WORKSHOP:

Applied AI in Agile Production, Logistics and Lab Automation

EUROPEAN ROBOTICS FORUM

ERF2022 ROTTERDAM 28-30 JUNE

eu ROBOTICS

Agenda

APPLIED AI IN AGILE PRODUCTION, LOGISTICS AND LAB AUTOMATION

16:10 **Introduction and Definition of Statements/ Key Questions**
Dr. Michael Suppa, Roboception GmbH

16:20 **Towards Detecting and Grasping Transparent Objects**
Prof. Markus Vincze, TU Vienna, Austria

16:30 **AI Driven Vision in Logistics**
Christian Baumgartner TGW Logistics Group, Austria

16:40 **Perception Challenges and Requirements in Lab Automation**
Dr. Patrick Courtney, Tec-connection, UK

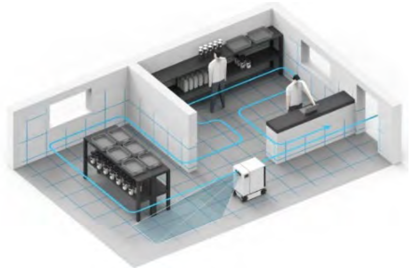
16:50 **Model-based Machine Learning for Pick-and-Place in Agile Production**
Dr. Michael Suppa, Roboception GmbH, Germany

17:00 **Cooperating Robots and AppliedAI for Reconfigurable Manufacturing**
Christos Gkournelos , LMS, University of Patras, Greece

17:10 **Interactive Session/ Round Table Discussion**

17:25 **Conclusion and Take Home Messages**

Perception is the Key Technology for flexible Automation



- In flexible automation, robots must be able to reliably detect and locate work pieces and human collaborators und varying illumination, work pieces type and locations
- In **logistics**, manual work is still pre-dominant due to the complexity of tasks and the variation of objects.
- In **industrial automation**, accurate placement is usually the key challenge
- In **lab automation,** usually fragile and transparent objects must be handled in the processes including human interaction
- Individual engineering of solutions is costly and does not scale

How to Scale Vision for Grasping in Robotics

FLEXIBILITY IS KEY

Industrial Automation

- Classical approach to use mechanical fixtures
- Individual engineering for feeding and grasping
- Usually <100 different parts
- Model data available
- Pick-and-place

Vision System

- Removal of fixtures for flexible cell design
- Model-driven approaches require a model but allow for time-saving off-site training
- Combination with classical methods allows for accuracy and robustness

Logistics

- High cycle time with 1.000 picks/h
- Usually >1.000 parts
- Objects unknown
- Pick-and-drop

Vision System

- Enables application of robots in the domain
- Data-driven approaches require data, i.e. time-consuming on-site recording and training
- Introduction of model-driven approaches reduces greediness

Lab Automation

- Traceability of process and documentation
- Transparent objects
- Pick-and-place

Vision System

- Enables application of robots in the domain
- Model-driven approaches with synthesized data for e.g. transparent objects

Trend #1:
Good Data, not Big Data

Good Data, not Big Data

SIMULATION REDUCES ON-SITE TRAINING EFFORT

Andrew Ng states that

"80% of the AI developer's time is spent on data preparation",

and calls for **GOOD DATA**, i.e.

"Data that is defined consistently, covers the important cases, has timely feedback from production data, and is sized appropriately."

https://www.forbes.com/sites/gilpress/2021/06/16/andrew-ng-launches-a-campaign-for-data-centric-ai

DEPALLETIZING

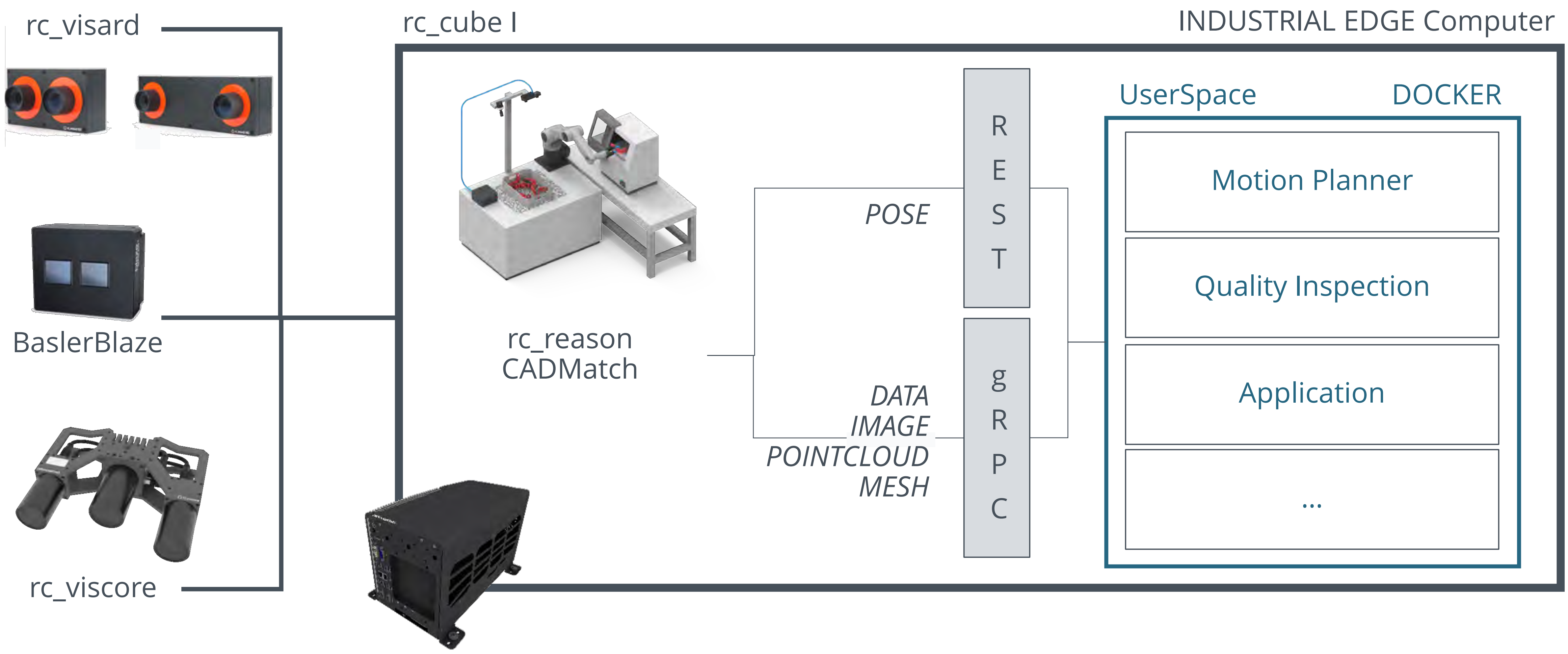
SINGULATION

BIN PICKING

- Development of model- and data driven software products for picking known and unknown items in mixed scenarios
- Combination of model-driven simulation and automatic labeling of data with onsite data enrichment leads to the **lowest onsite training time**

Trend #2: Plug-and-Produce

Scalable Software Platforms



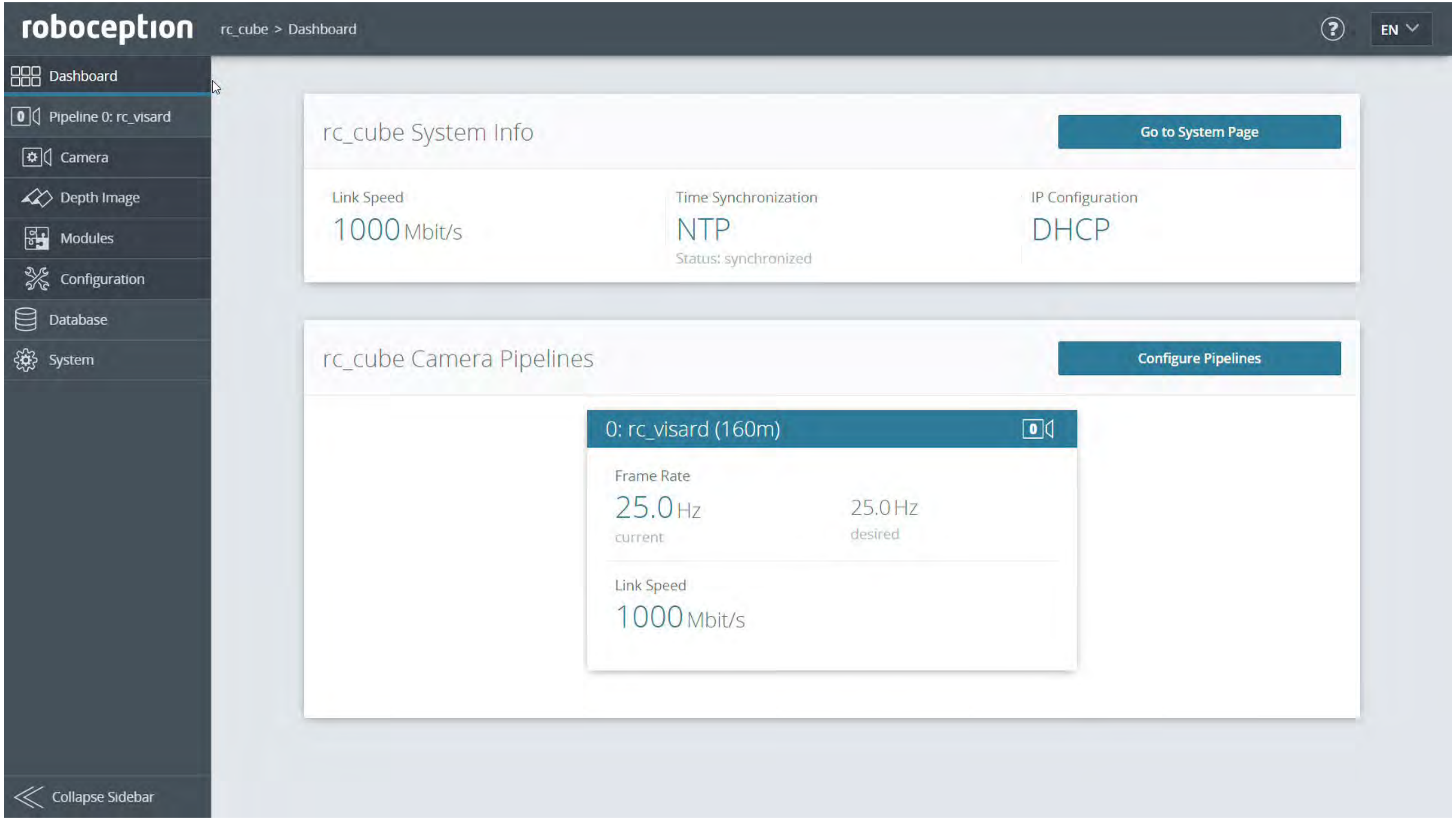
Trend #3:
Ease-of-Use

Ease of Use for Non-Vision Expert

INTUITIVE WEB INTERFACE ENABLES NON-EXPERT USE

Designed for quick and easy set-up and adaption, no vision expertise needed

- Highly intuitive user interface, accessible via a web browser
- Basic software and add-on modules managed via same interface
- ‚Try out' functionality for quick assessment of selected settings



https://youtu.be/W7JLaltGI5Q

Towards Detecting and Grasping Transparent Objects

Markus Vincze

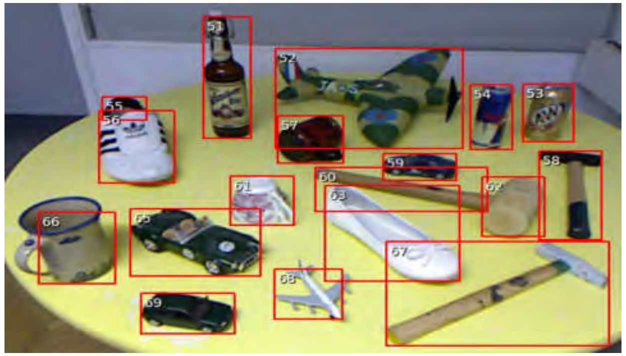
TU Wien, Automation and Control Institute

vincze@acin.tuwien.ac.at

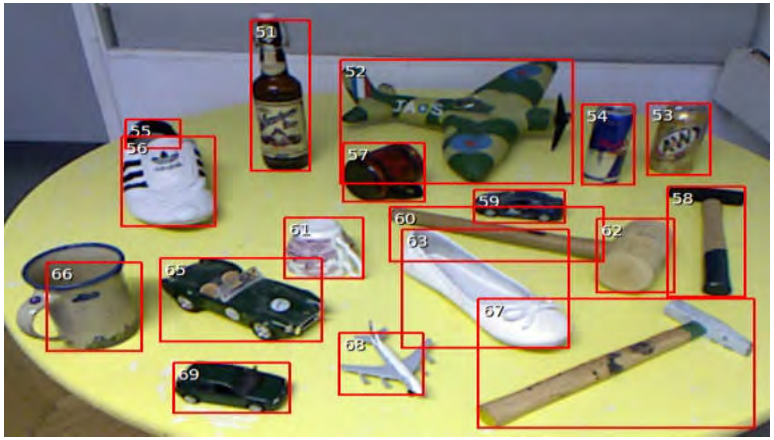
V4R – Vision for Robotics

„We make robots see“

- Objects X
  - Modelling
  - Recognition
  - Classification
  - Function
  - Manipulation
- RGB-D images



Transparent Objects

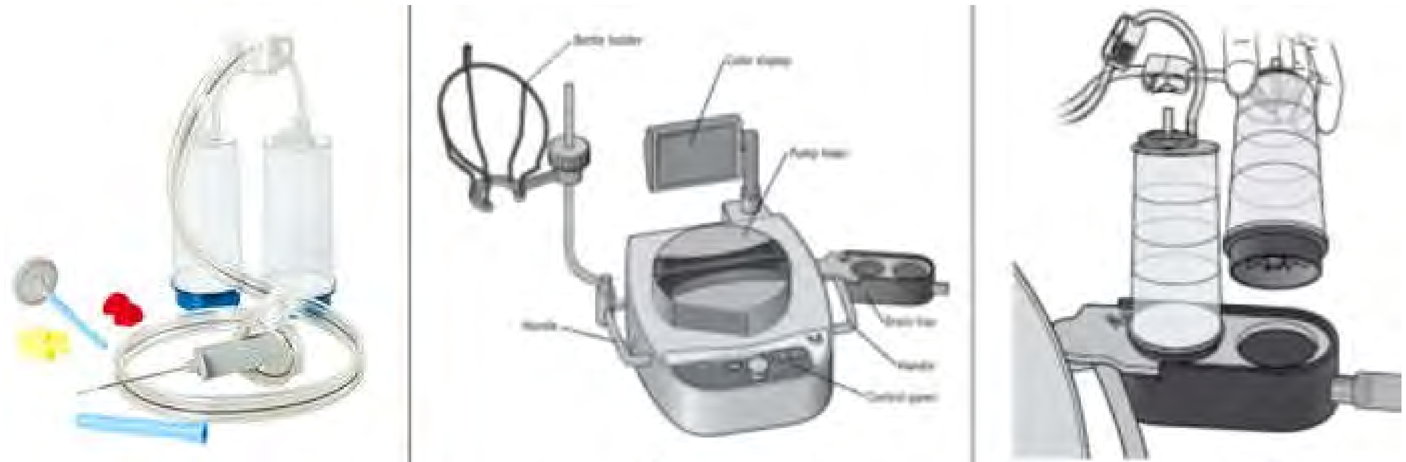


Verification of Object Pose

TRACEBOT H2020 Project

Traceable Robotic Handling of Sterile Medical Products

- Verification of every assembly step and creation of an Audit trail
- Recognition of transparent and small parts

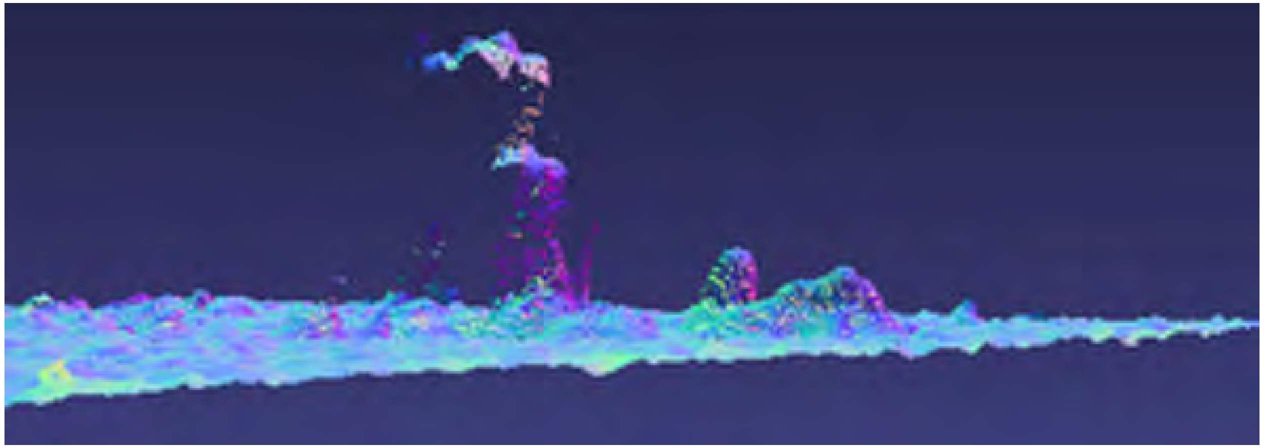


Parts of sampling kit | Part of pump tool | i) Fit canisters to drip tray

Partner:
Tecnalia,
invite,
CEA,
UoB,
astech,
Biolago

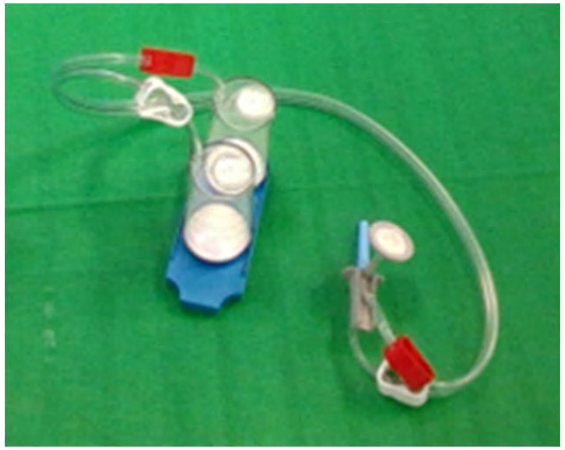
Transparency: Challenges

- Missing depth data
- All visible in RGB data



Approach

- Tools for creating data
- Modelling/rendering transparent objects
- Object pose estimation and verification
- Integration on robot for object grasping



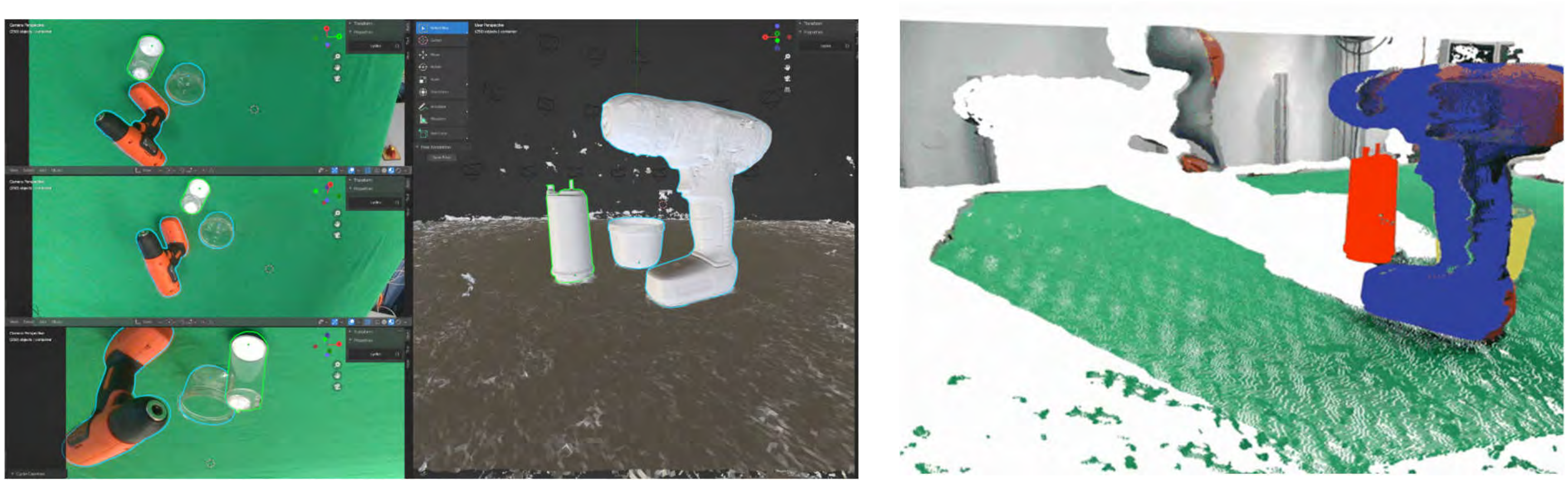
Creating a Dataset

Recording sequence

3D model from coated transparent objects

- KUKA arm, RealSense D415, D435, automatic motion planing for recording tabletop scenes
- Accurate models from scans using PHOTONEO sensor
- Scan with up to 104 views per scene

