and Computer Science provides fundamental university information technology, automation and regulation courses obligatory for students of all specialisations. The Institute also organizes and provides a three-year **Bachelor's degree** and a two-year **Master's degree** in **Applied Computer Science and Automation**.

The Institute also educates **Ph.D.** students in the fields of **Technical Cybernetics**, **Design** and **Process Engineering**, **Engineering Mechanics**, and **Mathematical Engineering**.

Our students are more than versatile soldiers who study in three areas of education: **mechanical engineering**, **electrical engineering** and **computer science**.



Partners & References

Industry 4.0 Cell

Organizational Structure

Assoc. Prof. Radomil Matousek, PhD.
Director of Department, Head of Laboratory

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matousek@fme.vutbr.cz

MSc. Roman Parak
Head of Research and Development (R&D)

Contact:
Roman.Parak@vutbr.cz

Assoc. Prof. Branislav Lacko, PhD.
Industry 4.0 Consultant

Contact:
lacko@fme.vutbr.cz

Assistant Professor, Assoc. Prof. & Prof.:

≈ 5

Students (PhD., MSc. & BSc.):

≈ 20

Roadmap: Design & Construction of a Robotic Cell

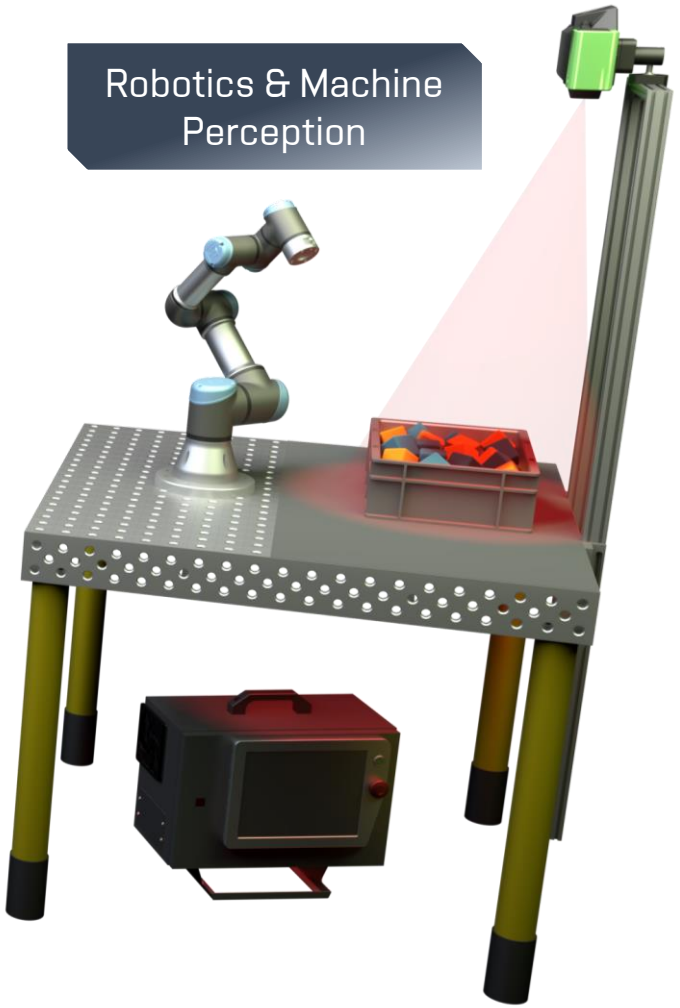
2019 → 2020 → 2021 → 2022

Industry 4.0 Cell (I4C) at the IACS

Advanced Robotics in Healthcare

Versatile Intelligent Robotics

Mobile Robotics

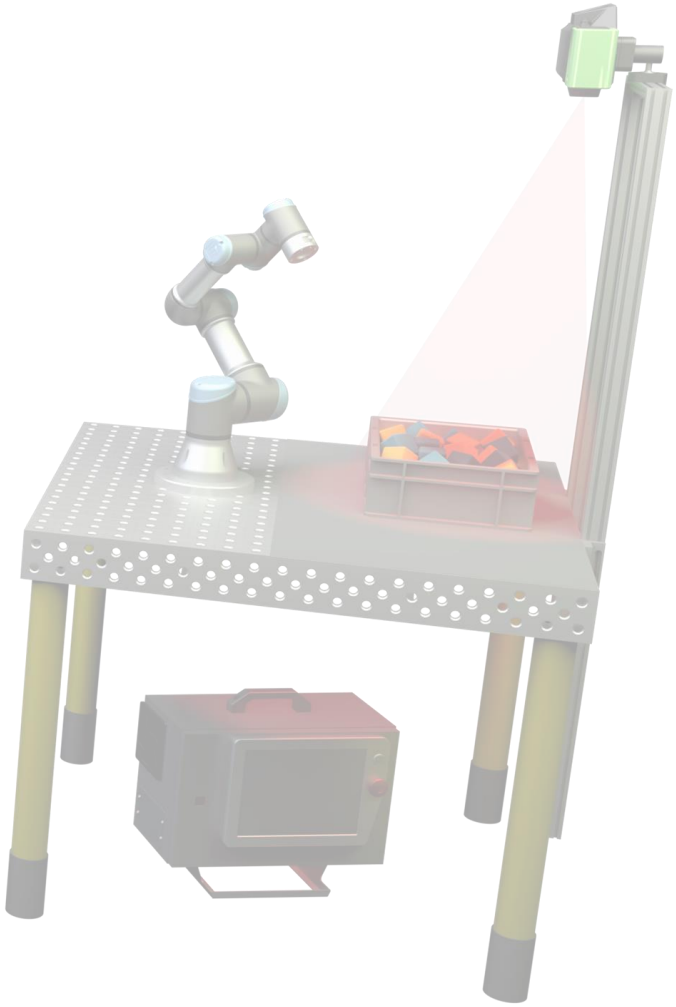


Robotics & Machine Perception

