EUROPEAN ROBOTICS FORUM
Brought to you by SPARC

Applied AI in Logistics and Industrial Automation

Dr. Michael SUPPA, Roboception GmbH, Germany

Towards applied AI in agile production, logistics, and lab automation Workshop

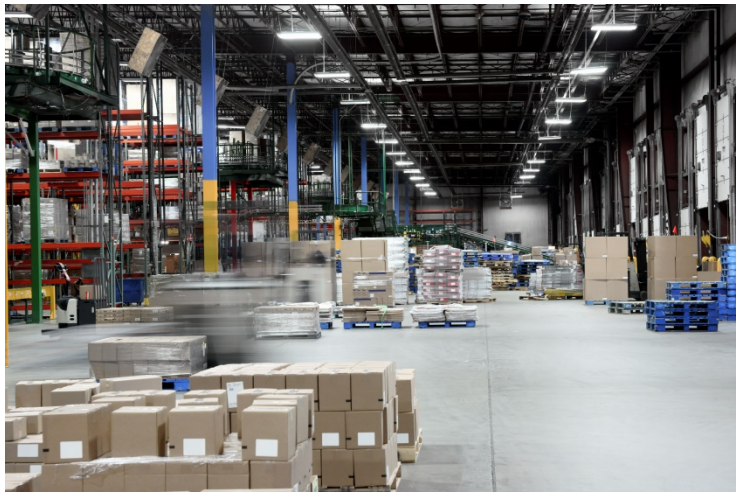
Virtual ERF 2021

April 14th, 2021

Industry 4.0: Users Seek Flexibility

LOW-COST ROBOTS ARE THE FUTURE

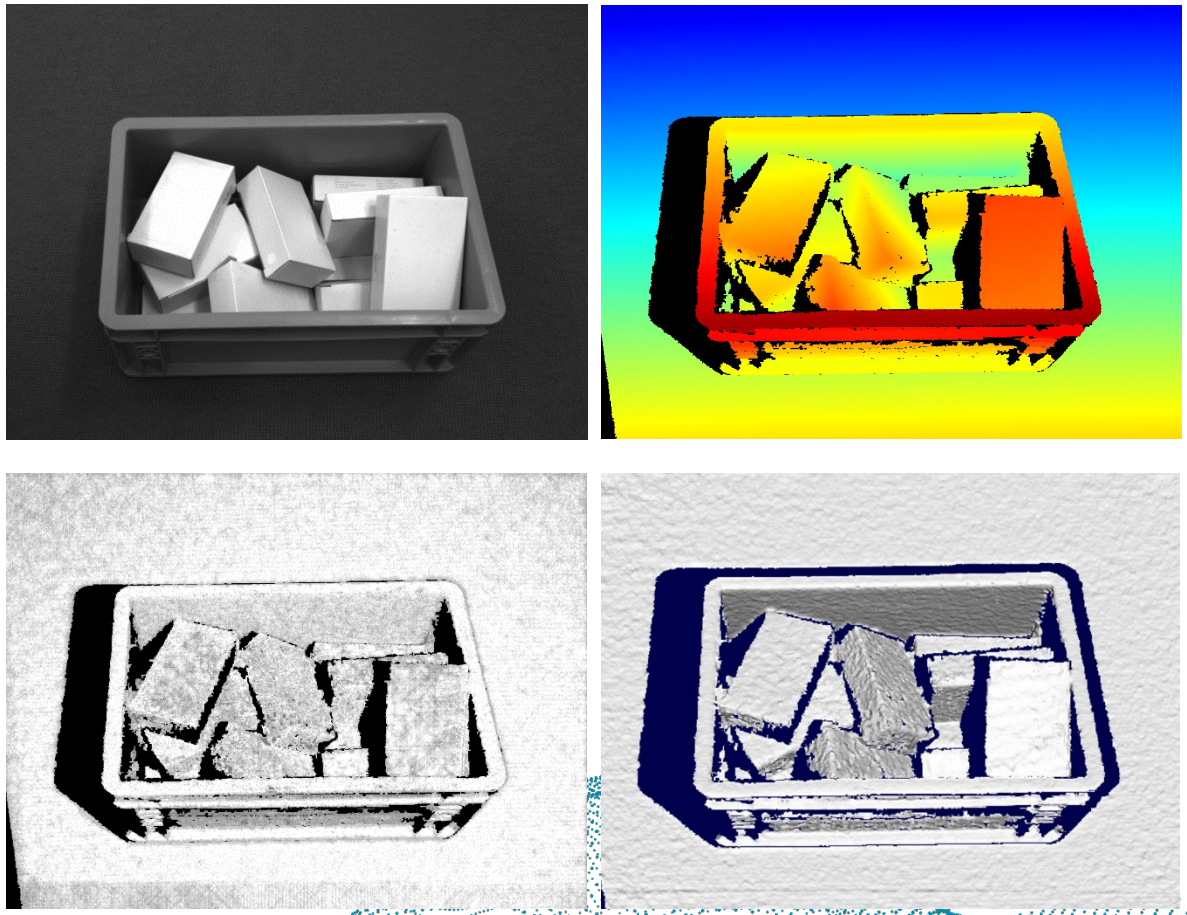
- Compatibility with robots and grippers
- Plug-and-Produce solutions
- Intuitive and standardized interfaces
- Ease-of-use for non-experts
- Modular software components, bundles
- On-board processing
- Affordability