EasyLabel – Annotation Tool

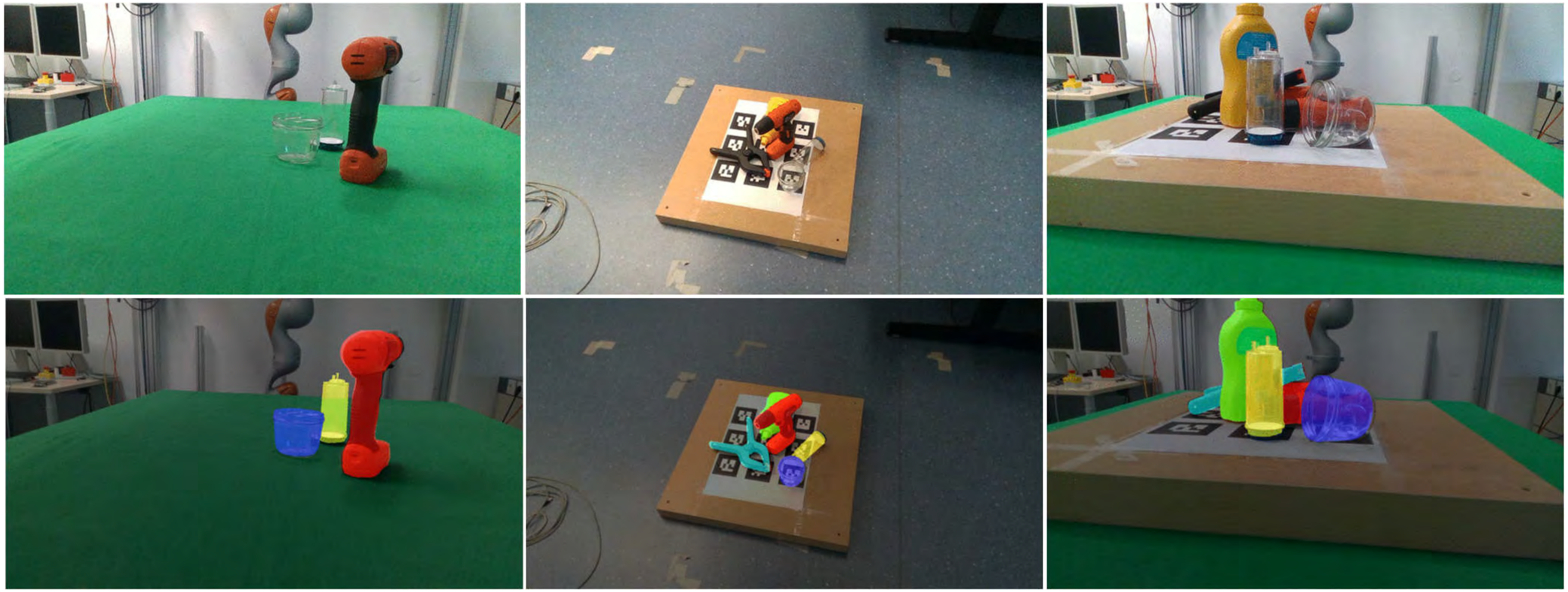


Pose annotation of tabeltop scene

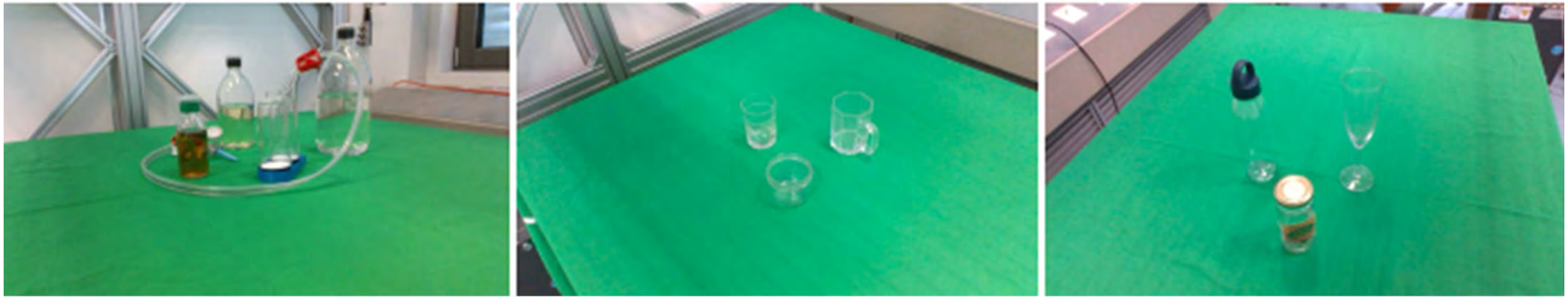
- Tool to import multiple scenes (camera poses, images, object models)
- Guide using depth reconstruction, export object pose annotations
- Allows to place models with poor depth data (transparent objects)

[Suchi et al., RA-L 2021]

Annotation Examples

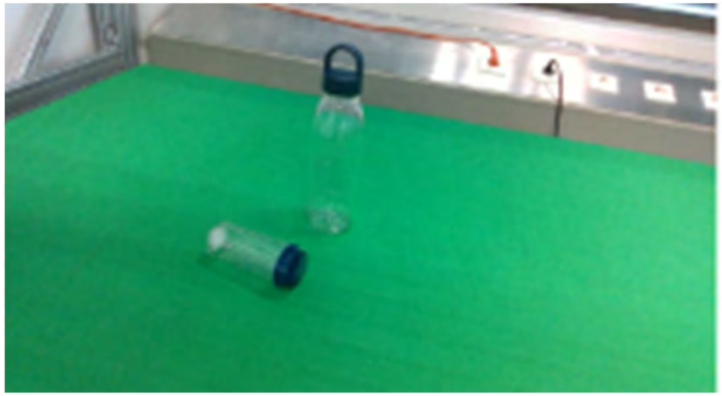


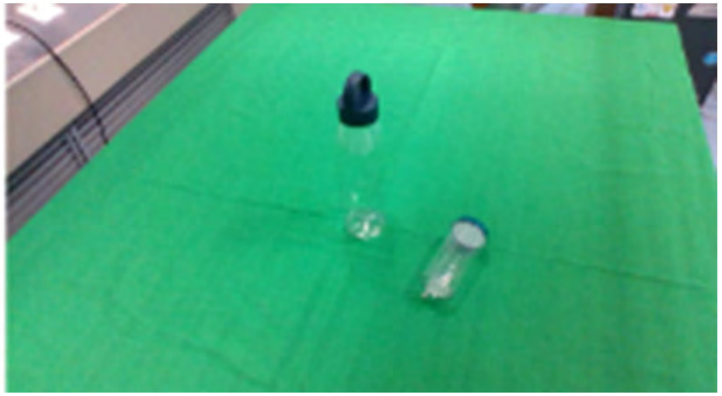
The TraceBot Dataset



- Camera: D435 RealSense. 64 views per scene from upper hemisphere, 60 to 100 cm standoff
- Annotation: one view → transferred to all other views

Evaluation on TraceBot Dataset

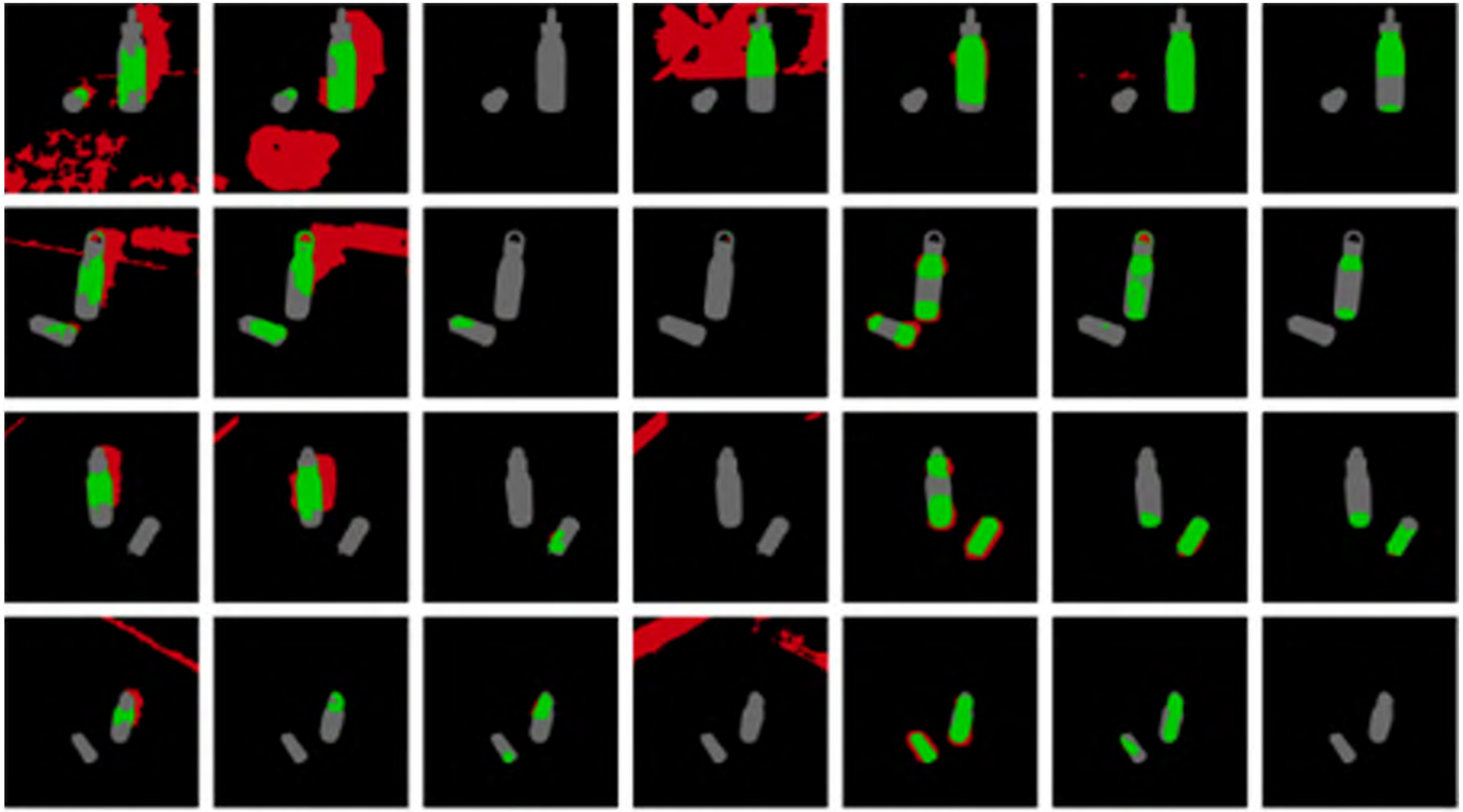




Results for object detection

Method	Recall [%]	Precision [%]	F1 [%]	IoU [%]
Invalid Depth (baseline)	43.29	27.62	30.77	19.92
Depth+GrabCut [1]	58.84	39.25	43.06	30.92
IR-based [2]	37.03	41.56	33.13	25.05
TOM-Net [3]	3.57	3.45	2.96	1.84
ClearGrasp [4]	**75.86**	49.99	56.24	42.72
TransLab [5]	73.50	**71.67**	**67.54**	**55.85**
Trans2Seg [6]	54.02	65.62	52.86	41.86

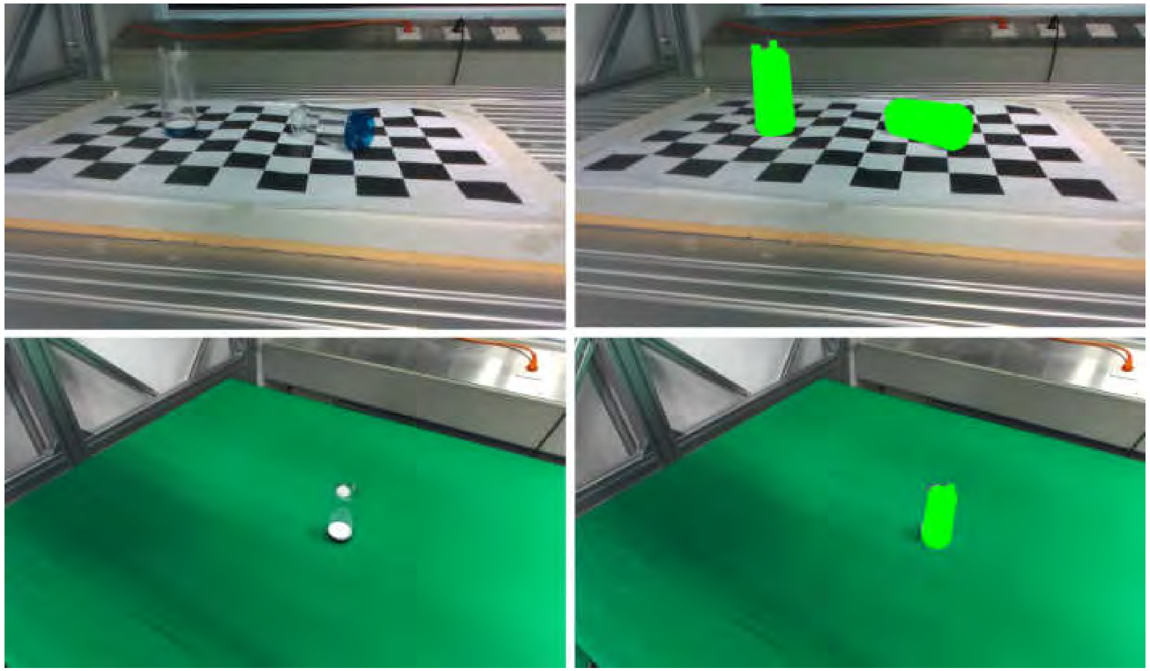
Qualitative Sample Results



invalid depth mask depth + GrabCut [1] IR-based [2] TOM-Net [3] ClearGrasp [4] TransLab [5] Trans2Seg [6]

Pose Estimation for Grasping

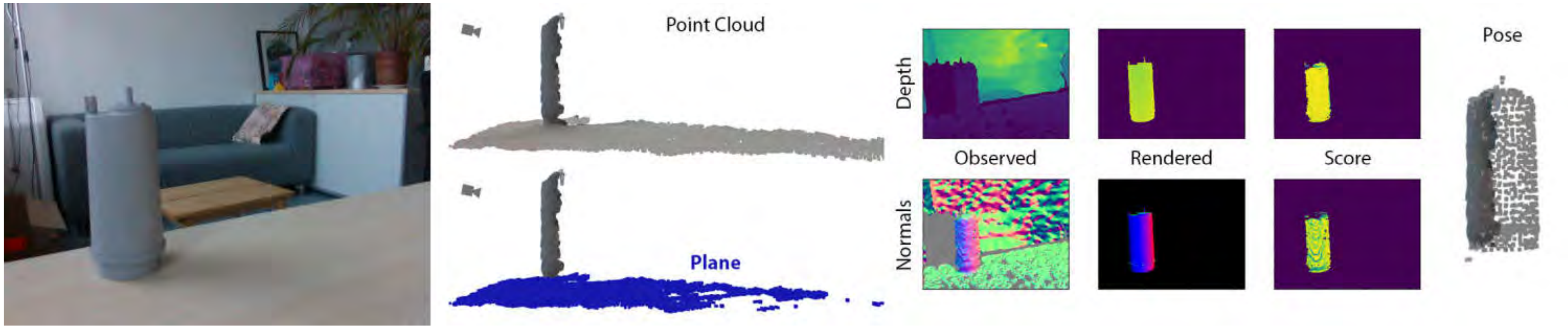
- Using annotated data for learning 6D pose estimation from RGB images only
- COPE (improved version of Pyrapose) [Thalhammer et al., RA-L 2021]



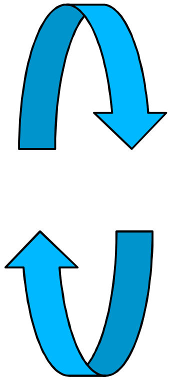
Visual Task Verification

Improving pose estimation by verification

- Rendering-based scoring
- Multiple hypotheses



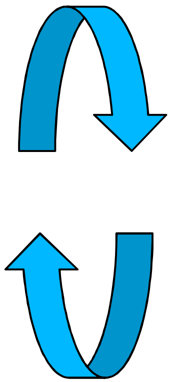
Verification Loop – Vision & Physics Simulation



- Physics simulation to improve pose estimate
- Rendering to optimise object pose
- Simulation increases robustness to verify object pose

Multiple initial (PPF) and **selected improved** pose

Verification Loop –
Vision & Physics Simulation



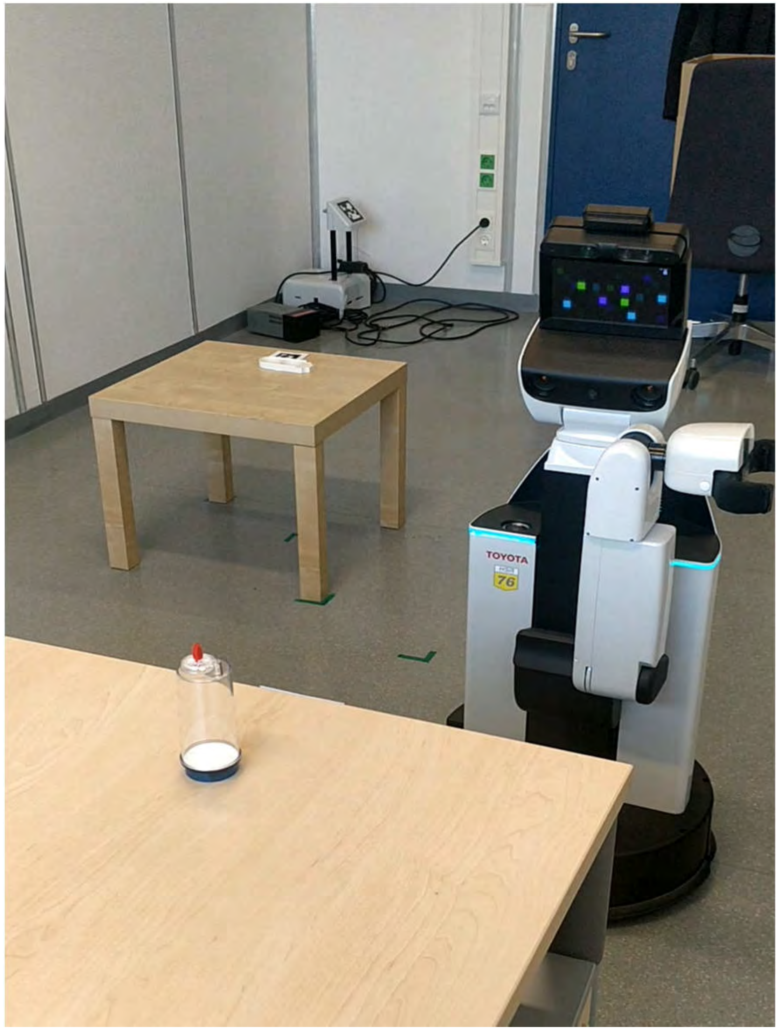
Physics simulation to improve pose estimate

Pose refine through inverse rendering

Verification =
hypothesis generation and
plausibility check with physics simulation

Grasping Transparent Objects

- Test suitability of RGB-based object pose estimation
- Experiments with pose estimation and grasping on HSR robot
- Grasp planning using MoveIt



Conclusion Transparent Object

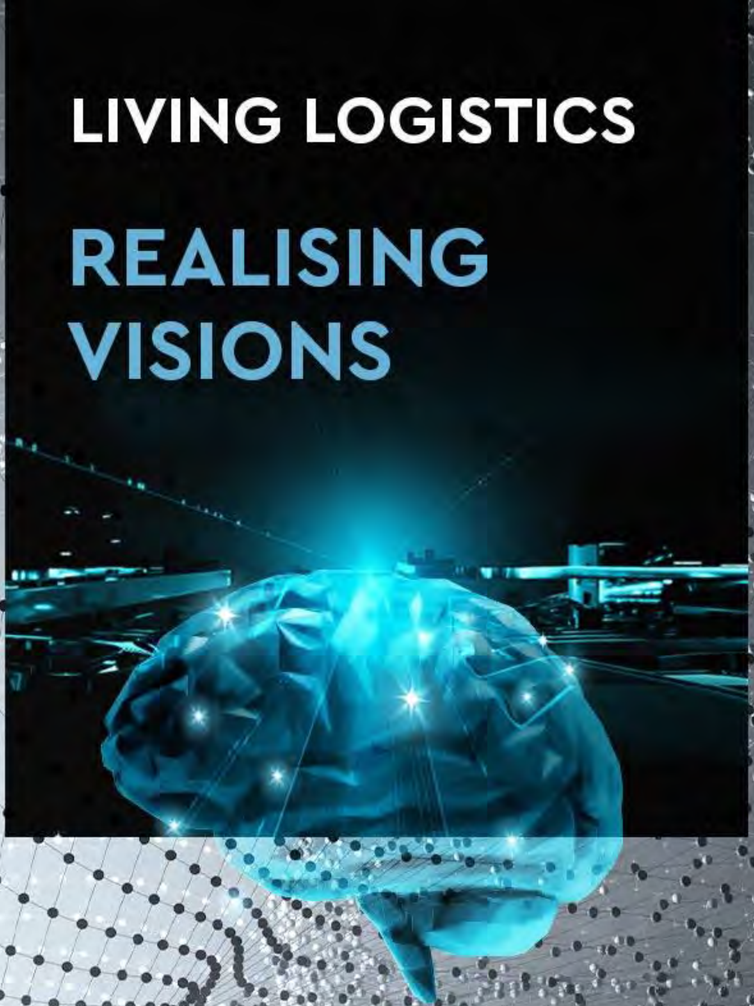
- Methods show significant dependence on view point and type of scene
- DataSets help but need to capture actual challenge
- EasyLabel to annotate 1 view & transfer pose to all views
- Mix of CAD and real data improves performance
- Pose verification with Vision & Simulation Loop