Industry 4.0 Cell (I4C) at the IACS

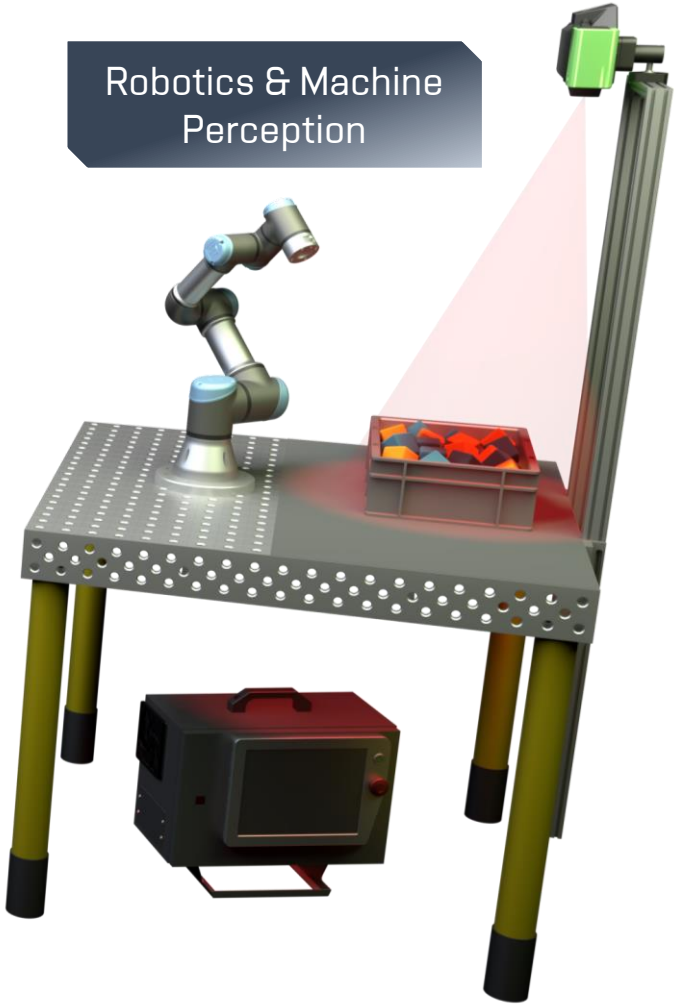
Industry 4.0 Cell (I4C) at the IACS

Advanced Robotics in Healthcare



Industry 4.0 Cell (I4C) at the IACS

Robotics & Machine Perception



Industry 4.0 Cell (I4C) at the IACS

Mobile Robotics

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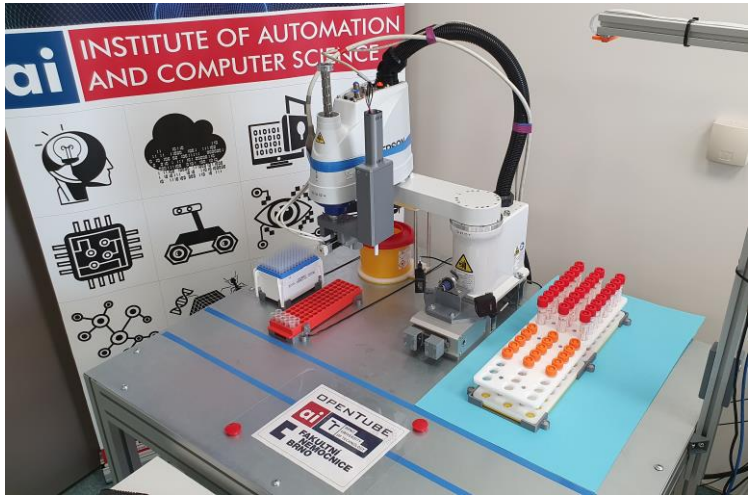


Educational Activities

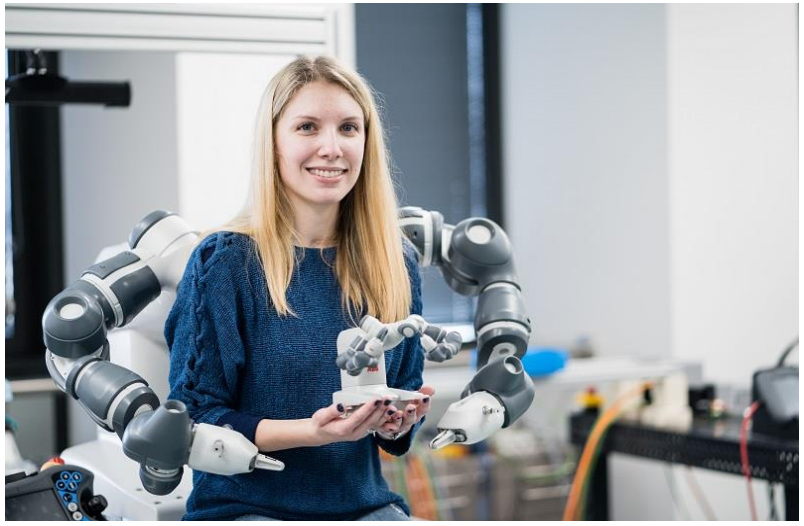
Main Activities

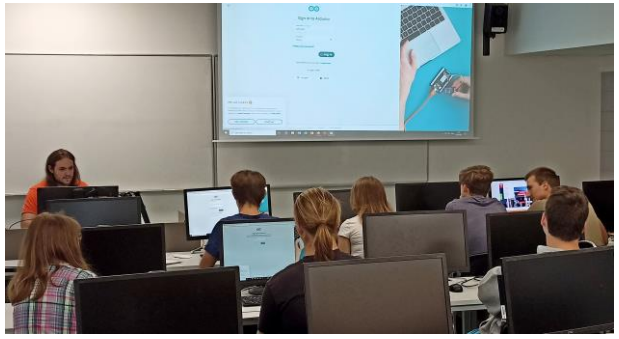
- Lectured courses (Programmable Logic Controllers, Machine Vision, Industry 4.0, AI Algorithms, Neural Networks and Evolution Methods, Programming for robots and manipulators, etc.)
- Doctoral and Bachelor's / Master's theses