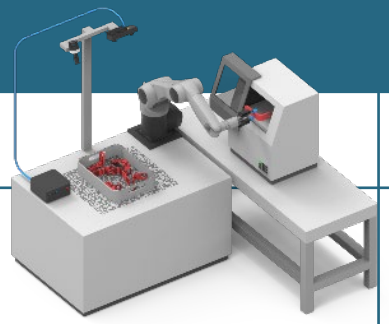
Why Stereo?

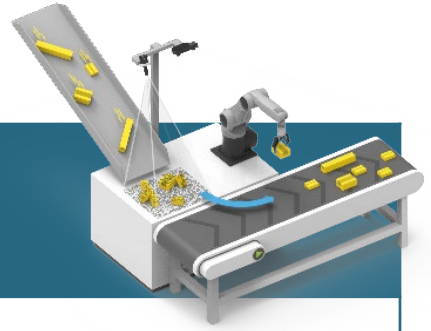
PERCEPTION IS THE KEY TECHNOLOGY FOR FLEXIBLE PRODUCTION

- 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



Requirements Vary Across Domains



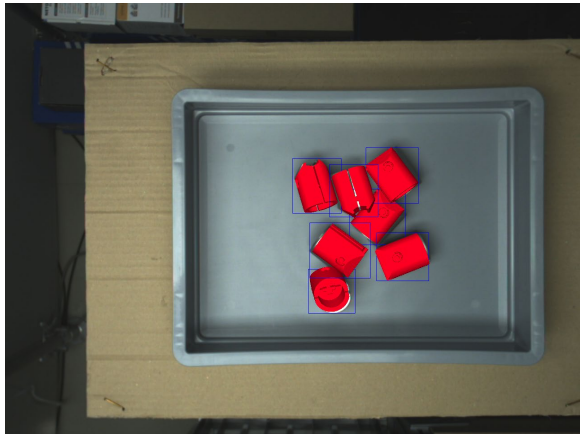


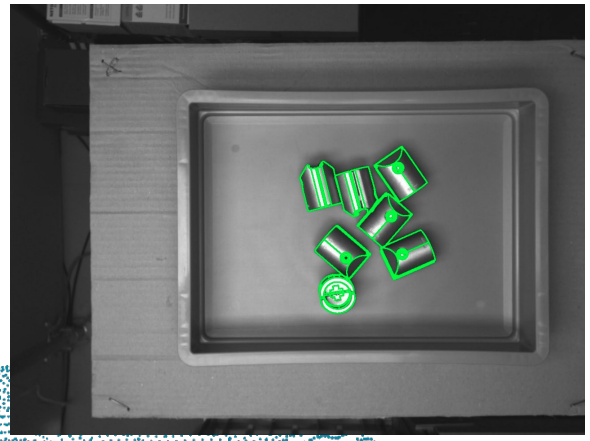
	INDUSTRIAL AUTOMATION	LOGISTICS
OBJECT TYPES	known	unknown
MIXED SCENARIO	(de)palletizing	postal items, goods returns
UNMIXED SCENARIO	machine tending	intralogistics, warehouse
KEY REQUIREMENT	accuracy and reliability	constant flow of goods
DOMINANT TASK	pick-and-place	pick-and-drop

Object Detection

ESSENTIALS

- 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 target accuracy by edge alignment
  - Classical algorithm