[Park ICCV‘20; Bauer CVPR 21’; Bauer WACV ’22]

TRACEBOT HORIZON 2020

EUROBOTICS FORUM 2022

AI DRIVEN VISION IN LOGISTICS



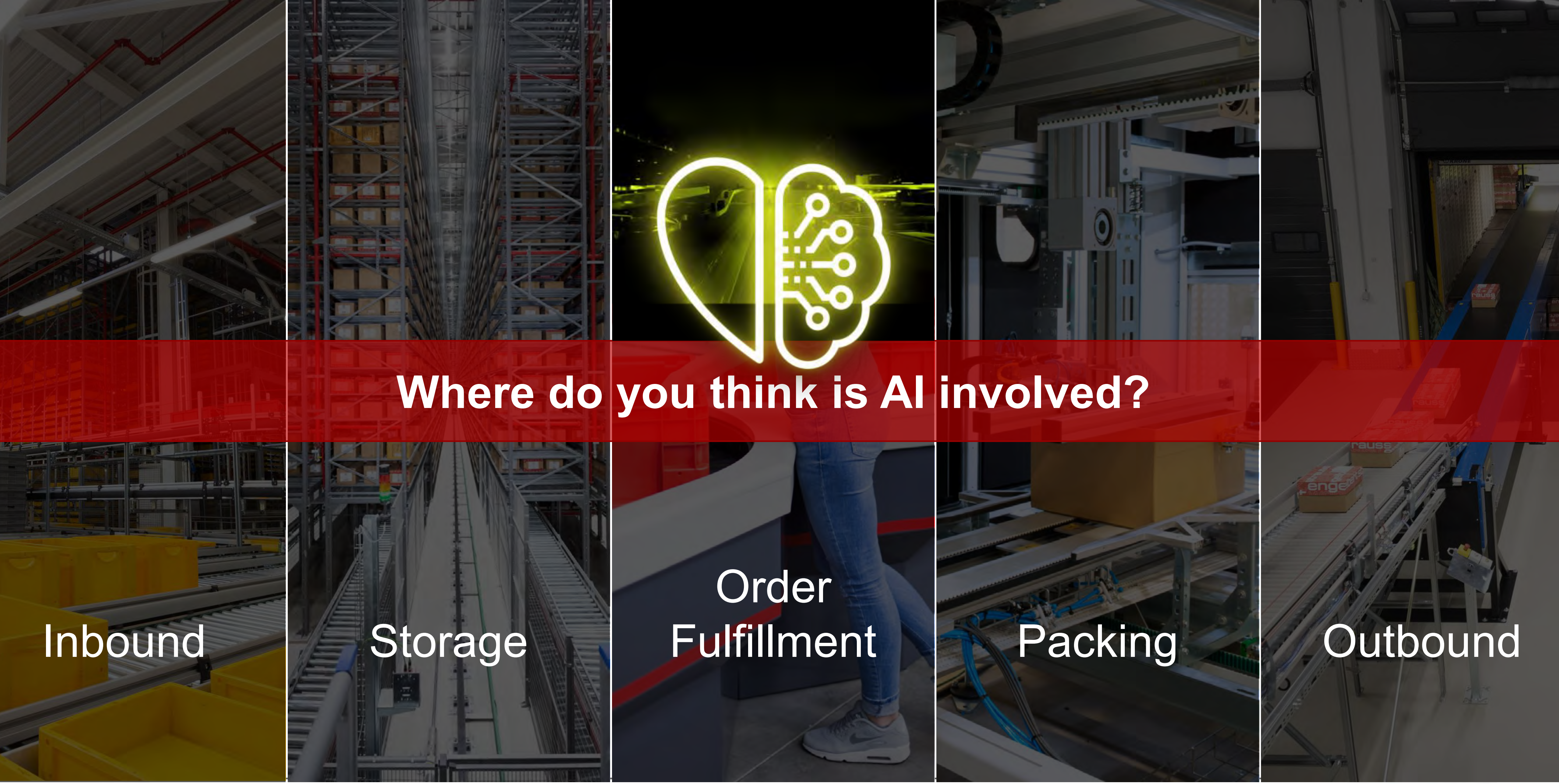
Transport Logistics

Warehouse Logistics

LIVING LOGISTICS

About

- Founded 1969
- HQ in Marchtrenk, Austria
- 4.000+ employees
- Delivers automated warehouse solutions



TGW LIVING LOGISTICS

CARTON QUALITY INSPECTION

AI POWERED REPLENISHMENT & PURGING

AI POWERED TARGET SEQUENCER

ROBO PACKAGING

OPPORTUNISTIC PALLET PACKING

AI is EVERYWHERE!

Inbound

Storage

Order Fulfillment

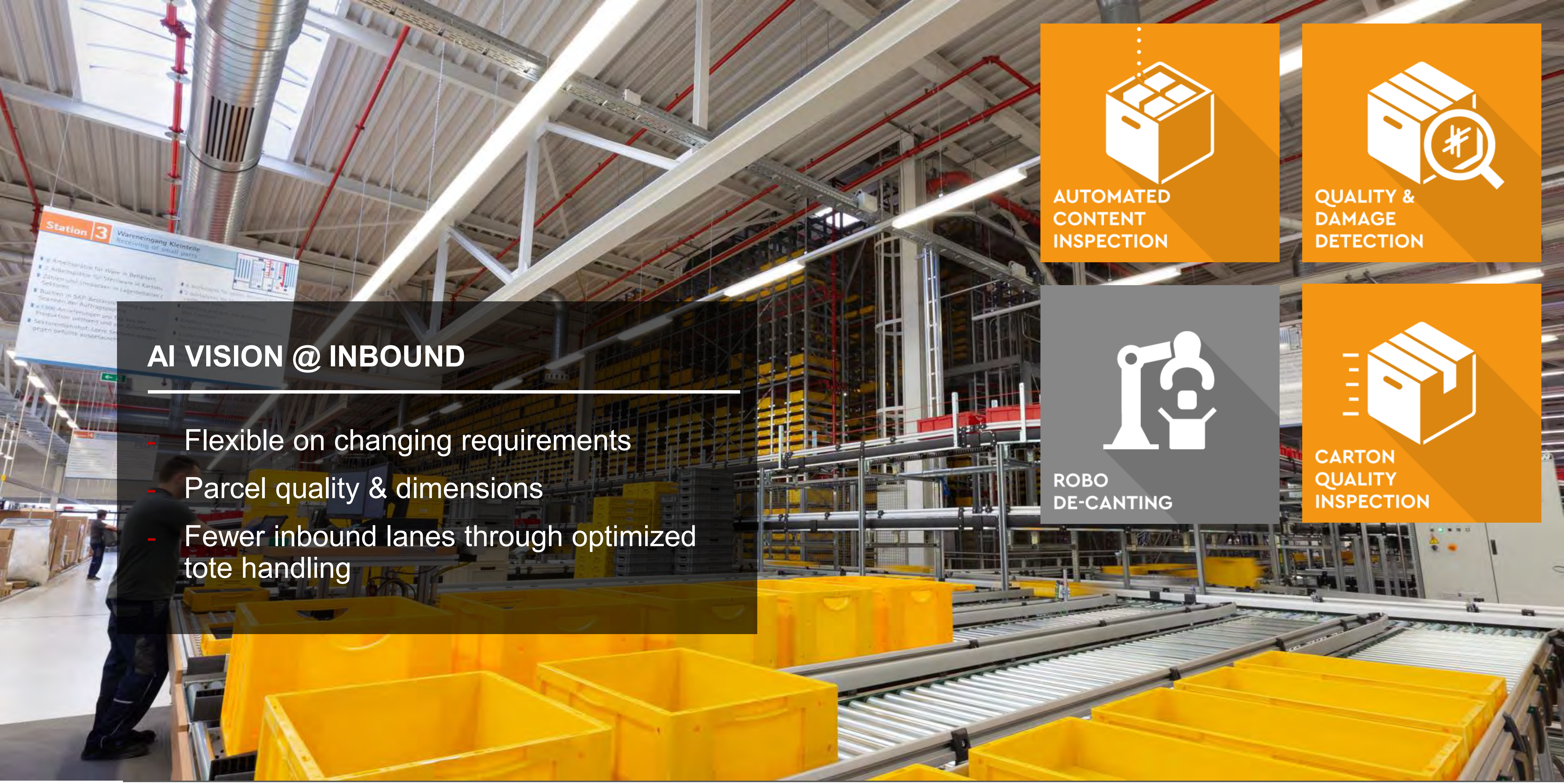
Packing

Outbound

LIVING LOGISTICS

WHAT'S IMAGINABLE WITH AI

- Empty/Fill-Level detection
- Contamination detection
- Un-/Strapped detection
- Damaged detection
- Item counting
- Difference counting
- Pick- & Place area recognizion
- Dimensioning
- Optimization in De-/Palletizing (Sorting)
- Jam detection



AI VISION @ INBOUND

- Flexible on changing requirements
- Parcel quality & dimensions
- Fewer inbound lanes through optimized tote handling

AUTOMATED CONTENT INSPECTION

QUALITY & DAMAGE DETECTION

ROBO DE-CANTING

CARTON QUALITY INSPECTION

TGW LIVING LOGISTICS

QUALITY @ INBOUND

- Tote quality inspection
  - Contaminated
  - Damaged
  - Un-/Strapped

SMART CAMERA

CARTON QUALITY INSPECTION

QUALITY & DAMAGE DETECTION

Contaminated

Deformed

Strapped

EMPTY @ INBOUND

- Empty tote detection
- Challenge:
  - Different tote types
  - Contamination
  - Colors, …

SMART CAMERA

CARTON QUALITY INSPECTION

QUALITY & DAMAGE DETECTION

← Empty vs. Not Empty →

TGW LIVING LOGISTICS

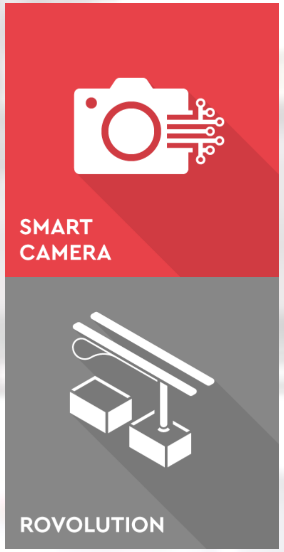
PICKING @ ORDER FULFILLMENT

- Optimized Picking
- Find best item to pick
- Reenforcement approach to find best areas to place items
- Count articles (double check)

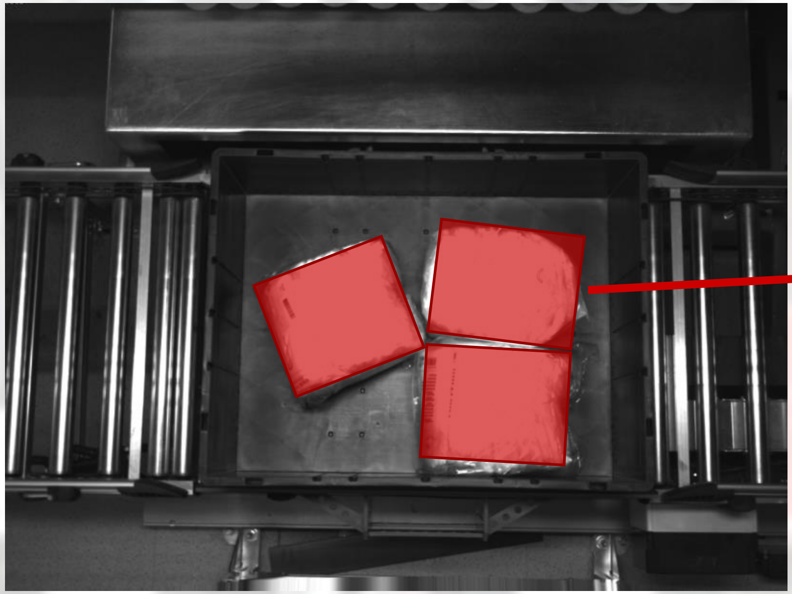
TGW LIVING LOGISTICS

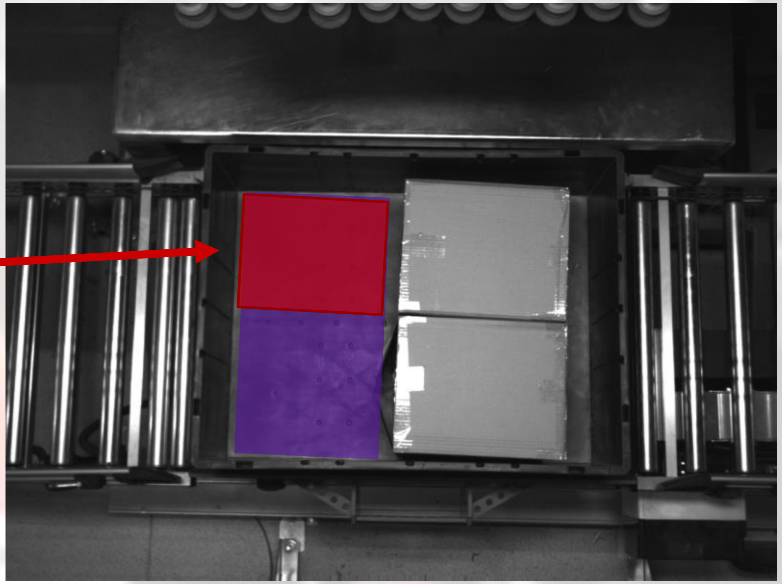
PICKING @ ORDER FULFILLMENT

- Optimized Picking
- Find best item to pick
- Reenforcement approach to find best areas to place items



- Hand-Eye Coordination
- Find a gripable item on the source side (left image)
- Put it on an empty/available area on the target side (right image)





LIVING LOGISTICS

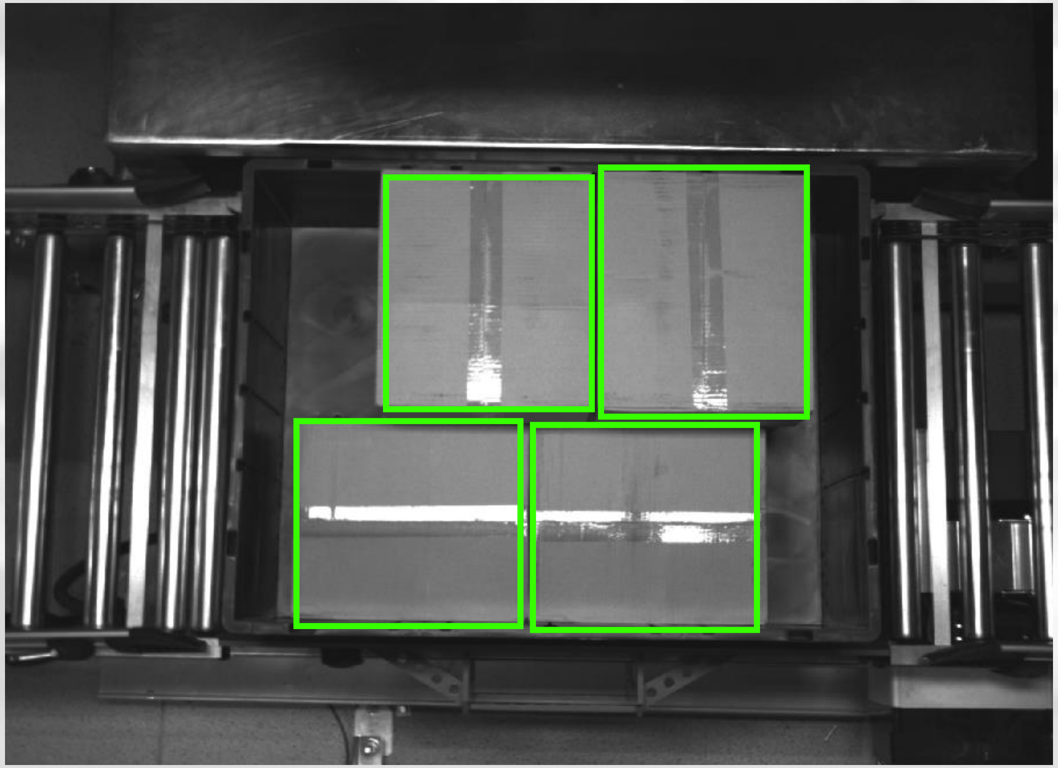
COUNTING @ ORDER FULFILLMENT

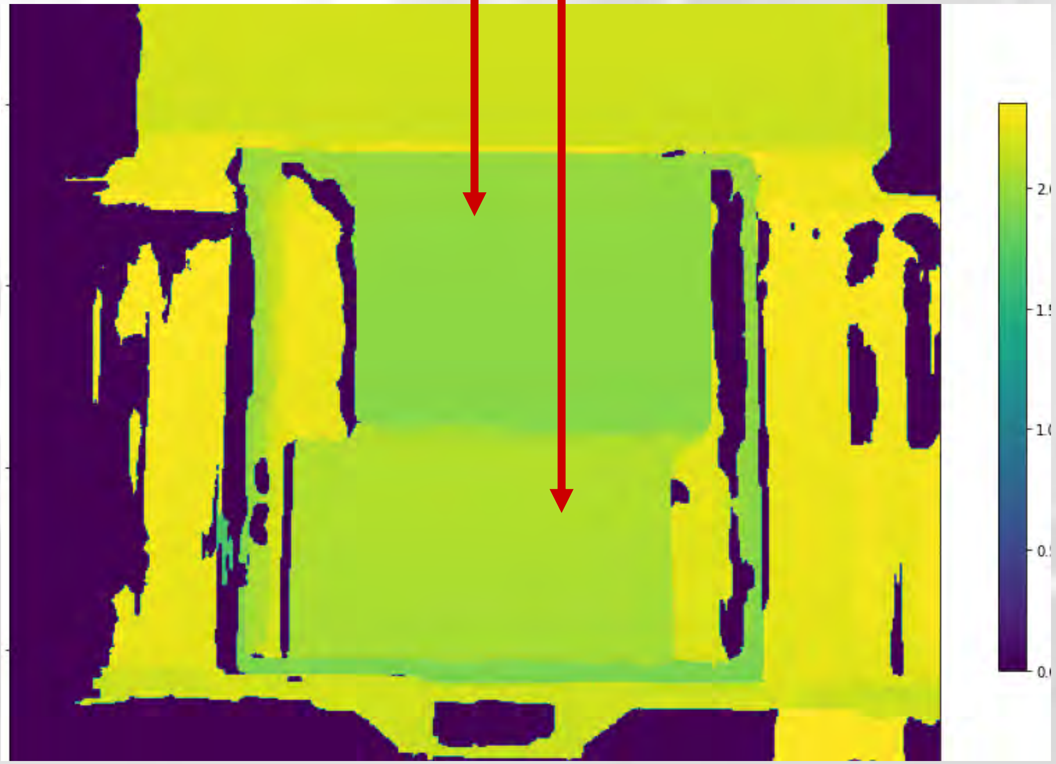
- Count on Source & Target side
- Enough items in source
- Correct amount picked on target

SMART CAMERA

We can assume that there are 2 more items below the top ones.