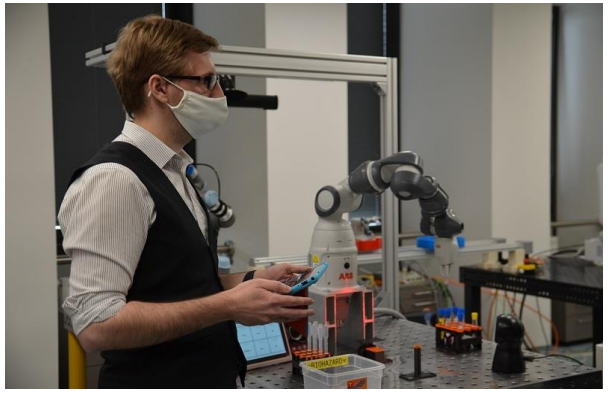
Other Activities

- Workshops, Open Days, Robotics promotion (Science enjoys us, Night of Scientists, Summer University for secondary school students), Robotics Conferences, International Engineering Fair, etc.
- Brno University of Technology helps with COVID-19

Educational Activities







The main technologies used to teach Robotics and Artificial Intelligence

Programming Languages

C# C++ C · PLCopen logic ST LD IL SFC FBD IEC 61131-3 · Python · julia · MATLAB & SIMULINK · LabVIEW

Tools & Technologies

ROS industrial · ABB · AUTODESK · TensorFlow · OpenAI · PYTORCH · OPEN3D · pcl · unity · OpenCV · blender · vuforia · CoppeliaSim from the creators of V-REP

Research Activities

Main Activities

- Advanced System Integration, Artificial Intelligence Techniques (ML, DL, etc.), Trajectory optimization / Motion planning, Kinematics, Data Analysis and Processing
- Visual Inspection, Structured / Random Bin – Picking, Human – Machine Collaboration
- Virtual / Digital Twin (Simulation), Human-Machine Interface, Functional Safety

Other Activities

- Virtual / Augmented Reality
- 5G networks, IoT (Internet Of Things), Cybersecurity