Collision Detection

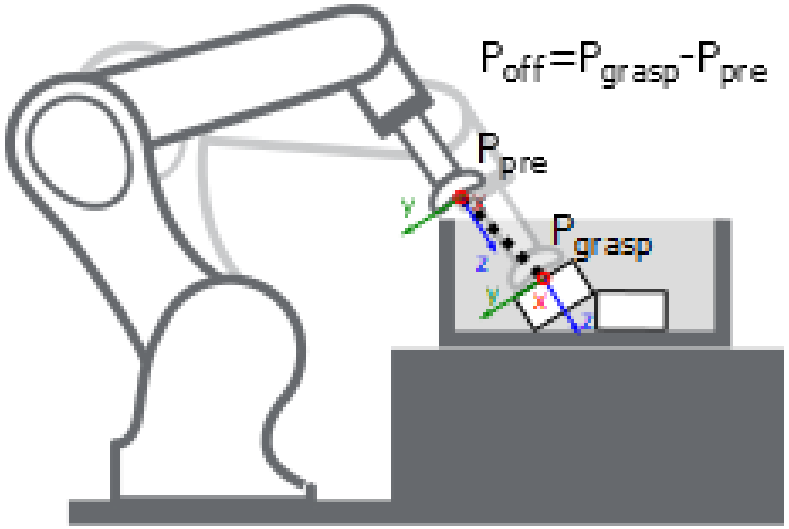
ESSENTIALS

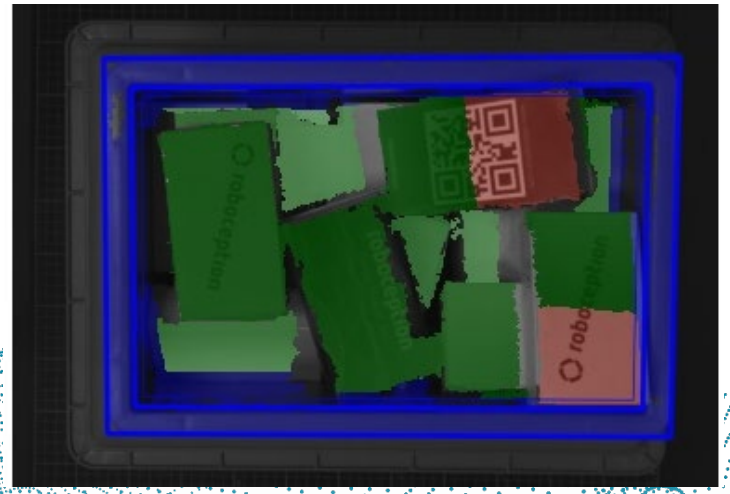
Technical Requirements

- Definition of a gripper, e.g. in the WebGUI
- Definition of grasps required for consideration of items

Approach

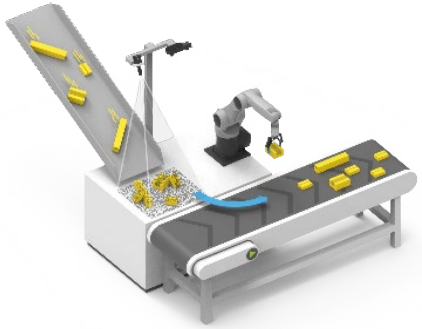
- Detect load carrier and items
- Perform collision check inside the bin
- Provide only grasps that are NOT in collision (load carrier and the detected items)