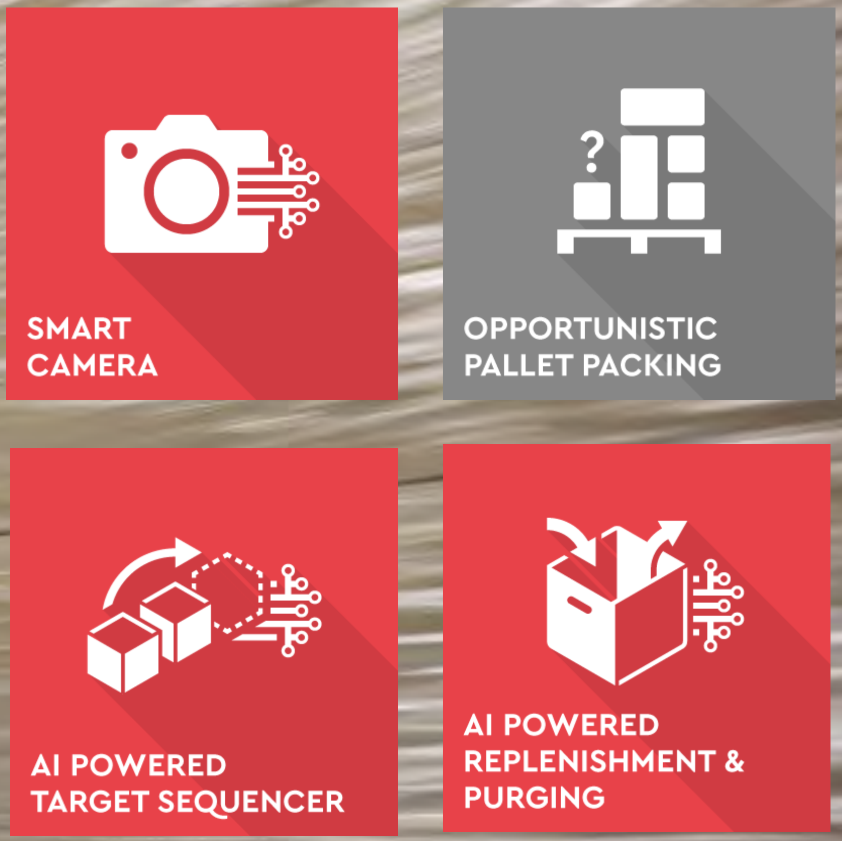
Therefore we count 6 items instead of 4 visible with a confidence of >90%.





AI VISION @ PACKING

- Carton Reduction by Fill-Level
- Optimized Palletizing (Sorting)
- Reenforcement through pack density



TGW LIVING LOGISTICS

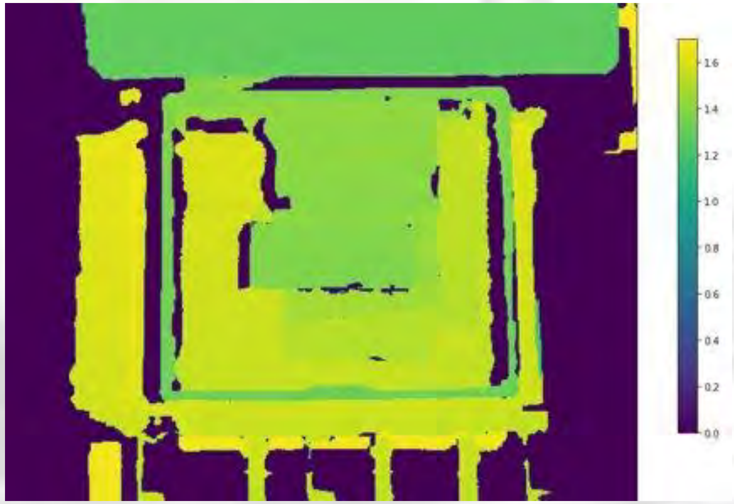
REDUCTION @ PACKING

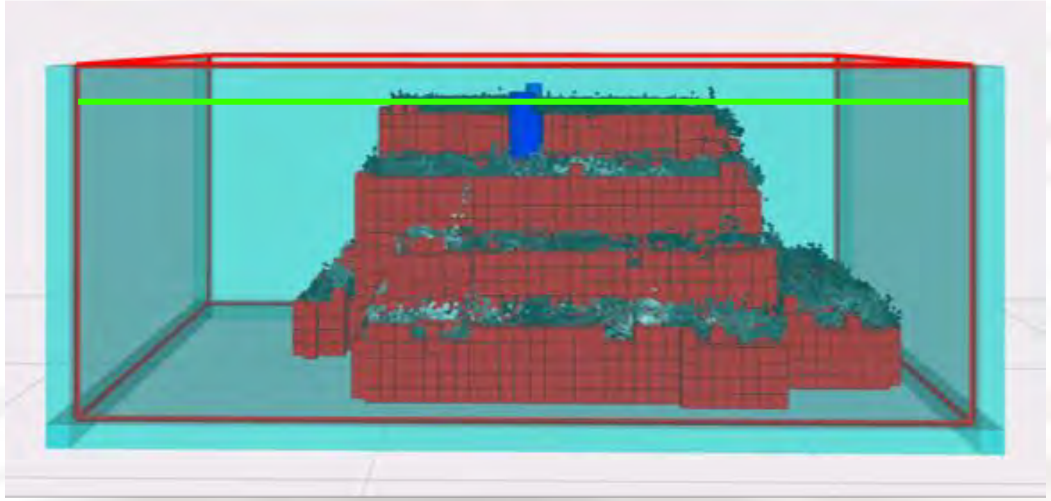
- Fill Level / Volume detection
- Cut the height to optimize shipping storage
- Gain space on pallets

SMART CAMERA

Left: 3D camera depth image
Right: computer calculated perspective

Fill-Lvl: 89%
Fill-Volume: 42%





AI Vision is under heavy R&D with lots of specialized island solutions.

SMART CAMERA

Our vision is a holistic approach,
a simple to use ecosystem for all applications,
ready for market.

SMART
CAMERA

LIVING LOGISTICS

EUROBOTICS FORUM 2022

CONTACT

Christian Baumgartner
Product Manager AI Products

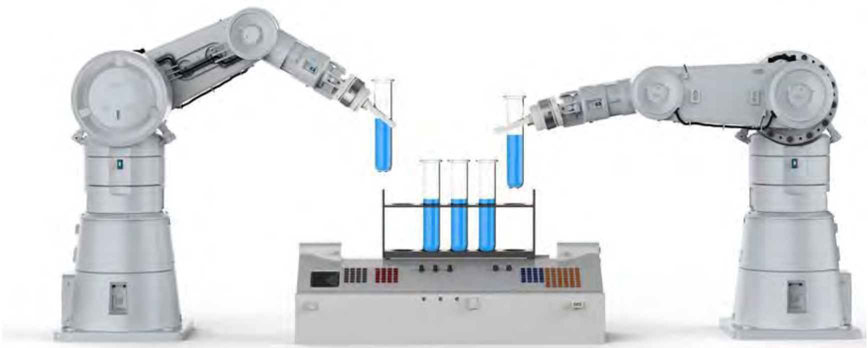
c.baumgartner@tgw-group.com
+43 676 87171649

ERF 2022

Perception challenges in the laboratory

Patrick Courtney

TG analytical laboratory robotics



A terrible headache

What's still missing?

pharmacopeia

TRACEBOT

- What: traceable robots in regulated operations
- Why: scaling up vaccine, medicines

- TraceBot project

sterility testing according to USP<71>

Setting up materials in a controlled environment (Isolator)

Sample Filtration in the canisters to concentrate it on a membrane.

Canisters filling with culture.

Visual readout: a cloudy appearance in canister reveals contaminant growth

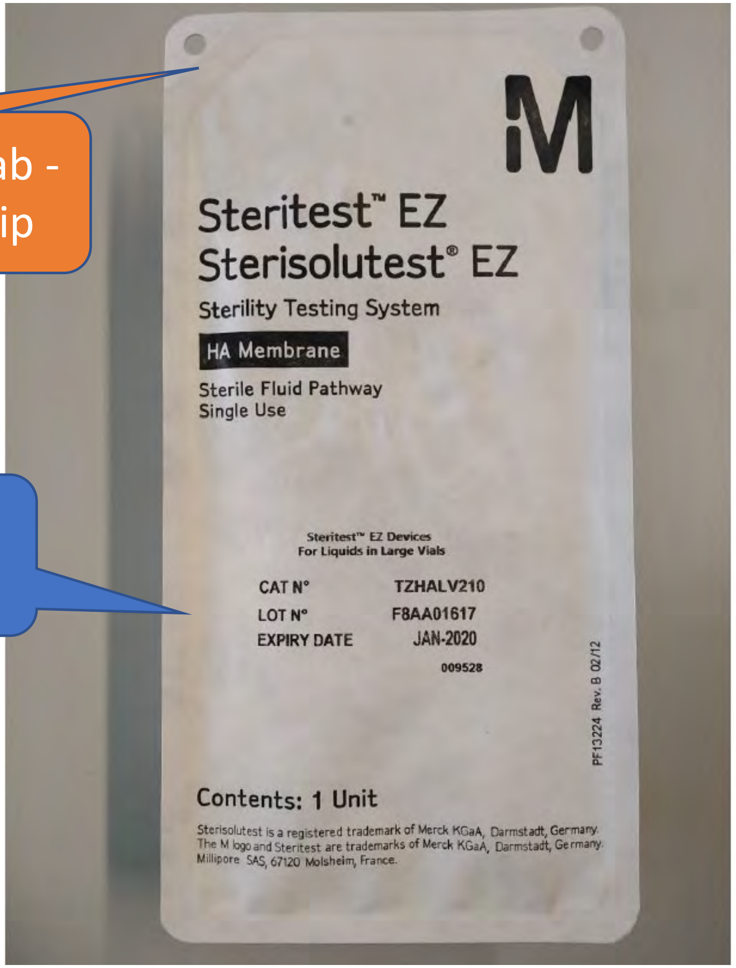
- **4 year €7M**
- **AI (Uni Bremen)**
- **digital twins**
- **Pharma driven**

https://cordis.europa.eu/project/id/101017089

Kits and Packaging – not yet robot friendly

White-on-white pull tab - hard to locate and grip

Labelling not barcoded



Glossy transparent plastic - hard to see

flexible plastic – no obvious grasp points

Glossy transparent plastic - hard to see

Sustainability? Lots of waste

How would a disabled person open this ?

TRACEBOT

Robots are not superheroes, they are disabled

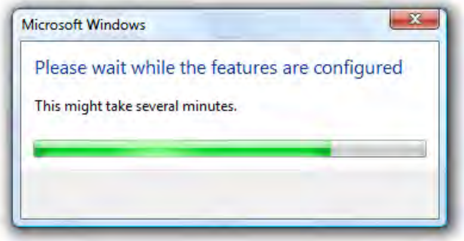
Some myths about robots

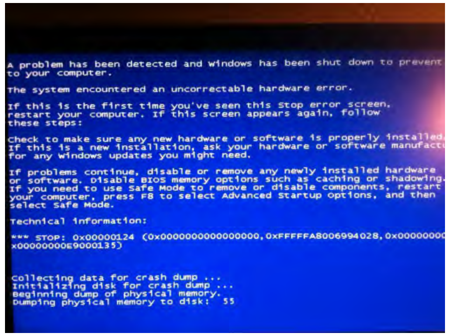
- Don’t get ill
- Don’t go on strike
- Don’t take a break
- Don’t go on holiday
- Don’t ask for a pay rise

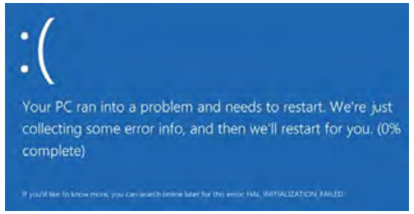
Spot by Boston Dynamics

Robots are not superheroes, they are disabled

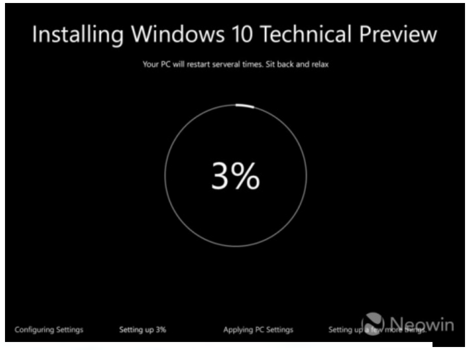
The myth of Robot uptime

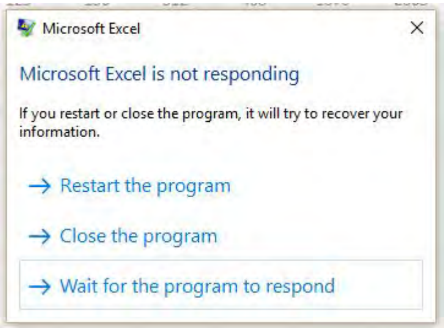


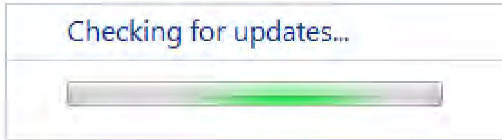


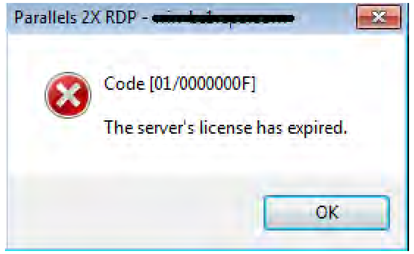


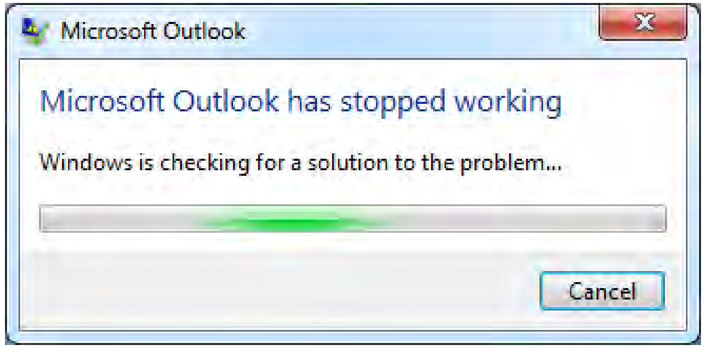
- Robot on a coffee break
- Robot with flu: virus, a worm
- Robot going to sleep
- Robot going to the toilet
- Robot on holiday
- Robot in a meeting, gossiping
- Robot on a training course
- Robot swimming in a data lake

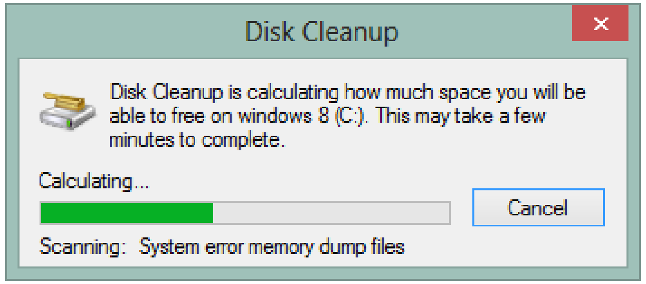


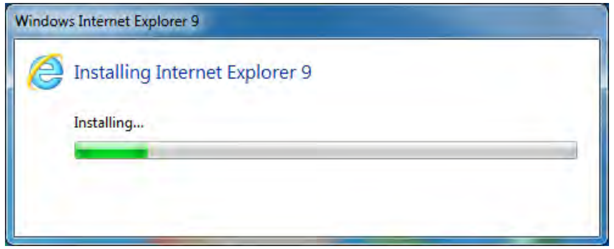




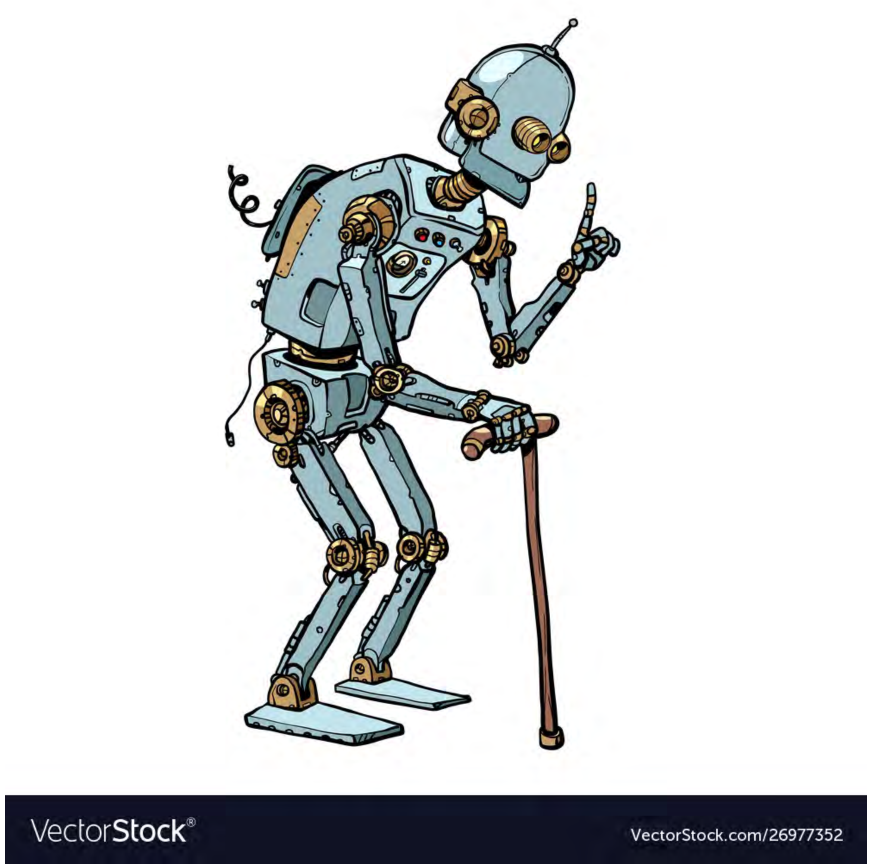








We are learning to be kind to our fellow humans. Can we learn to be kind to our robots?



St Paul's Cathedral

Sumaira Latif, Accessibility Leader, Procter & Gamble

Meanwhile, in the supermarket

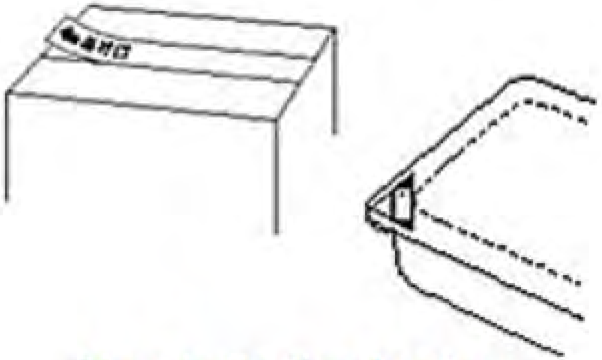
- Great progress in recent years
- But still a lot to do


Figure 1: Examples of accessible designs for elderly and disabled people in the field of packaging

[i] Easy to identify contents

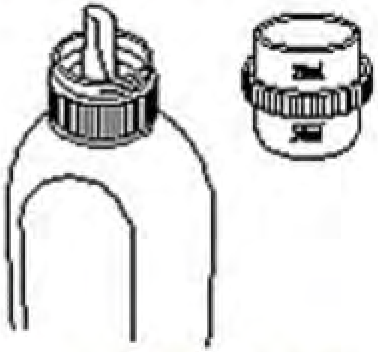
Shampoo bottles as containers with a tactile mark

[ii] Easy to identify how to open



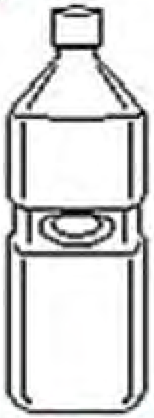
Clear indication to show a section to open containers