Research Activities

Main Activities

- **Advanced System Integration**, Artificial Intelligence Techniques (ML, DL, etc.), Trajectory optimization / Motion planning, Kinematics, Data Analysis and Processing
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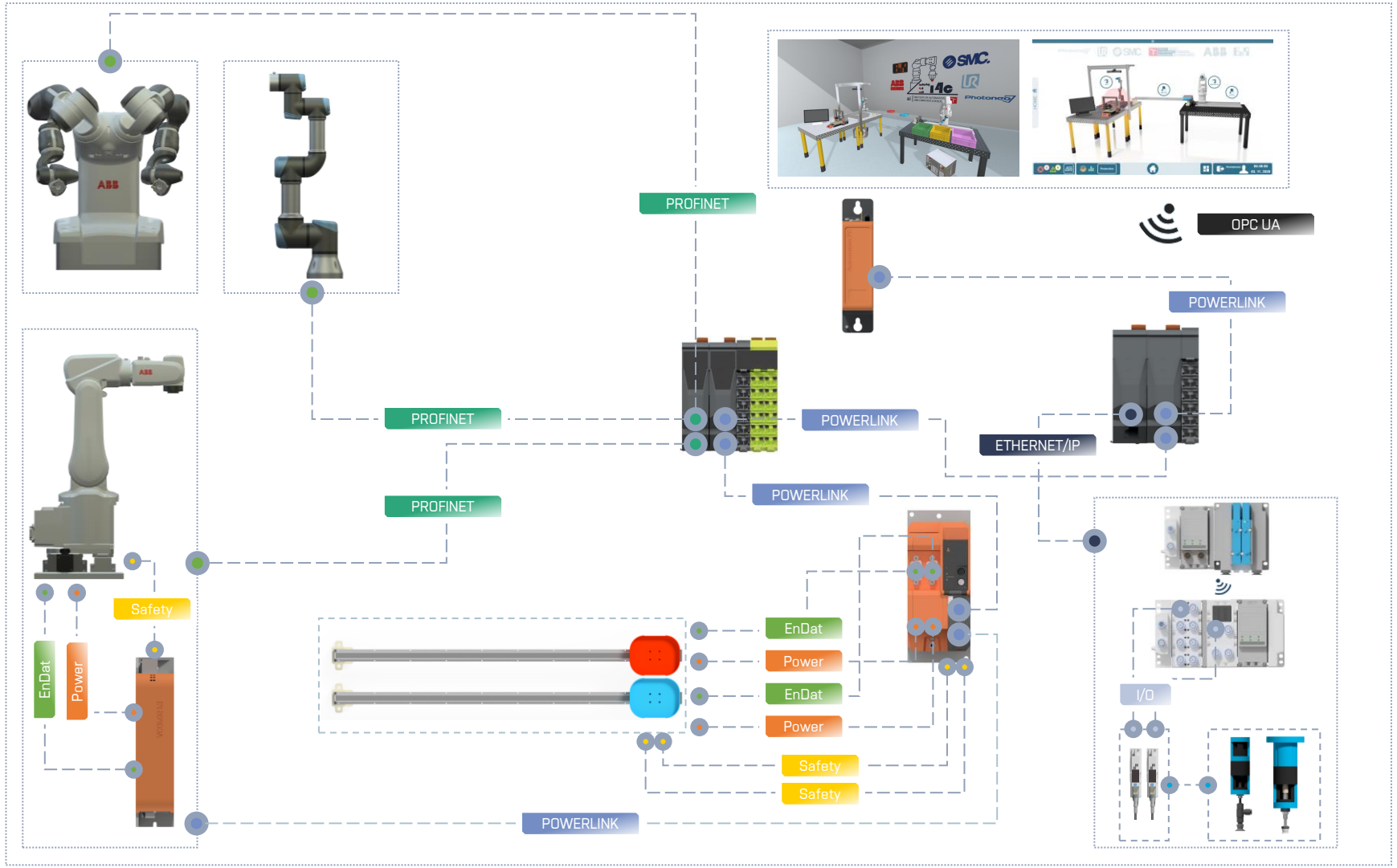
System Integration



POWERLINK

PROFINET

ETHERNET/IP

Digital/Analog I/O

OPC UA

Human – Machine Interface

...

OPC Unified Architecture (UA)

Platform Independence

Intuitive Operation

Multi-client / Multi-user

mapp View

Virtual / Digital Twin

Industrial Robot ABB
- Data Collection
- Real / Simulation
- Robot Web Services (RWS), EGM
- XML, JSON and UDP