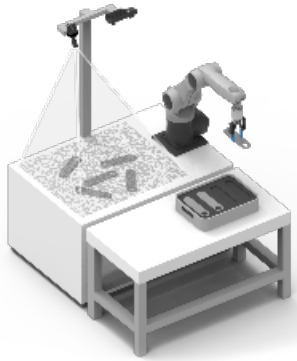


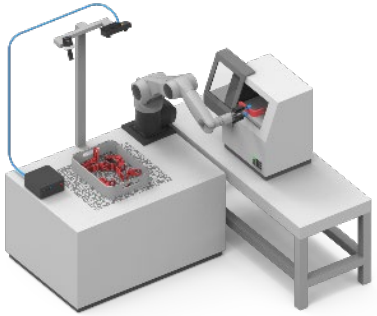


One Hardware – Scaled by Software

rc_visard
3D Stereo Sensor Family







ItemPick
Grasp poses for suction grippers in pick-and-place applications

BoxPick
Identify size and pose & pick rectangular objects

SilhouetteMatch
Identify & pick flat objects on a plane, based on a template

CAD Match
Detect & pick from unmixed bins based on their CAD data

Machine Tending

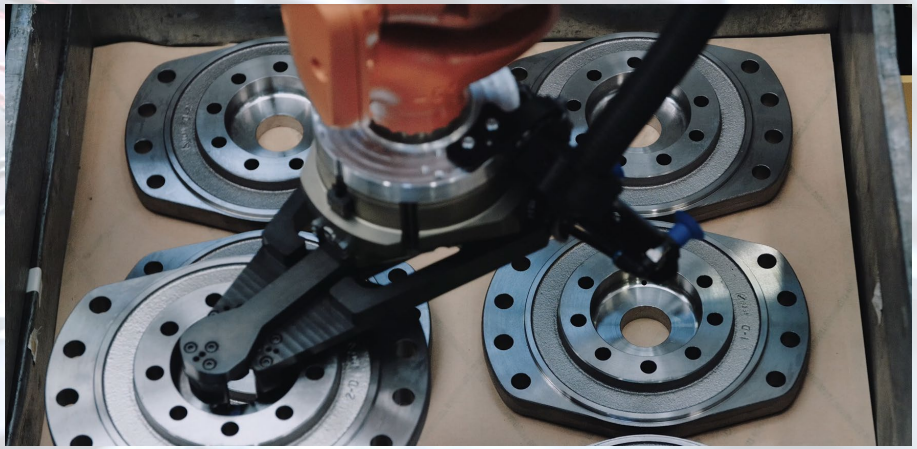
USE CASE FROM THE INDUSTRIAL AUTOMATION DOMAIN

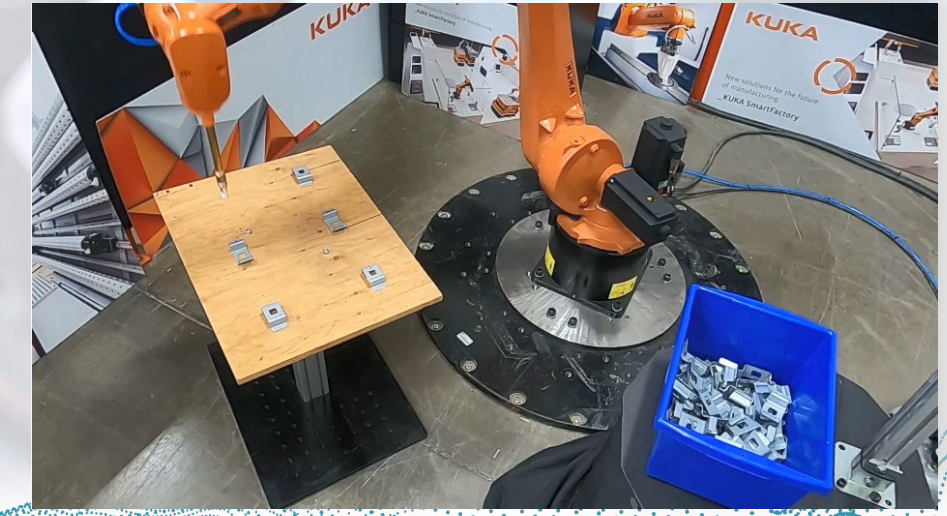
Challenge: Pick unmixed metal parts and place them accurately

- No onsite training
- Large number of different parts via same cell
- No experts on shop floor for changing parts

Approach

- Detection of parts based on CAD data
- Template creation as-a-service or DIY
- Intuitive teaching of grasp points
- Automated ‚over night' training of parts
- Application-specific software components