[iii] Easy to measure and pour contents



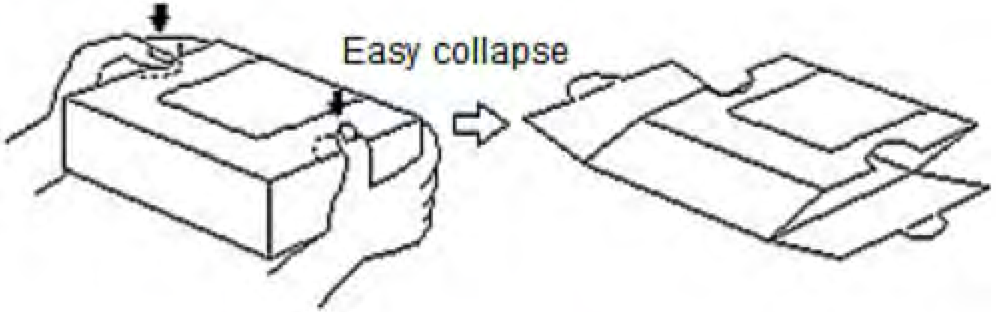
Knurled bottle-caps to measure contents

[iv] Easy to carry and pour contents



PET containers with dents or dimples

[v] Easy to dispose containers

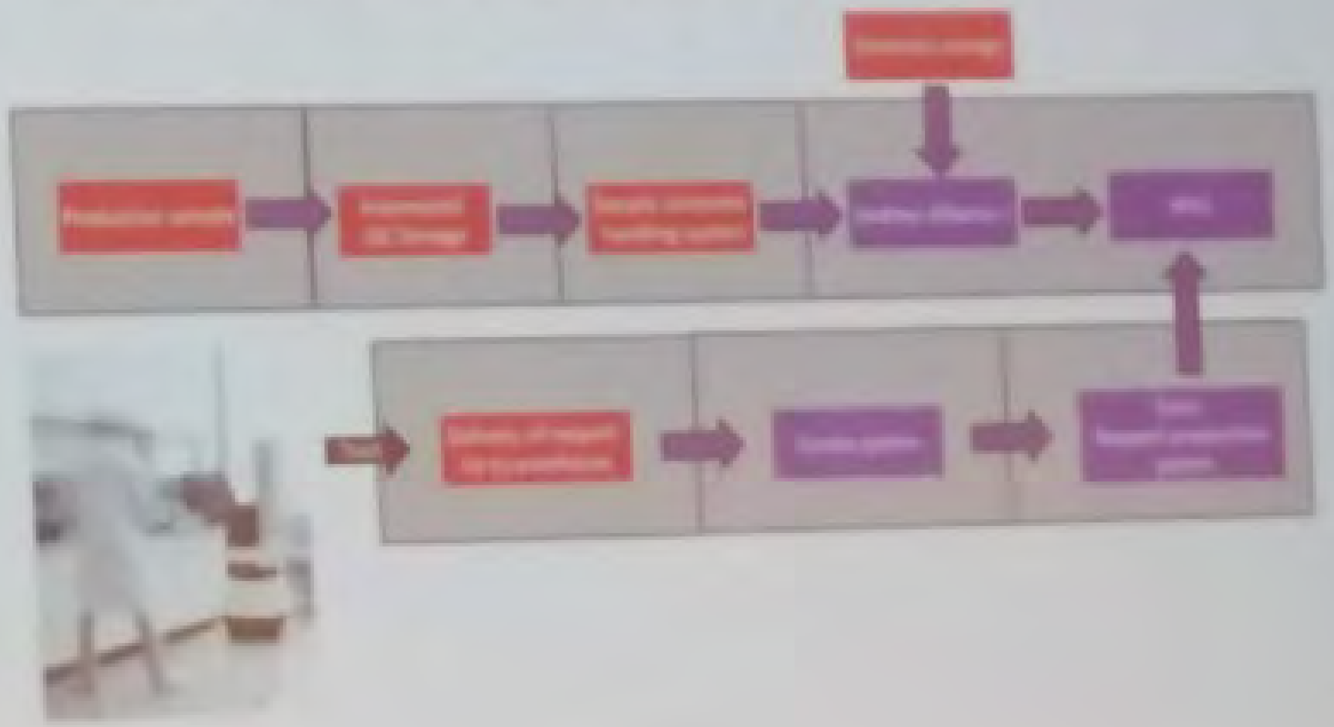


Containers smoothly collapsible before disposal

Standardized robot-friendly materials

- Sample containers
- Robot Friendly Packaging
- Labelling

The Lab ecosystem using mobile robots



roboceptıon

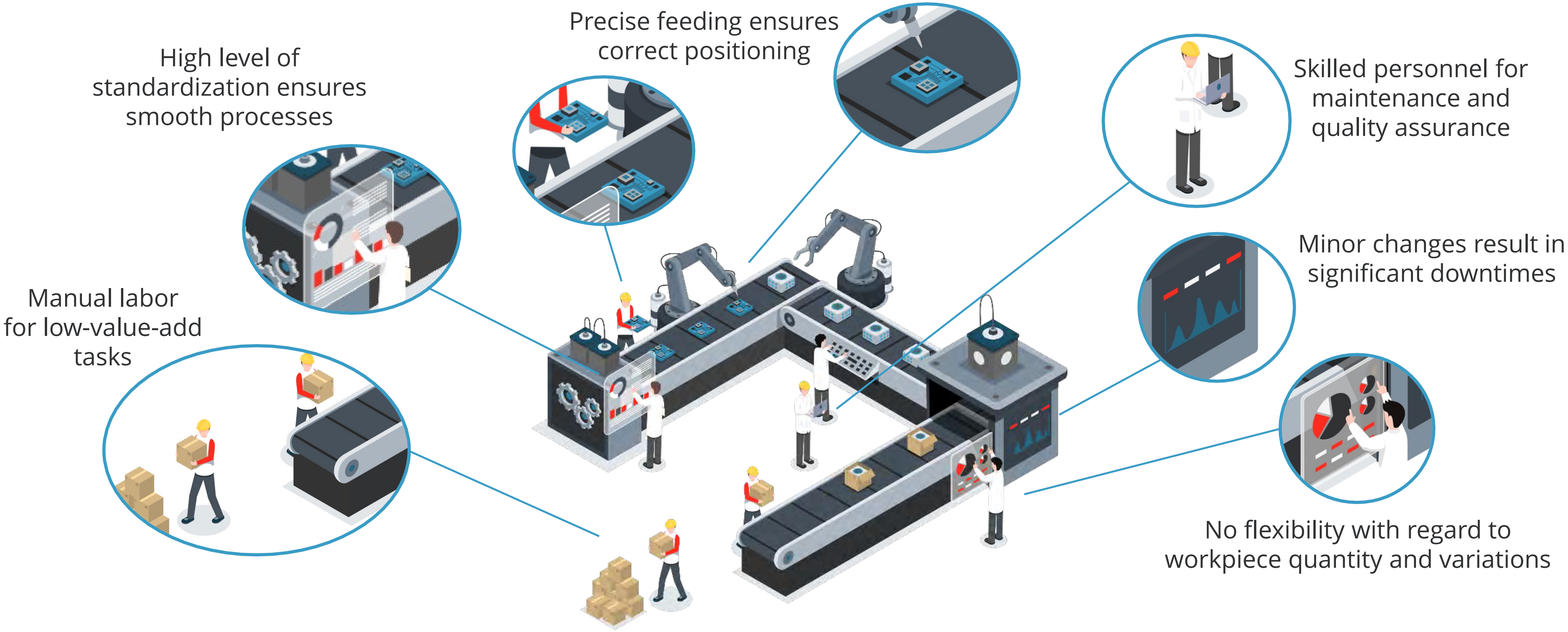
Model-based Machine Learning for Pick-and-Place in Agile Production

Dr. Michael Suppa

ROBOTS NOT SMART ENOUGH FOR NEXT-LEVEL INDUSTRY 4.0



- Potential offered by automating simpler use cases has been exhausted
- Next evolutionary step for Industry 4.0 is urgently needed
- Robots must be enabled to automate more complex tasks

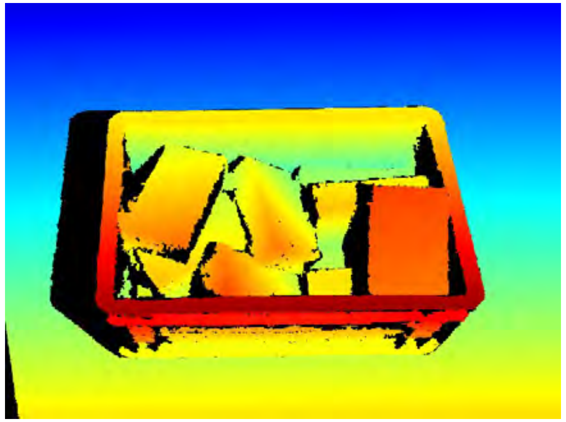


Why 3D Stereo?

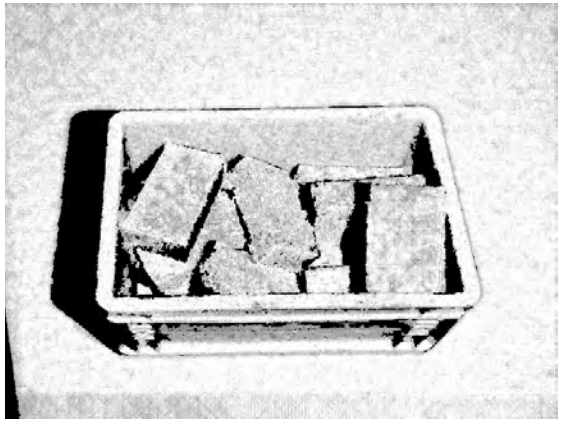
UNSTRUCTURED ENVIRONMENTS REQUIRE 3D DATA

- Stereo delivers RGB-D data directly synchronized in time and calibrated
- Increase in computing resources allows for onboard computation in real-time
- Depth is needed for accuracy and flexibility, images are the key data base for machine learning
- Combination of algorithms and machine learning in one system

Camera Image



Depth Image



Confidence Image

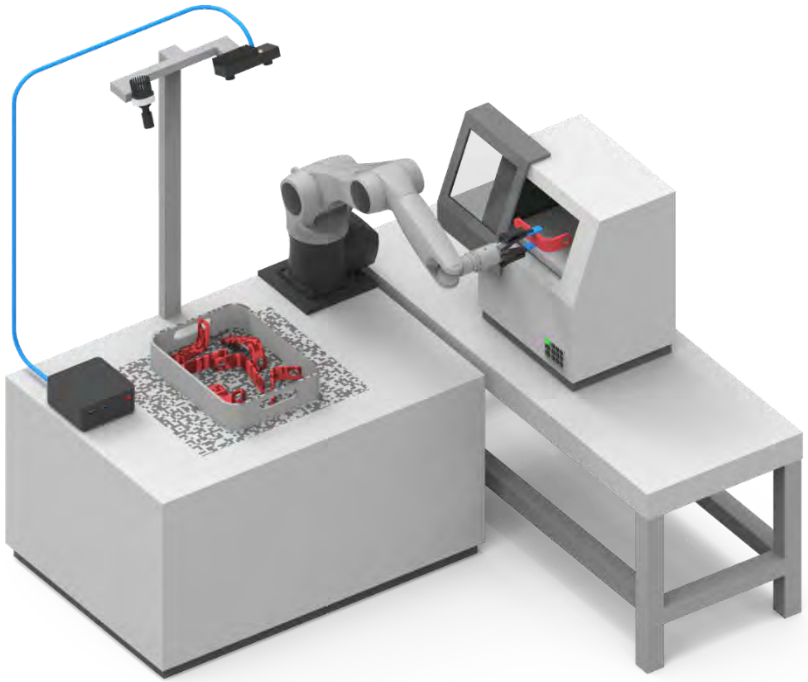
3D Reconstruction

rc_reason CADMatch

ROBOTIC MACHINE TENDING

Detects position and orientation of objects using CAD models.

- Detection and localization of objects based on CAD data
- Delivers grasp point(s) for reliable pick-and-place
- Grasp teaching interface
- Applied AI-based part training process
- Works with static and robot-mounted sensors coupled with rc_randomdot pattern projector
- Runs offboard on rc_cube



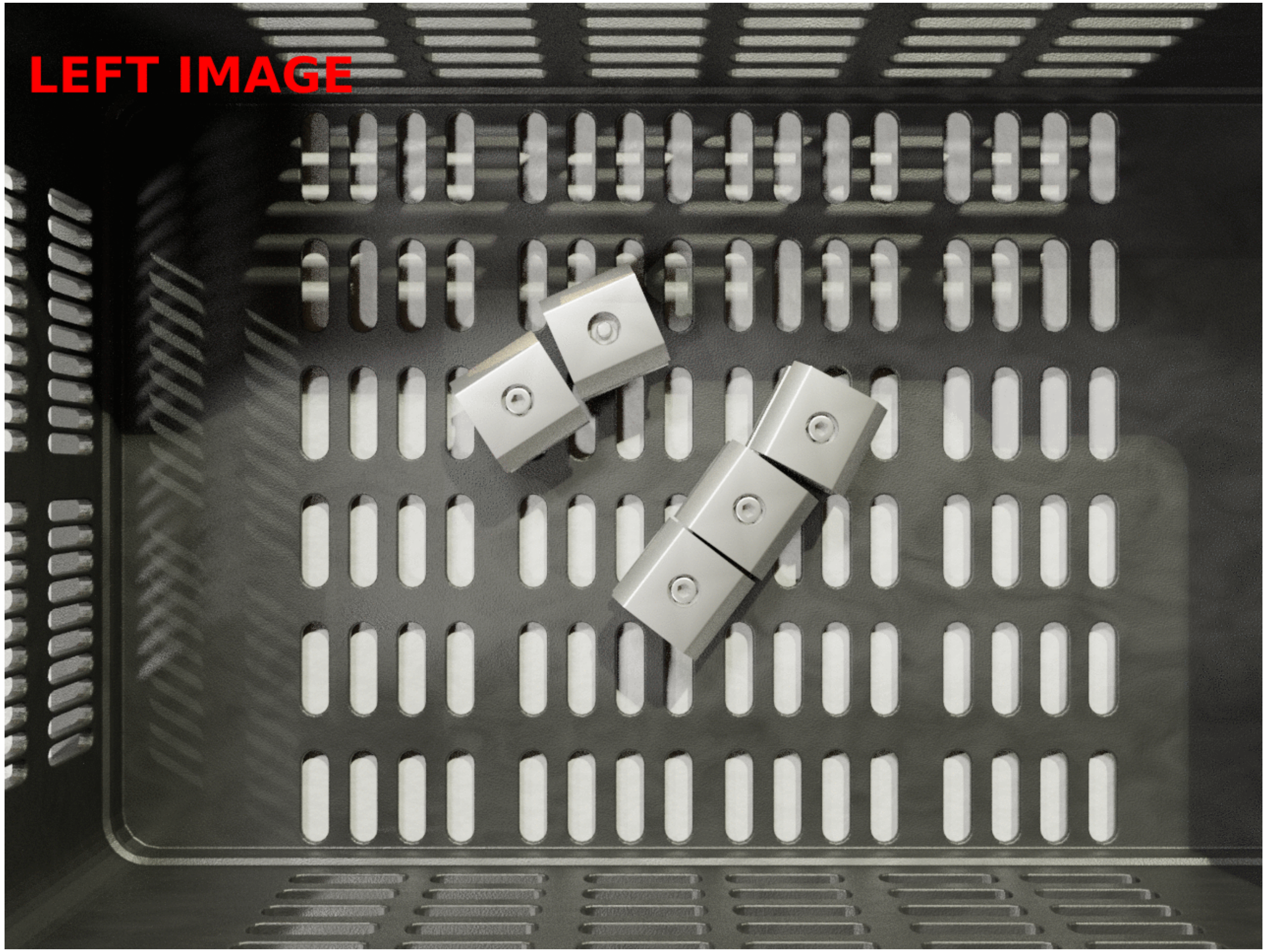
roboception

rc_reason CADMatch

TWO-STAGE DETECTION USING CAD MODELS

Stage 1: Object detection and pose estimation using machine learning (CNNs). Automated training procedure on simulation images, no manual labeling required

Stage 2: Object pose refinement to reach target accuracy



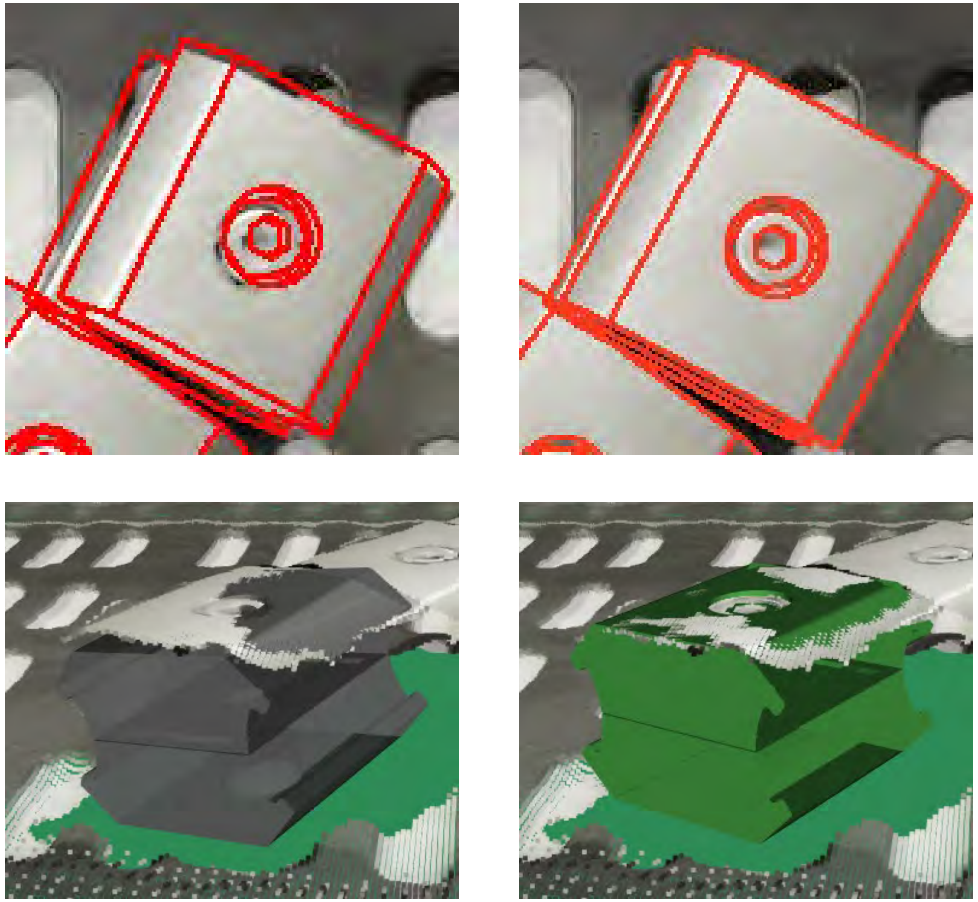
roboceptıon

rc_reason CADMatch

EDGES AND POINT CLOUD ALIGNMENT FOR ACCURATE DETECTION

- Object poses estimated by the AI component are refined to reach the target accuracy
- The pose refinement component:
  - Aligns edges in the CAD model to edges in the 2D image
  - Aligns the CAD model surface to the 3D point cloud
- Advantages of this solution
  - Robustness to environment conditions from AI component
  - Robustness to missing data in 3D reconstruction
  - Leverage multi-object view from stereo system

Stage 1 **Stage 2**

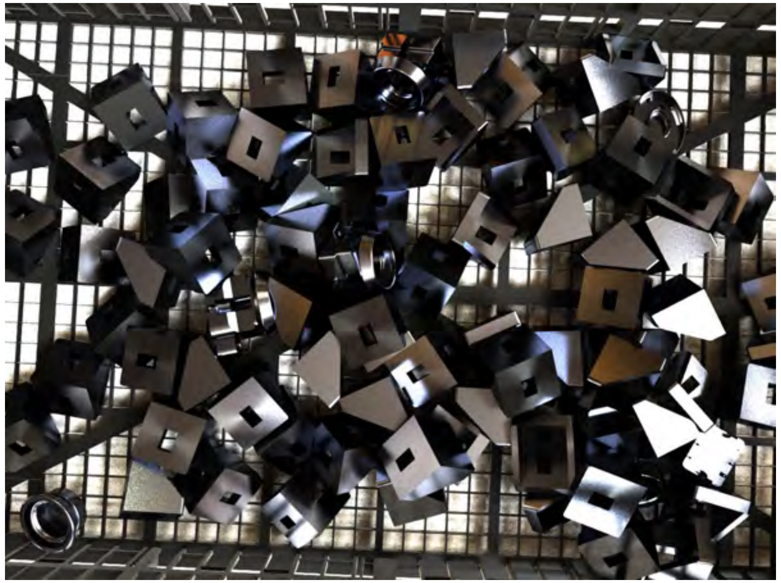


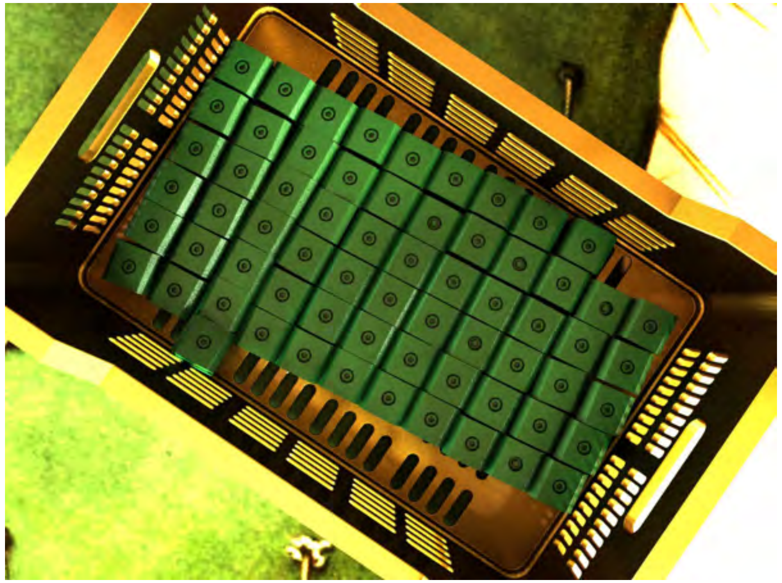
roboception

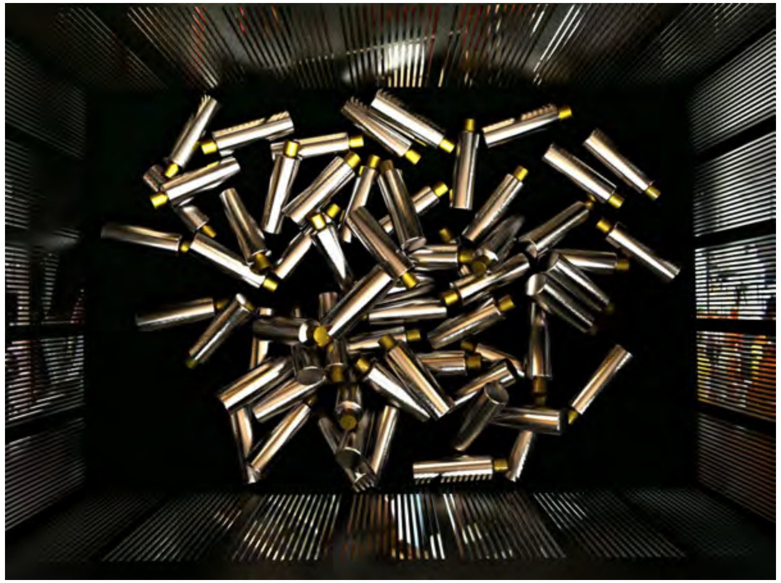
CADMatch Template Generation

SIMULATION ENVIRONMENT

- Training images generated in a photorealistic simulation environment
- Large material library for robustness against color response and lightning conditions
- Requires **no on-site** data recording
- Support for different use-cases and multi-material parts