Joint / Cartesian

Industrial PC B&R
- Data Collection
- Real / Simulation
- OPC UA

Axis Position

Digital / Analog I / O

Collaborative Robot UR
- Data Collection
- Real / Simulation
- TCP/IP

Joint / Cartesian

Unity3D Virtual / Digital Twin application

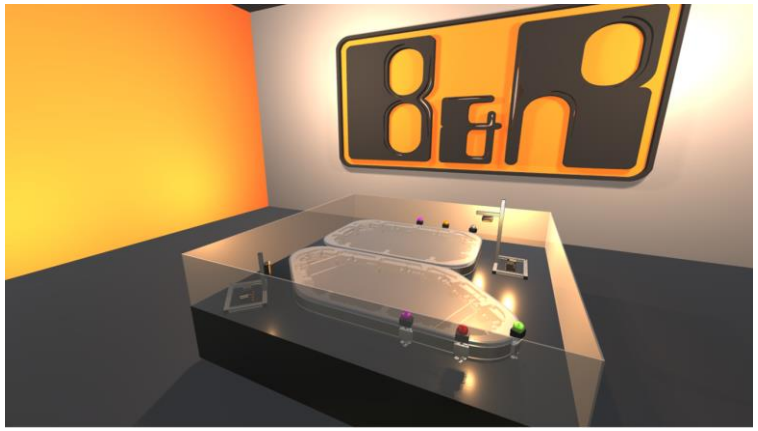
- UDP (User Datagram Protocol)
- TCP/IP
  Transmission Control Protocol (TCP)
  Internet Protocol (IP)
- OPC Unified Architecture (UA)

- Platform Independence
- Intuitive Operation
- Multi-Threading
- NVIDIA PhysX

Easy compilation into Augmented reality (AR)

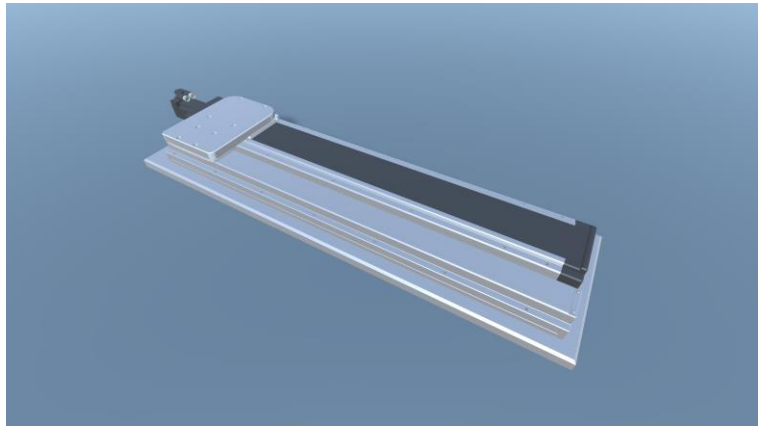
Unity3D Application Portfolio

Industry 4.0 Cell: Sorting Line



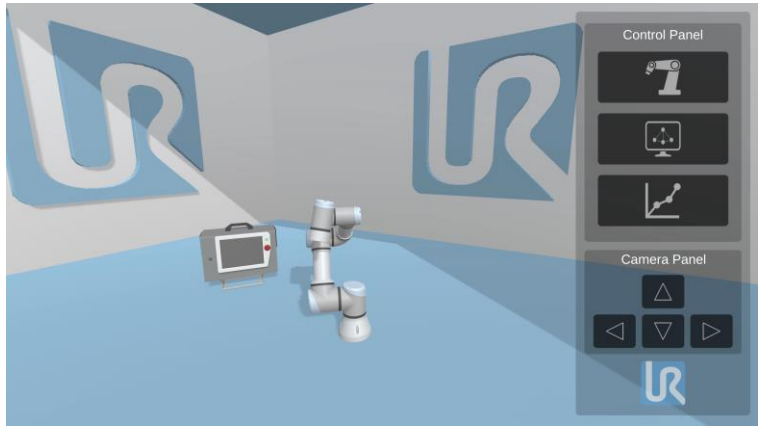
B&R Automation ACOPOStrak

Industrial Robot ABB IRB 120



Simple Linear Axis (B&R Automation, SMC)