Warehouse Automation

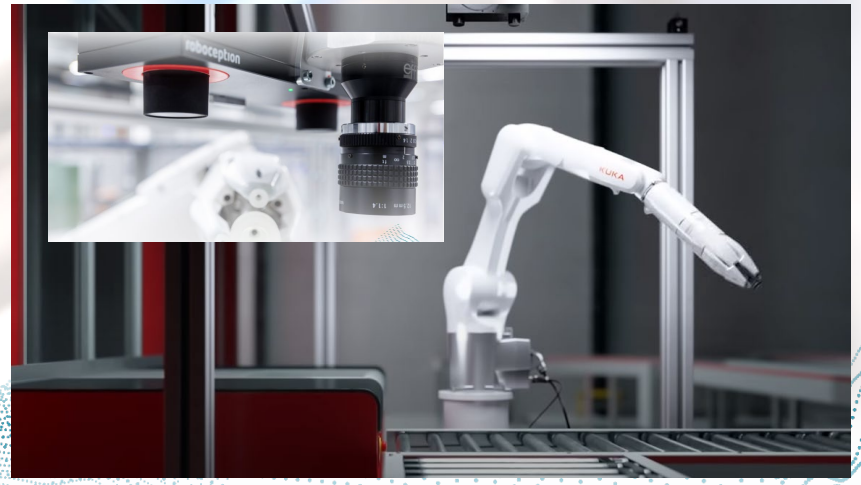
USE CASE FROM THE LOGISTICS DOMAIN

Challenge: Picking unknown objects at a rate of 1,000 picks per hours

- Each object looks different
- Pre-defined grasp points are not possible

Approach

- Identification of flat surfaces on object
- Define grasp points for suction gripper per individual element
- Application-specific software component
- Self-learning system improves with every pick



Mail Processing, Boxes …

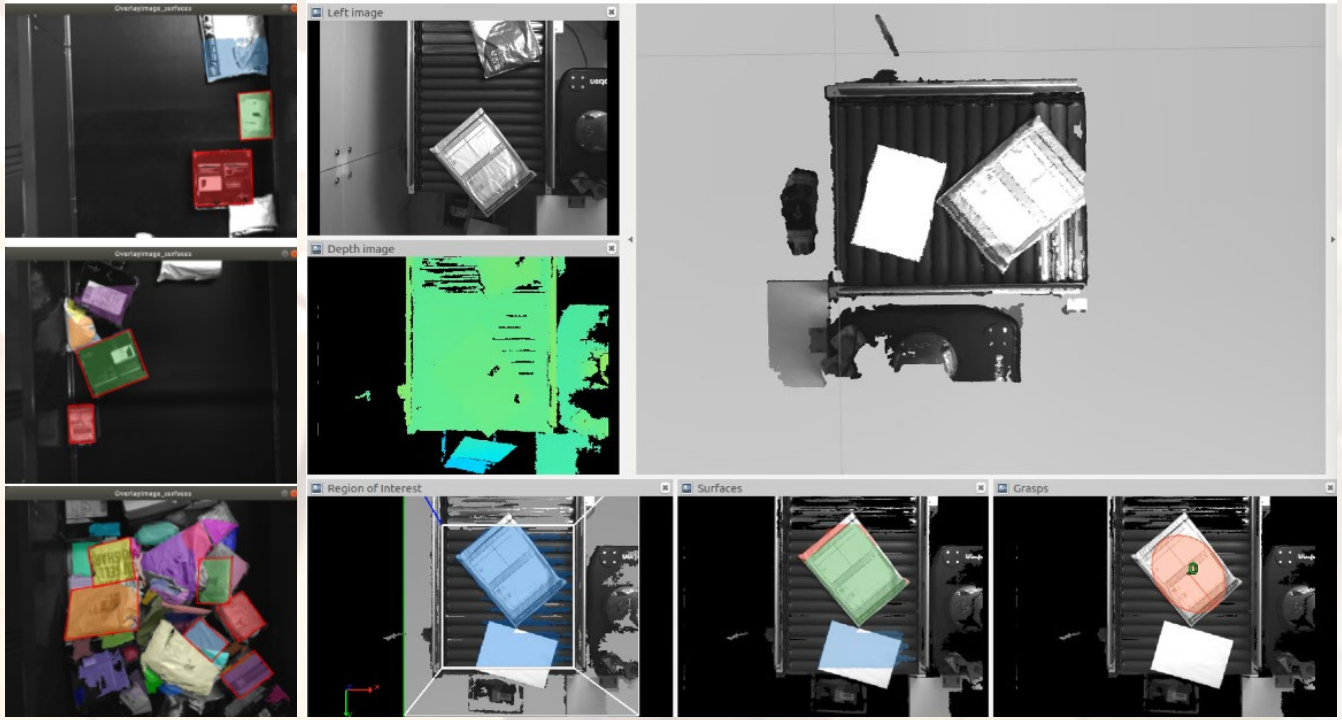
USE CASE FROM THE LOGISTICS DOMAIN

Challenge: Picking of flyers of various sizes and shapes

- moving on a conveyor
- possibly overlapping

Approach

- Detection of objects based on rectangular shape
- Definition of grasp points
- No prior teaching required
- On-board processing
- Application-specific software component



Summary

PERCEPTION IS THE KEY TECHNOLOGY FOR FLEXIBLE 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
- Grasp determination & collision detection
- Trend towards bundles and DIY robotics