CADMatch Template Generation

PERFORMANCE EVALUATION IN SIMULATION ENVIRONMENT

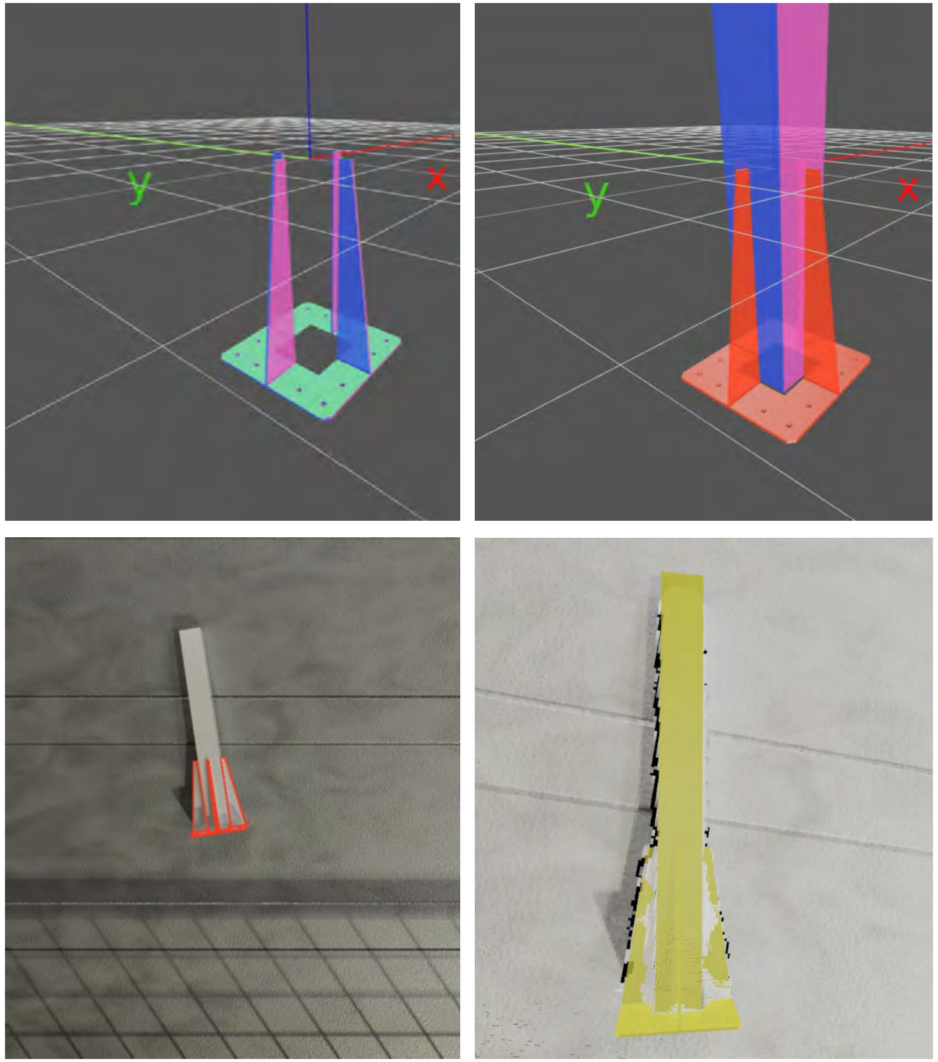
- The simulation environment is also used to estimate the achievable detection accuracy for each part
- The 3D point cloud is computed using Roboception stereo algorithm from a simulated stereo image pair (high realism of 3D data, including sensor noise)
- Training can be enriched with real data
- Simulation results included in a report provided with each template




CADMatch Template Generation

PARTIAL TEMPLATES

- Enables detection of portions of a complete CAD model (partial objects)
- Target use-cases:
    - Large objects that cannot be entirely in one camera view
    - Objects that are highly occluded when placed in a bin (e.g. large stacks of flat parts)
    - Configurable objects (e.g. a switch that can change between two configurations)
    - Partially solid objects: object that have a partially soft or changing structure (e.g. brushes)

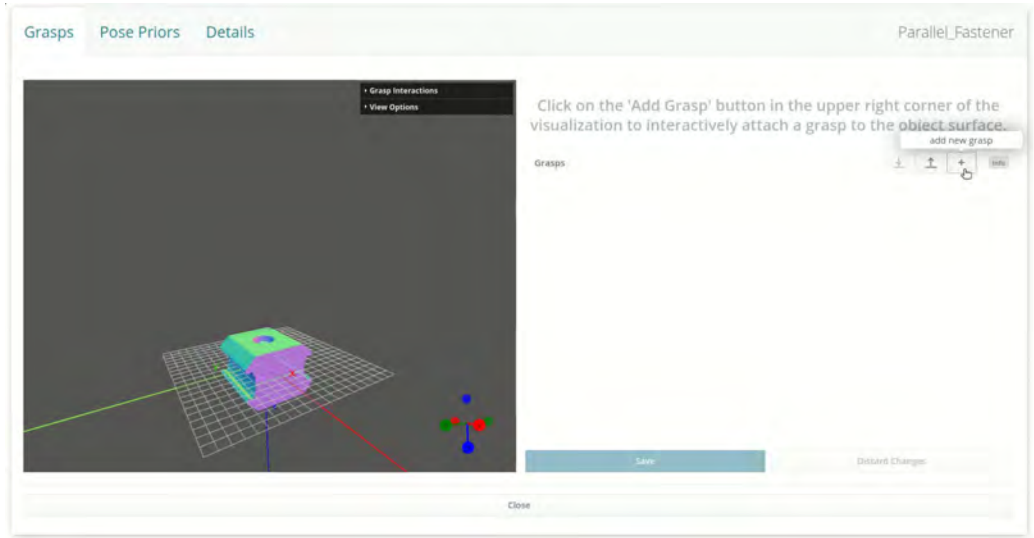


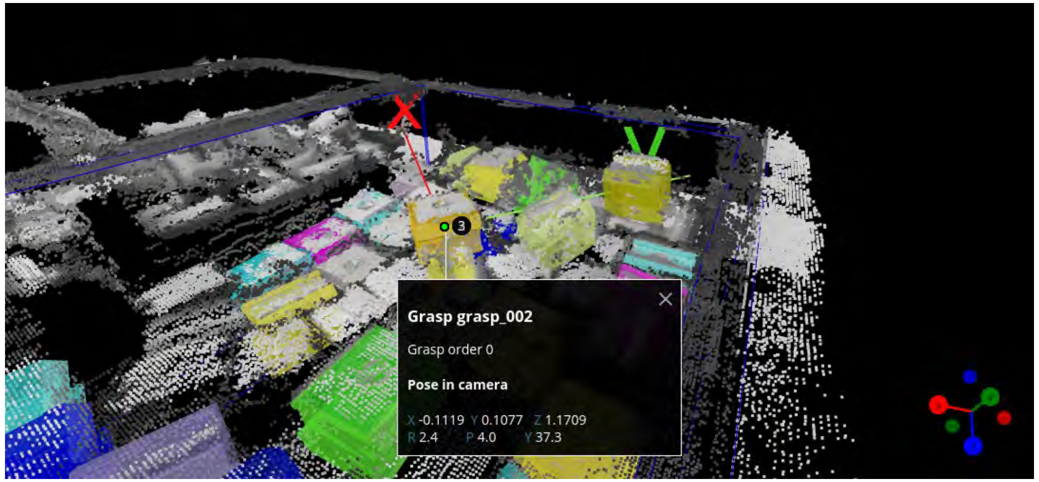
roboceptıon

CADMatch Configuration

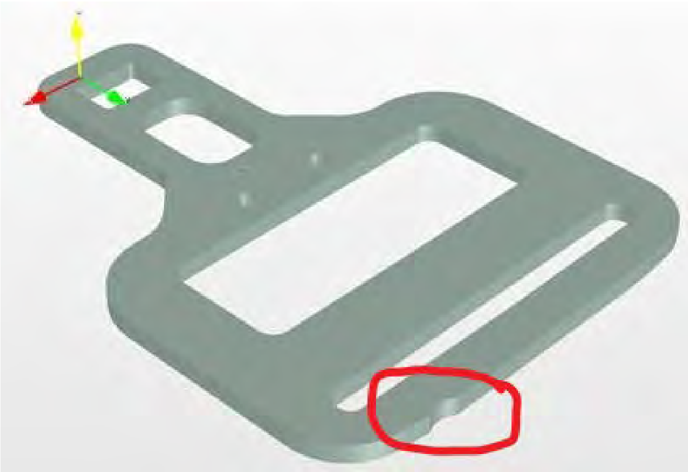
GRASP TEACHING INTERFACE

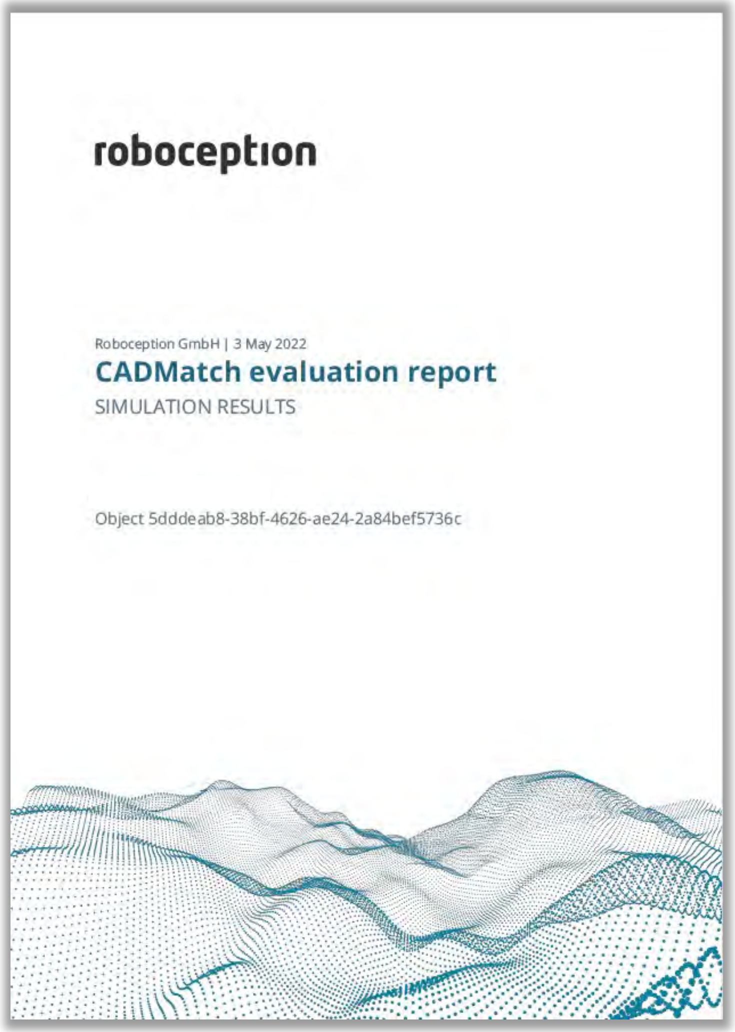
- Grasp poses are configurable
  - via the Web GUI with an interactive visualization of the CAD model
  - programmatically via the REST API
- Automatic projection of grasps on symmetric objects
- Configurable sorting strategies define the order of grasps returned at detection time
- A preferred TCP orientation can be configured to minimize the rotation of the gripper during picking





CADModel and CADMatch Report




roboception

Roboception GmbH | 3 May 2022

CADMatch evaluation report

SIMULATION RESULTS

Object 5dddeab8-38bf-4626-ae24-2a84bef5736c

Object model

1 Object model

The object origin corresponds to the object center of mass.

The model used by CADMatch has a position offset to the original CAD model of [0.000, -0.057, -0.001] m.

The object does not have any exact symmetry.

The object has a discrete partial symmetry.

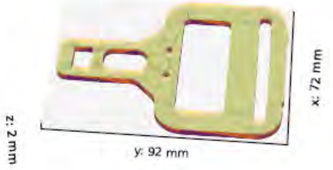


Figure 1.1: CAD model and object dimensions.

The table below reports the indicative minimum and maximum detection distances for different rc_visard models. Additionally, the rc_visard X-Y workspace at the minimum and maximum distances is also shown.

The maximum distance is computed assuming an object minimum size in the camera image of 100 pixels.

Table 1.1: Indicative CADMatch detection ranges.

		rc_visard 65m/c	rc_visard 160m/c	rc_visard 160m-6	rc_viscore
Min Distance	Z [mm]	200	500	500	500
	Workspace [mm]	175x180	440x450	240x300	233x324
Max Distance	Z [mm]	870	870	1305	3782
	Workspace [mm]	979x783	884x783	884x783	3143x2453

-confidential- 2

Example Case

DETECTION ACCURACIES

Working range:

		rc_visard 65m/c	rc_visard 160m/c	rc_visard 160m-6	rc_viscore
Min Distance	Z [mm]	200	500	500	500
	Workspace [mm]	175x180	440x450	240x300	233x324
Max Distance	Z [mm]	870	870	1305	3782
	Workspace [mm]	979x783	884x783	884x783	3143x2453

Detection for best matched parts:

	Position accuracy [mm]	Rotation accuracy [deg]	Rotation accuracy with symmetry [deg]
Mean	2.035	38.1	1.3
Standard Dev	1.026	72.4	1.0
Median	2.006	1.3	1.0

Assuming the parts to be symmetric (ignoring the Poke-Yoke feature) gives good results

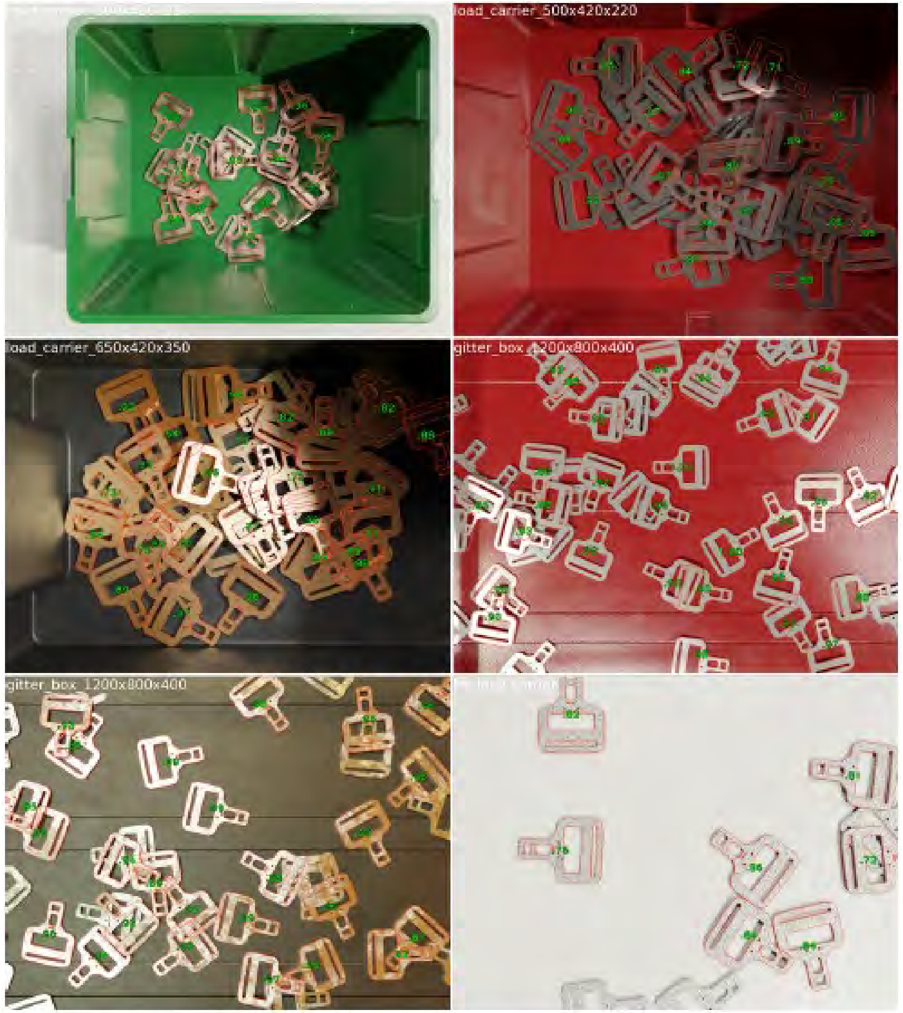
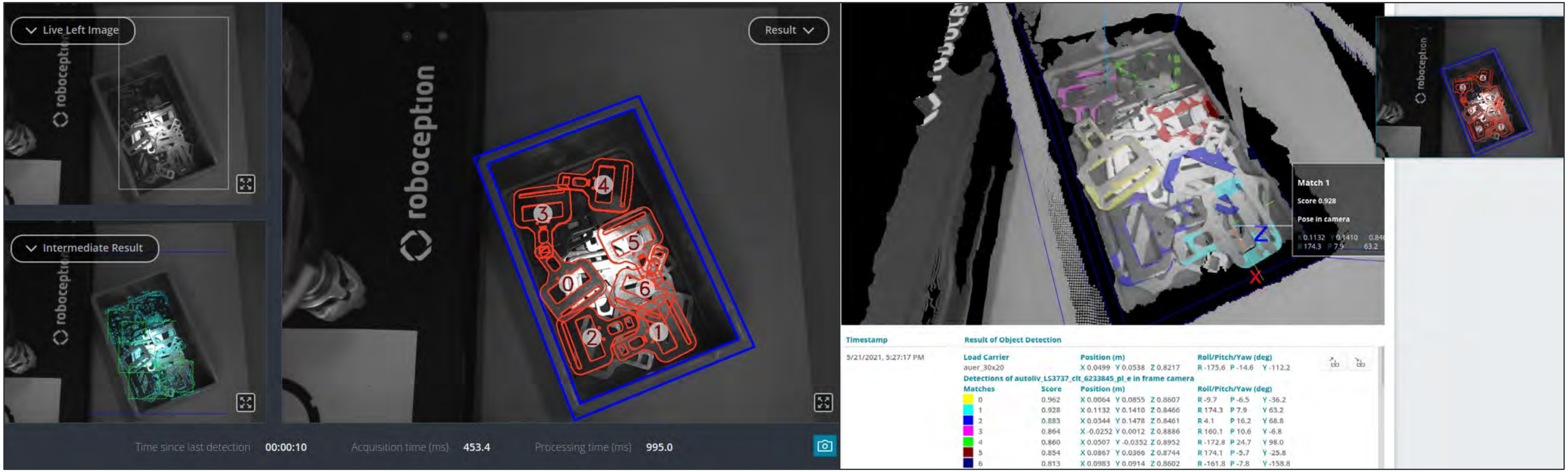


Figure 2.1: Sample detection results on simulation images. The green number represents the detection score computed by CADMatch.

Example Case

DETECTION RESULTS IN SIMULATION MODE



Model-based Machine Learning for Pick-and-Place in Agile Production

- 3D stereo for sparse and dense data, as resolution can be easily scaled
- Combined object detection using classical and machine learning approaches delivers robustness and flexibility
- Intuitive standard interfaces allow for compatibility and usability by non-vision experts
- Machine learning-based picking can be differentiated:
  - Offsite training without labelling in unmixed scenarios
  - Data-driven and onsite training for mixed scenarios
- Bundles/interoperable components allows scaling effects by reduction of project specific engineering effort

roboception

THANK YOU

Cooperating Robots and Applied AI for Reconfigurable Manufacturing

Presenter: Christos Gkournelos

Laboratory for Manufacturing Systems and Automation, University of Patras, Greece

Email: gkournelos@lms.mech.upatras.gr

The Problem

Factories struggle to follow the market demand for new products

Fixed automation is efficient only for mass production

- Processes are predetermined
- Robots & machines in fixed position & pre-programmed
- Costs time and effort to introduce new product variants

Full manual production creates strain to workers

- **7.6 million people** must lift and carry heavy loads
  - Musculoskeletal disorders (MSD)
  - High work absenteeism reasons → production downtimes

Current Practices

Industrial practice

- High payload Industrial robot in fences
- No collaboration among varying resource types
- AGVs follow fixed navigation paths
- Production stops due to lack of consumables

Automated Guided Vehicles

Industrial robots in cages

R&D practice

- Only low payload collaborative robots
- Mobile manipulators face poor acceptance in industrial settings
- Research on the individual parts neglecting real use cases
- Lack of perception abilities

Source: MM-500, Neobotix.