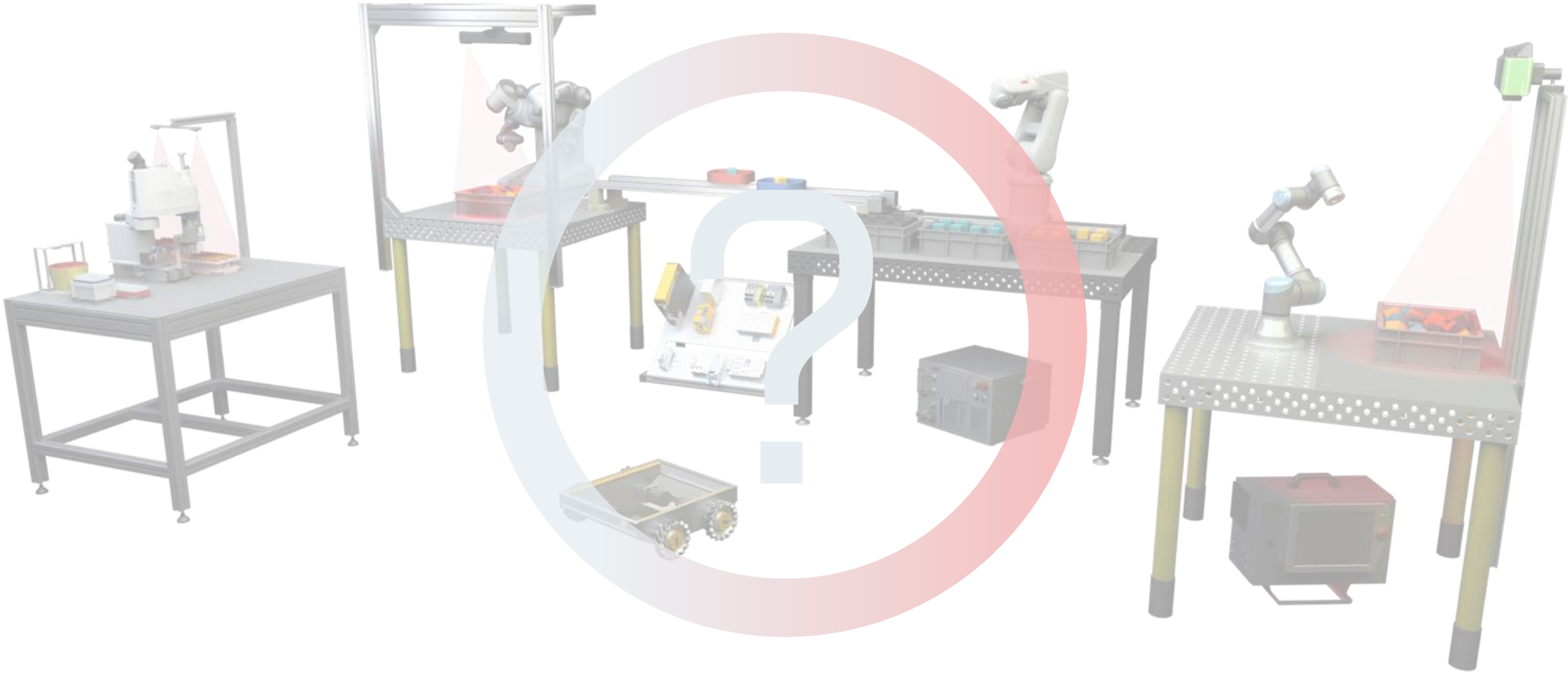
Sorting Machine (B&R Automation, SMC)



Collaborative Robot Universal Robots UR3

Vision of the Future

Vision of the Future



Contact

Contact

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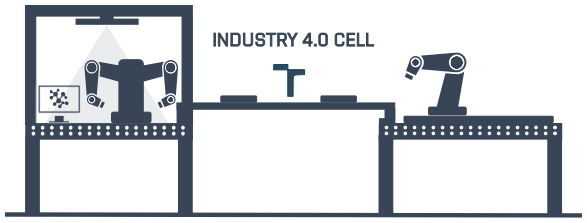