Collaborative low payload robots

New Assembly paradigm

- Eliminated fixed tooling and jigs
- Flexible and exchangeable tooling
- Robot arms on mobile platforms
- Ability to collaborate with humans

THOMAS

Mobile dual arm robotic workers with embedded cognition for hybrid reconfigurable manufacturing systems

Visit our website: www.thomas-project.eu

LMS
Laboratory for Manufacturing Systems & Automation
(Project Coordinator)

PSA GROUPE

INTRASOFT INTERNATIONAL

AERnnova

roboception

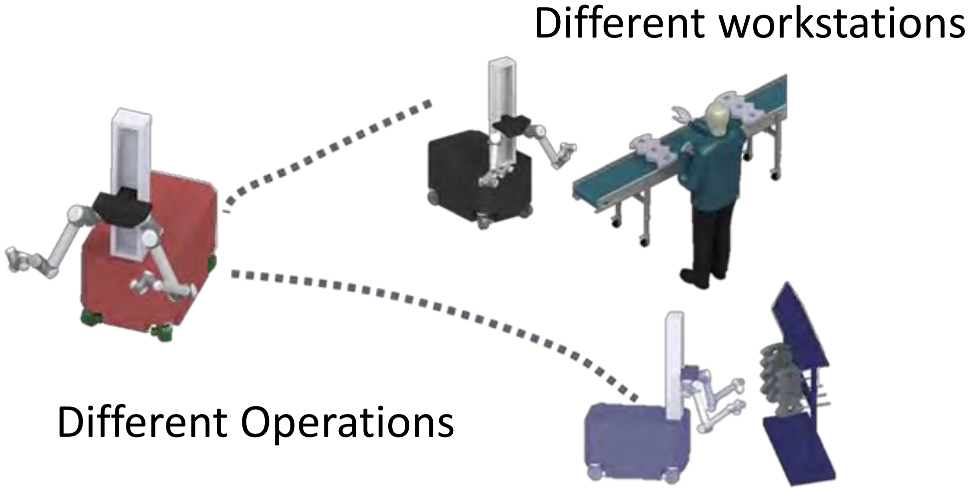
tecnalia Inspiring Business

SICK Sensor Intelligence.

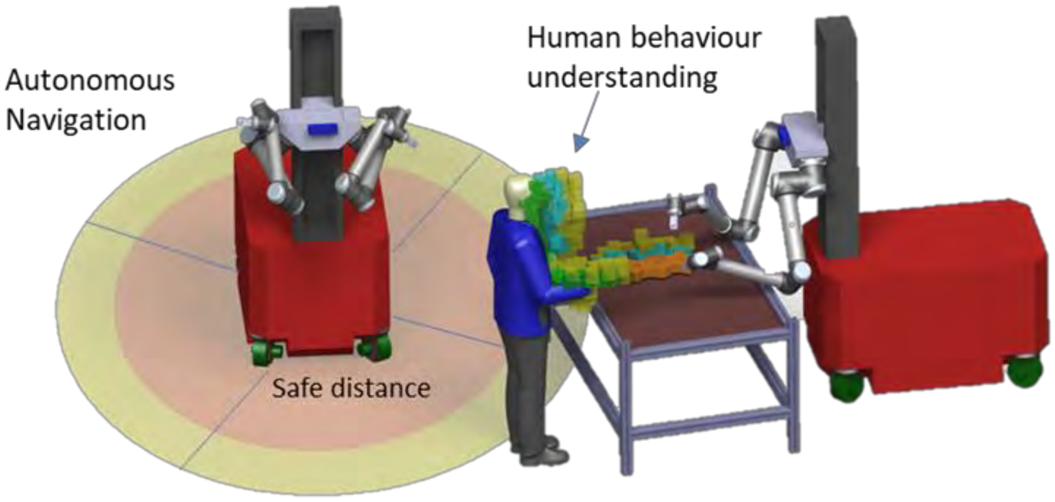
DGH ingeniería mantenimiento industrial

Dynamic Reconfigurable Factories

Flexible robot workers...

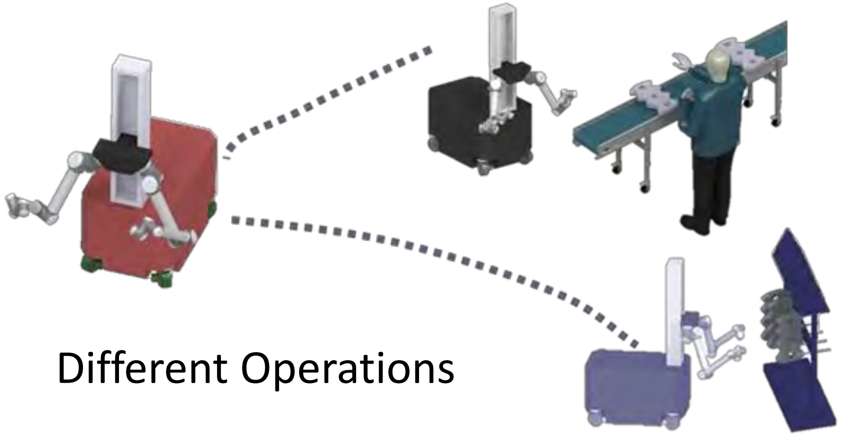


...acting as assistants to humans

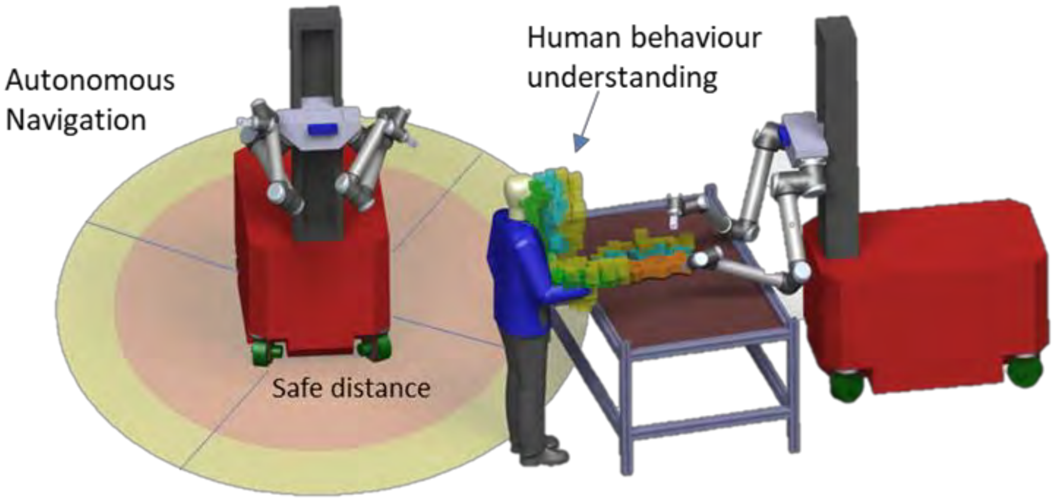


Dynamic Reconfigurable Factories

Flexible robot workers…

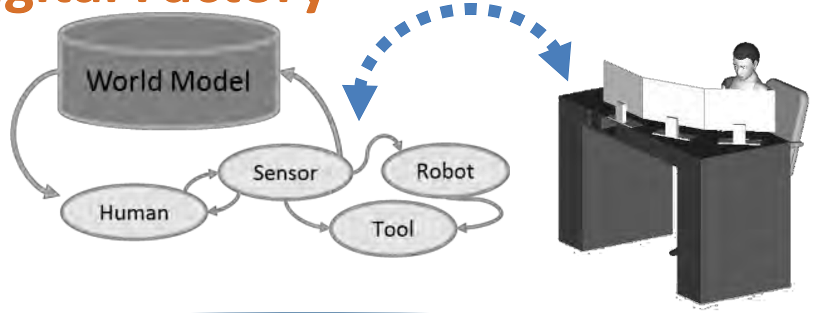


…acting as assistants to humans



… enabled by a Smart Robot Control System

Digital Factory



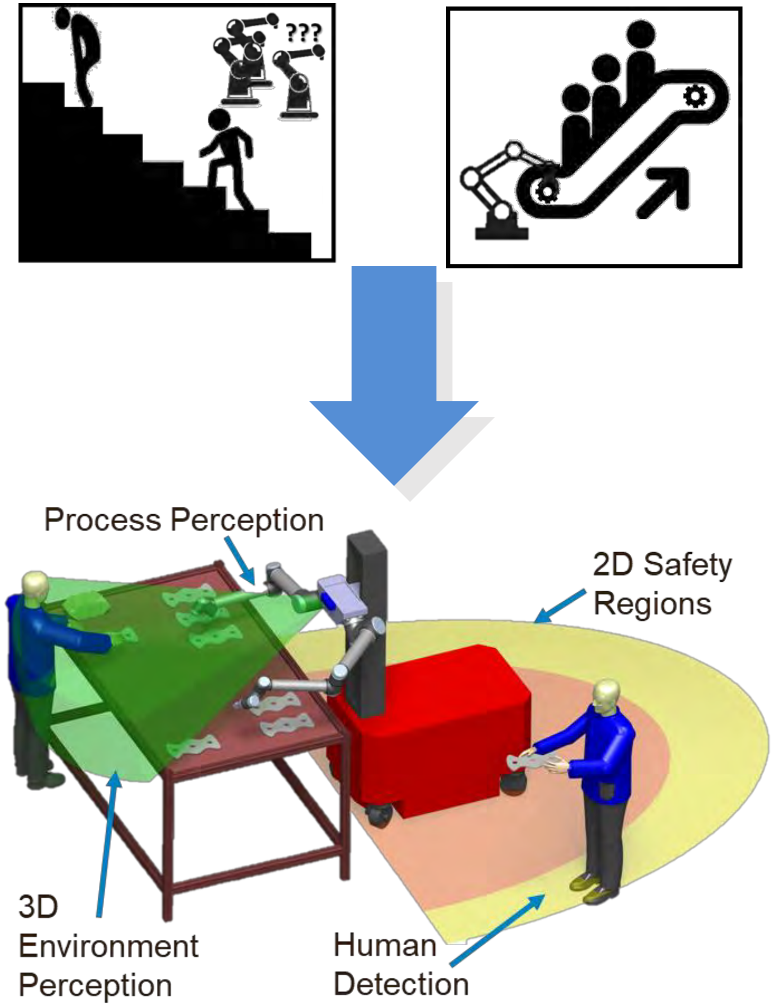
Artificial Intelligence

- Dynamic Task Planning
- Human behaviour understanding
- Robot Collision free trajectories

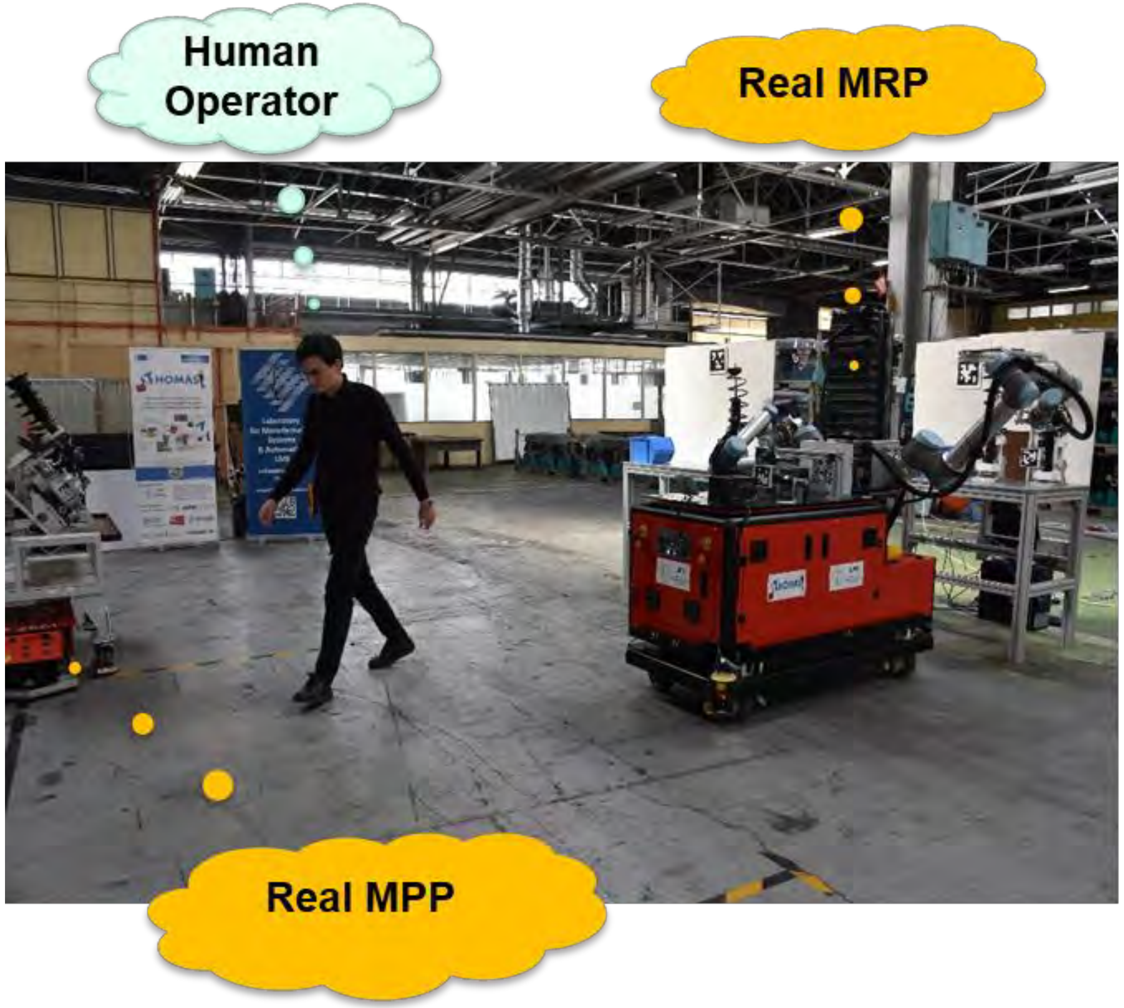
Challenges

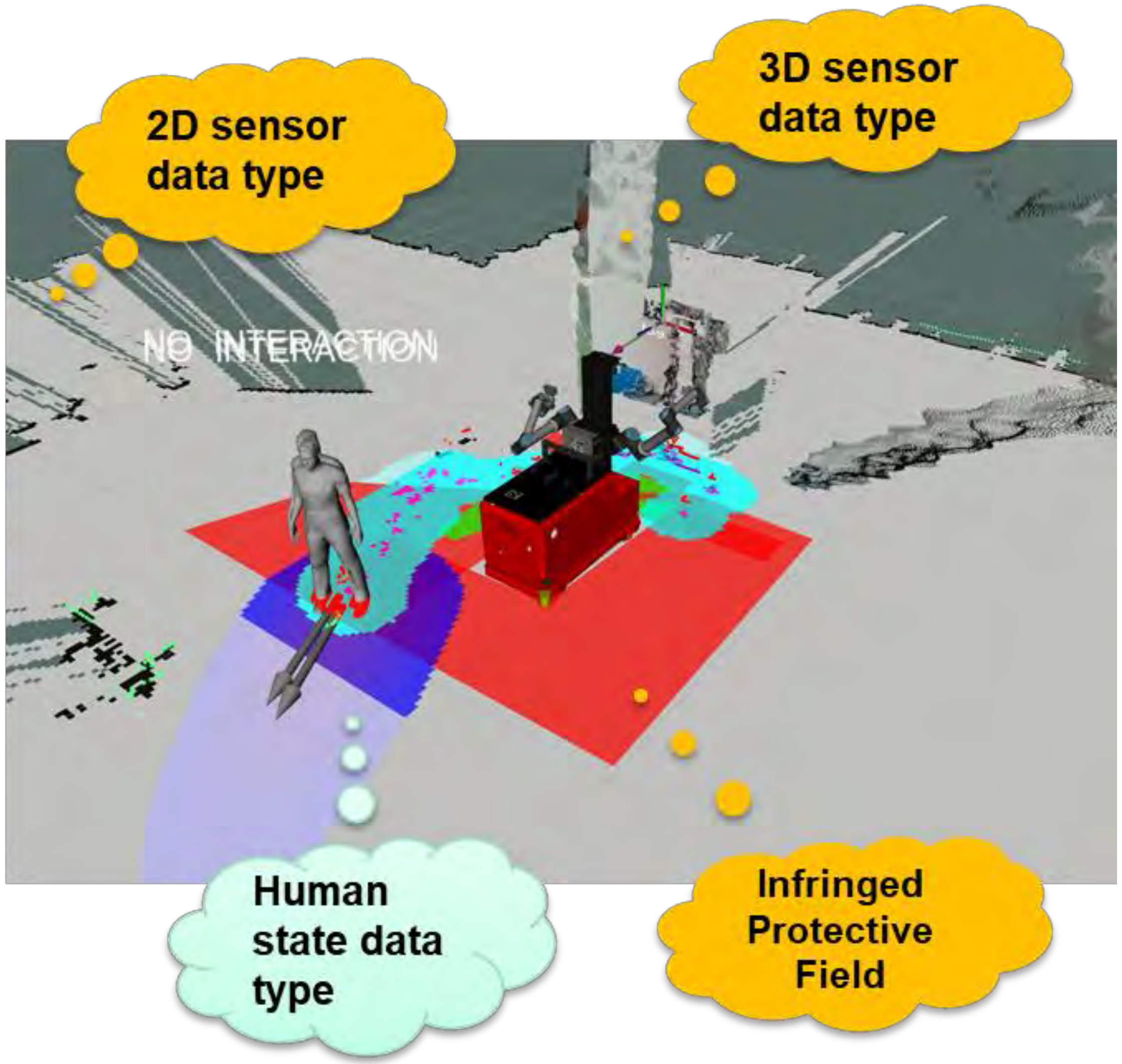
To enable system's **autonomy** and **reconfigurability :**

- Perception for the environment
- Perception for the process
- Perception for the human operators
- Where to find the required data?



Digital Twin





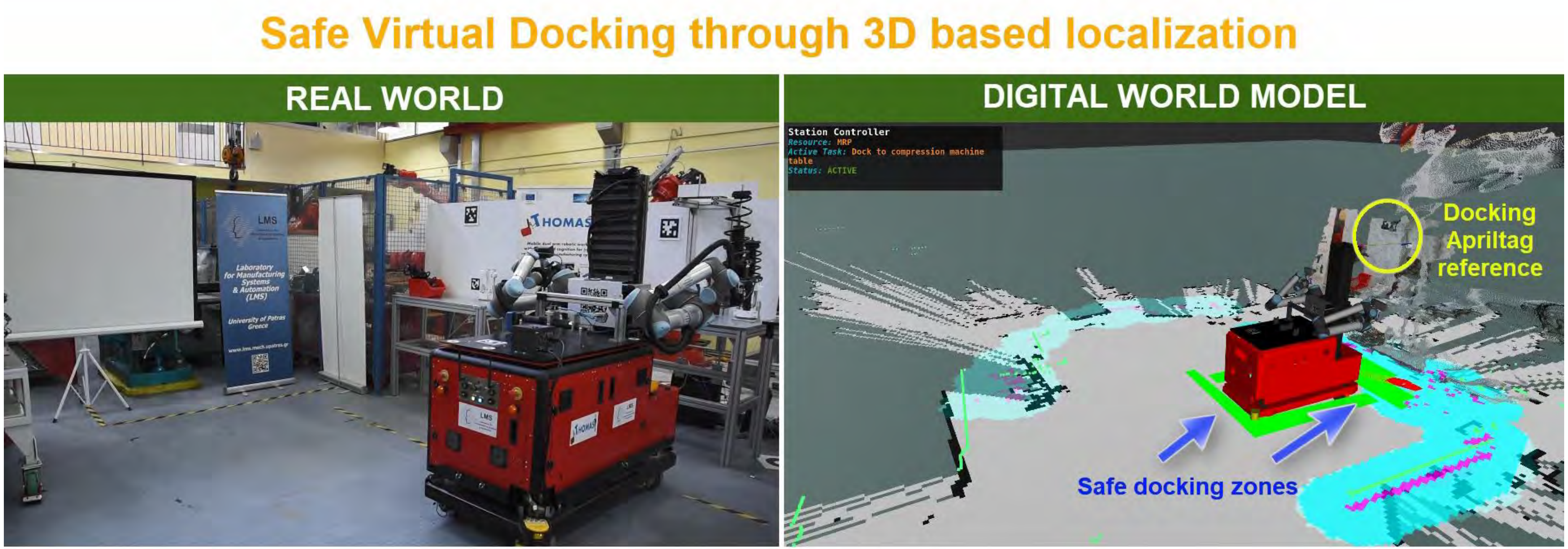
Perception for the Environment

Perception of the environment

Navigation (cell to cell) and **localization** (in-cell – safe)

ACCURACY ≈ 5 - 10 cm

ACCURACY ≈ 1 cm



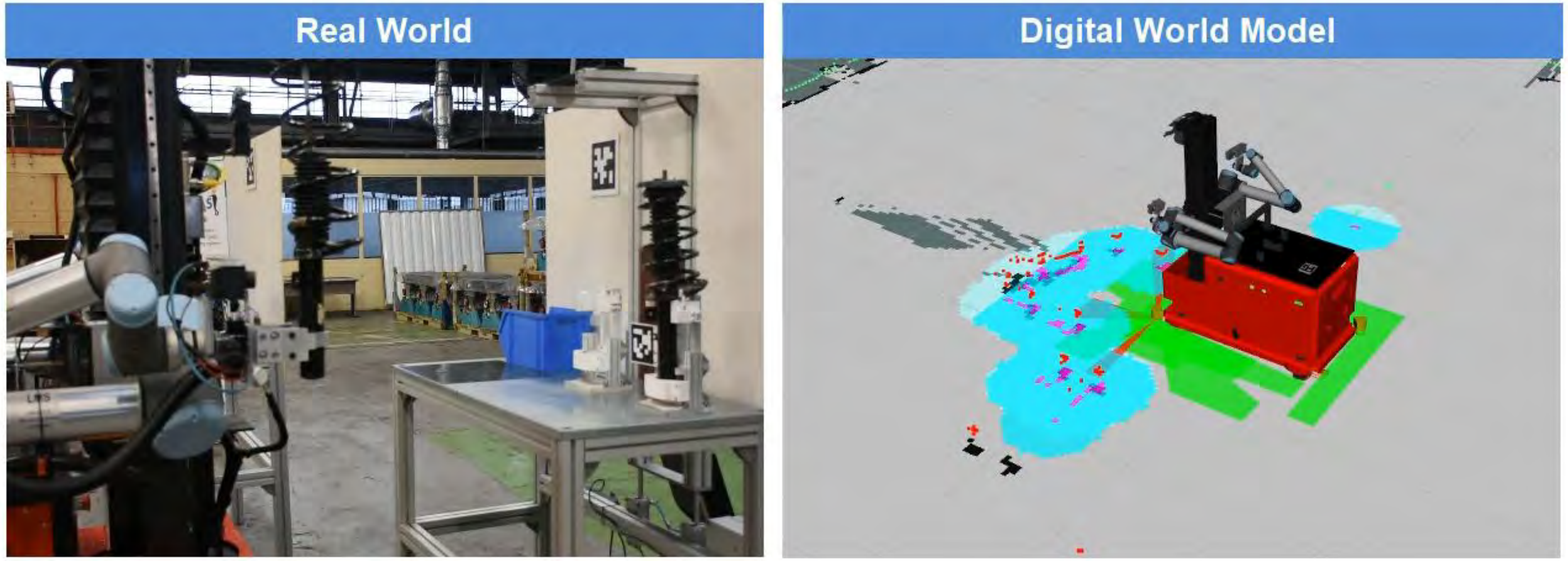
Perception for the Process

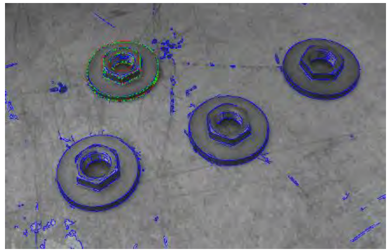
End to end integration of:

roboception

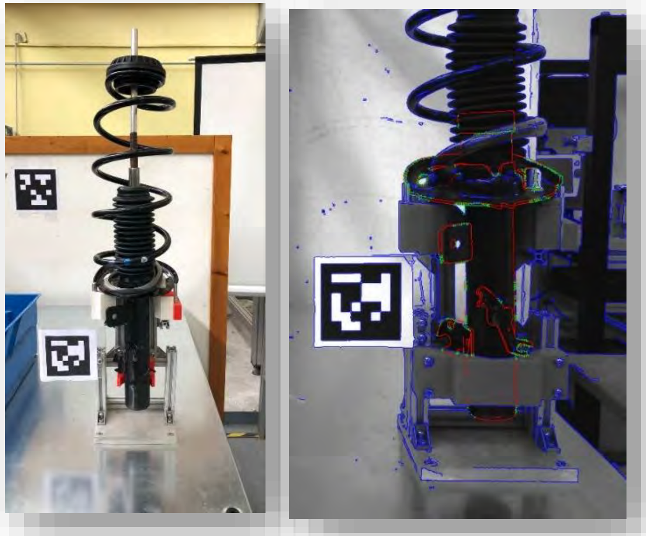
✓ **3D vision** systems enabling **process perception for manipulation**

ACCURACY ≈ **15 mm translation** **10 deg. rotation**



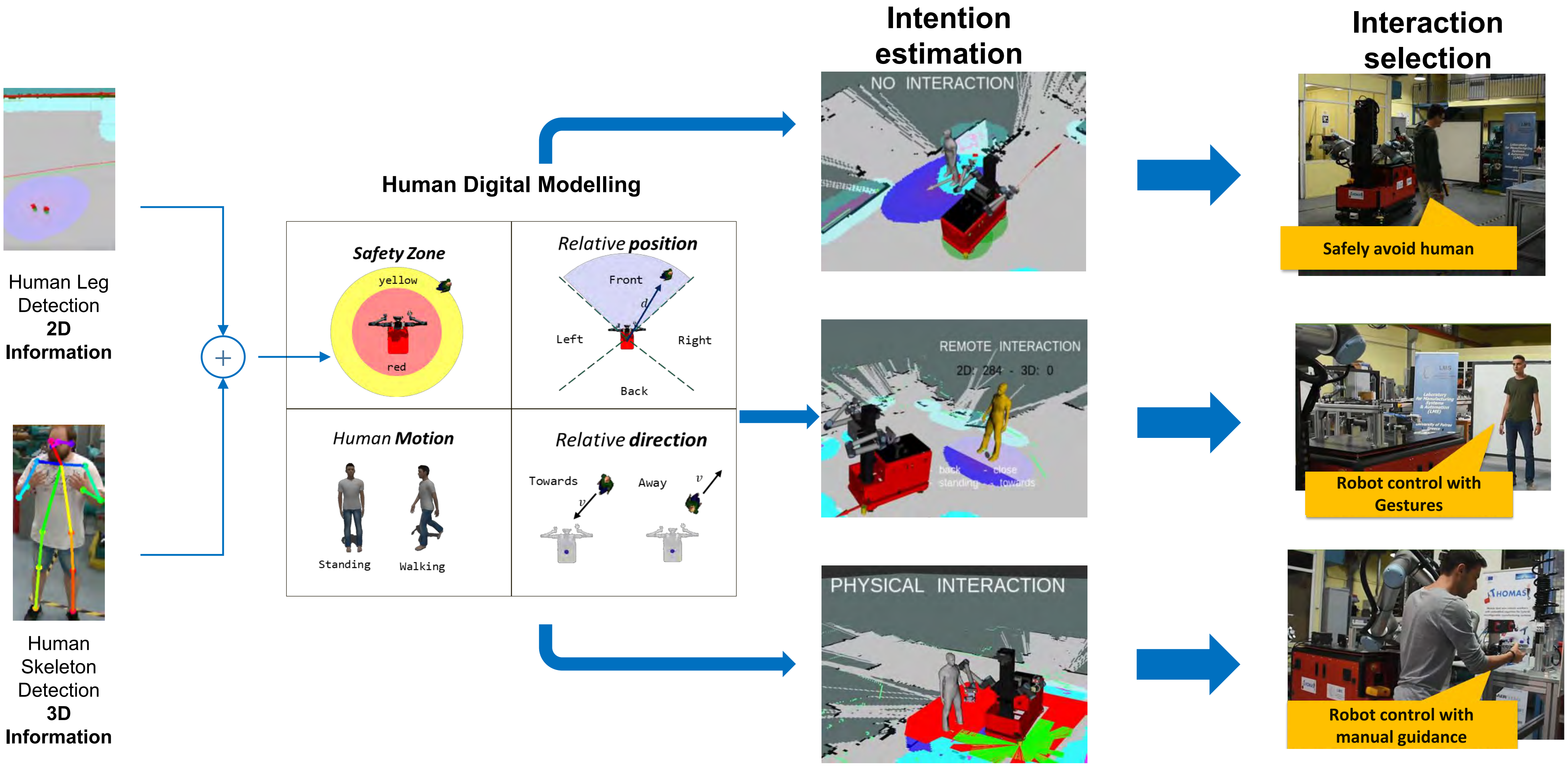


Nuts



Pre-compressed damper's detection

Perception for the Human



Open – Digital – Industrial and Networking pilot lines using modular components for scalable production

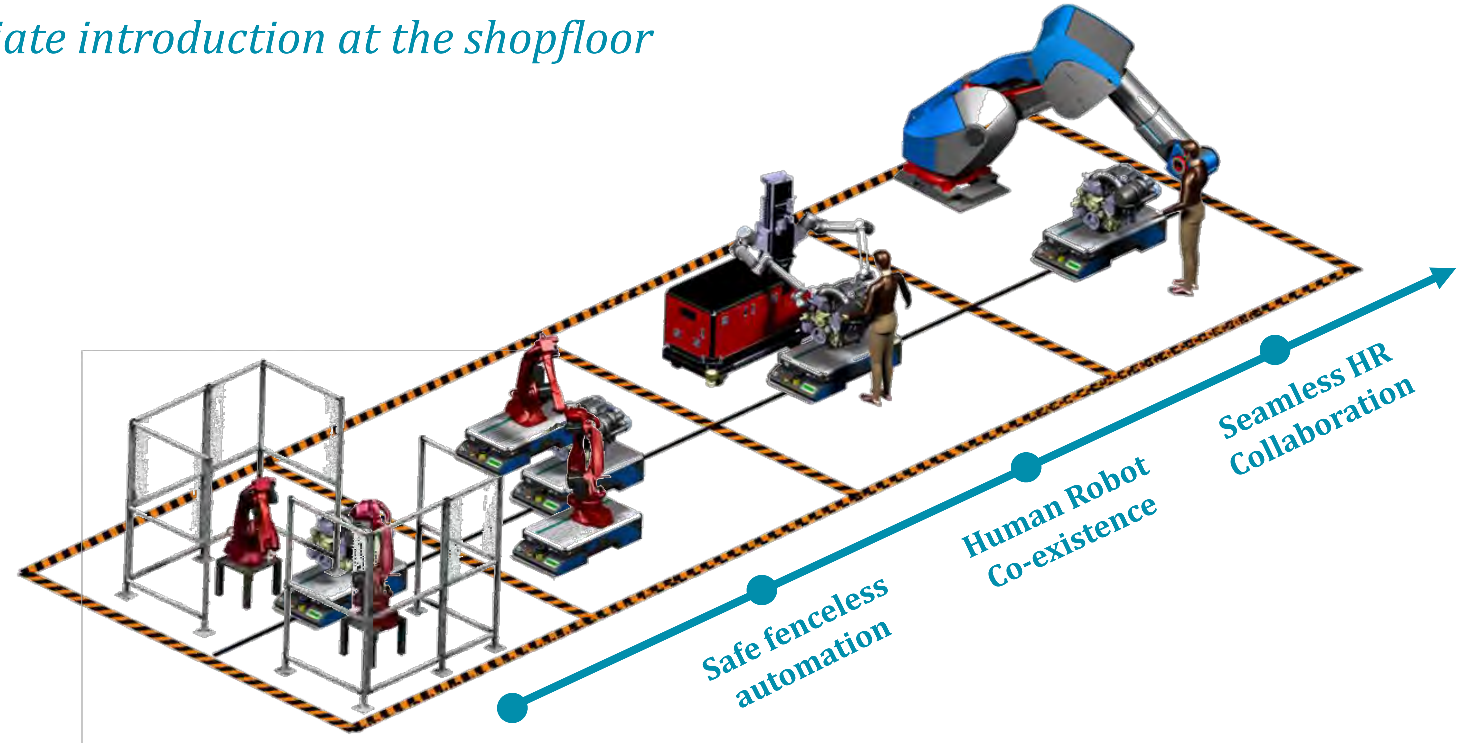
Visit our website: http://odin-h2020.eu/

(Project Coordinator)

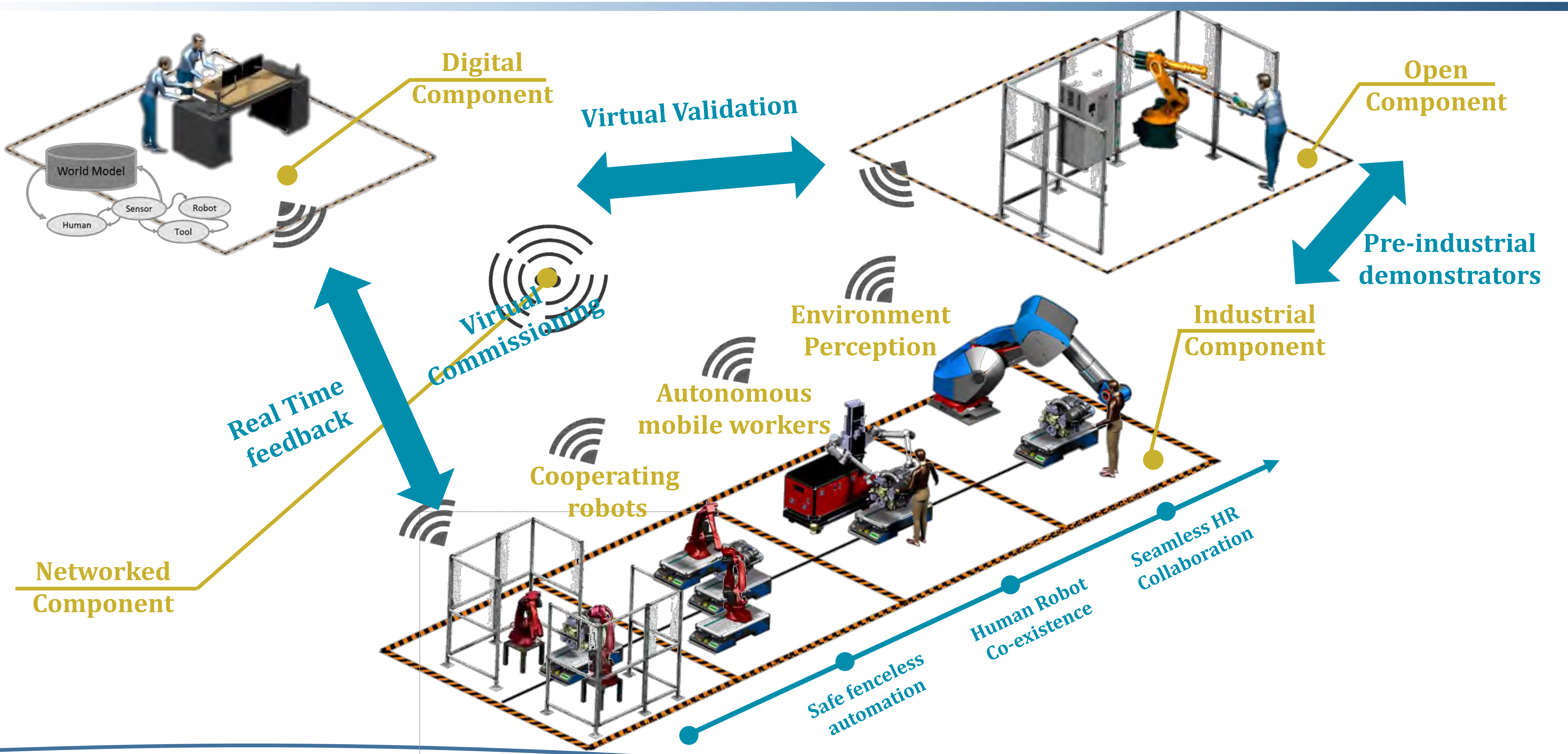
ODIN Ambition

How to integrate these modern robot capabilities?

ODIN vision is to *demonstrate that these modern robot capabilities are not only technically feasible, but also efficient and sustainable for immediate introduction at the shopfloor*



ODIN Approach



Thank you for your attention!

Presenter: Christos Gkournelos

Laboratory for Manufacturing Systems and Automation
University of Patras, Greece
Email: gkournelos@lms.mech.upatras.gr

References

- N. Kousi, G. Michalos, S. Aivaliotis, S. Makris, An outlook on future assembly systems introducing robotic mobile dual arm workers, Procedia CIRP. 72 (2018) 33–38. doi:10.1016/j.procir.2018.03.130.
- Michalos, G., Kousi, N., Makris, S., Chryssolouris, G., 2016. Performance Assessment of Production Systems with Mobile Robots. Procedia CIRP 41, 195–200. doi:10.1016/j.procir.2015.12.097
- G. Michalos, S. Makris, G. Chryssolouris, "The new assembly system paradigm", International Journal of Computer Integrated Manufacturing, Available Online (2014)
- G. Michalos, P. Sipsas, S. Makris, G. Chryssolouris, "Decision making logic for flexible assembly lines reconfiguration", Robotics and Computer-Integrated Manufacturing, Available Online (2015)
- G. Michalos, S. Makris, N. Papakostas, D. Mourtzis, G. Chryssolouris, “Automotive assembly technologies review: challenges and outlook for a flexible and adaptive approach”, CIRP Journal of Manufacturing Science and Technology, Volume 2, Issue 2, 2010, Pages 81-91 DOI: 10.1016/j.cirpj.2009.12.001.
- G. Michalos, S. Makris, D. Mourtzis, “An intelligent search algorithm based method to derive assembly line design alternatives”, International Journal of Computer Integrated Manufacturing, Volume 25, Issue 3, 2012, 211 -229
- P. Tsarouchi, G. Michalos, S. Makris, G. Chryssolouris, Vision System for Robotic Handling of Randomly Placed Objects, Procedia CIRP, Volume 9, 2013, Pages 61-66.
- S. Makris, P. Tsarouchi, A.-S. Matthaiakis, A. Athanasatos, X. Chatzigeorgiou, M. Stefos, K. Giavridis, S. Aivaliotis, Dual arm robot in cooperation with humans for flexible assembly, CIRP Annals - Manufacturing Technology. 66 (2017) 13–16. doi:10.1016/j.cirp.2017.04.097
- S. Makris, P. Karagiannis, S. Koukas, A.-S. Matthaiakis, Augmented reality system for operator support in human–robot collaborative assembly, CIRP Annals - Manufacturing Technology. 65 (2016) 61–64. doi:10.1016/j.cirp.2016.04.038.
- N. Kousi, S. Koukas, G. Michalos, S. Makris, "Scheduling of smart intra – factory material supply operations using mobile robots", International Journal of Production Research, Volume 57, Issue 3, pg. 801-814, (2018)
- P. Aivaliotis, A. Zampetis, G. Michalos, S. Makris, "A machine learning approach for visual recognition of complex parts in robotic manipulation", 27th International Conference on Flexible Automation and Intelligent Manufacturing, (FAIM2017) 27-30 June, Modena, Italy, Volume 11, pp. 423-430 , (2017)
- K. Alexopoulos, S. Makris, V. Xanthakis, K. Sipsas, G. Chryssolouris, "A concept for context-aware computing in manufacturing: the white goods case", International Journal of Computer Integrated Manufacturing, 29(8), pp. 839-849 (2016)
- K. Kaltsoukalas,S.Makris,G.Chryssolouris, "On generating the motion of industrial robot manipulators", Robotics and Computer-Integrated Manufacturing, Volume 32, pp. 65–71 (2015)
- G. Chryssolouris, V. Subramaniam, "Dynamic scheduling of manufacturing job shops using genetic algorithms", Journal of Intelligent Manufacturing, Volume 12, No. 3, pp. 281-293 (2001)

Round Table Discussion

EUROPEAN ROBOTICS FORUM

ERF2022 ROTTERDAM 28-30 JUNE

eu ROBOTICS

Applied AI Responds to Three Major Trends in Robotics

#1

GOOD DATA INSTEAD OF BIG DATA REDUCES ONSITE TRAINING TIME

- Simulation helps create realistic training data using model-knowledge
- Ground truth can be used in the training
- Enrichment with data instead of data online
- Results in accuracy in mm and not detection rates in percent

#2

SCALABLE ML SOFTWARE PLATFORM FOR PLUG-AND-PRODUCE

- Share ressource by deployment concept
- Allow integrators and end customers to add modules on the same plattform
- Smart Sensors allow for distribution of computing ressources

#3

USING ML TO ENSURE EASE-OF-USE FOR NON-VISION EXPERTS

- ML reduces the parameter space for the customer
- Web Interfaces with wizards allow for non-expert use

Slides will be published on the website:
https://roboception.com/en/innovation-en/erf2022/

Interest in participating in TG Perception:
michael.suppa@roboception.de

and/or registration at
https://sparc-robotics-portal.eu/