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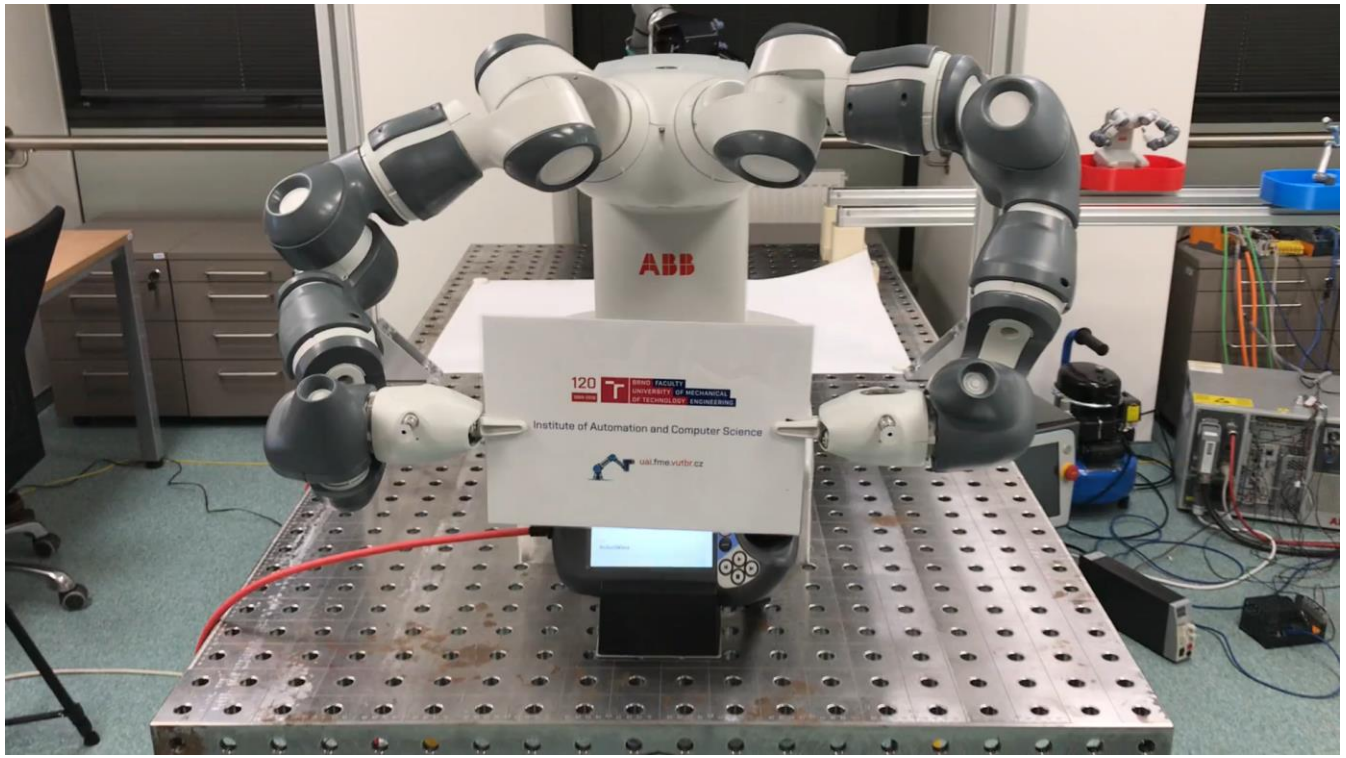

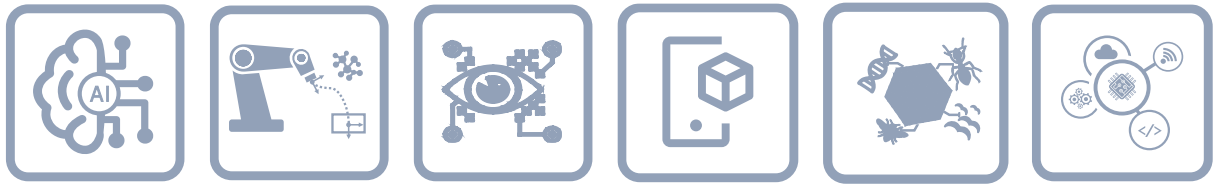

Thank You!

Questions?

INSTITUTE OF AUTOMATION AND COMPUTER SCIENCE