Master-Thesis Mechatronics & Automation

Robots for flexible production

Autonomous detection and pick-and-place of unknown items using computer vision algorithms

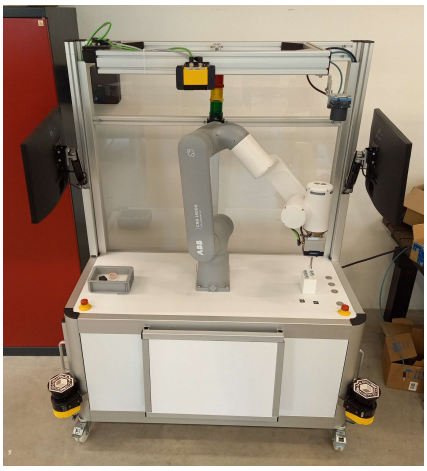

Figure 1: Showcase demonstrator

Figure 2: Result of the Masked R-CNN algorithm

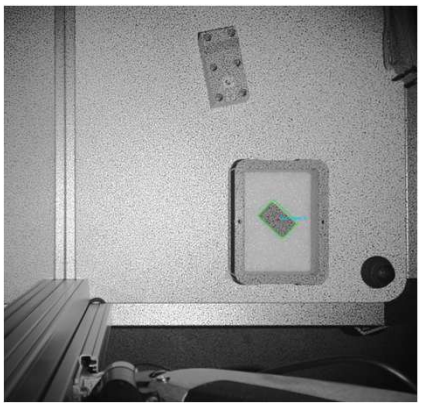

Figure 3: Result of the OBB algorithm

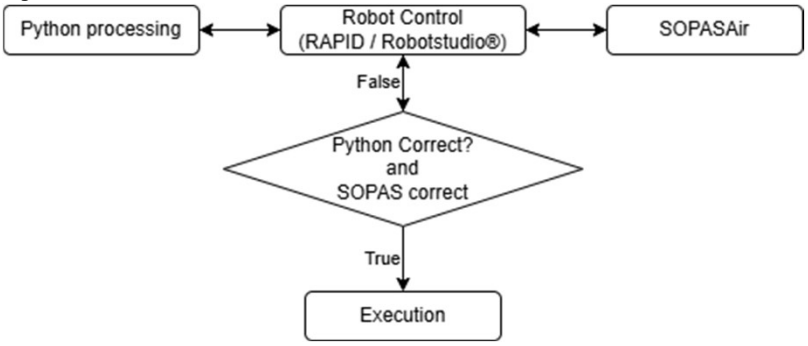

Figure 4: Communication between the different systems

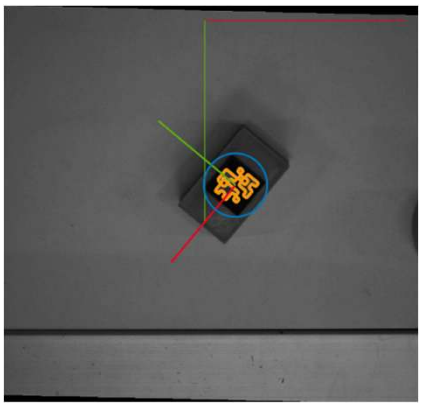

Figure 5: Detection of the AruCo Marker with the PLOC2D camera

Task

The objective of this project is to evaluate the feasibility of sensor-based object recognition for the identification, classification, and flexible sorting of heterogeneous components in an industrial context. A fundamental challenge is that the objects are organized in a random order and are not known priori.

The system aims to detect, grasp, and sort at least five different object types without requiring extensive reprogramming or prior adaptation to a specific task. In order to achieve this objective, a range of vision-based algorithms must be evaluated and compared within the context of a full robotic workflow.

The final system should be designed as a real-time capable and robust demonstrator, showcasing flexible operation under changing object sets and sorting requirements.

Concepts

- Identification and evaluation of computer vision algorithms and sensor systems
- Implementation and testing on a real robotic workstation using camera data
- Integration with the GoFa CRB1500, including development of an interface to transmit the computed object positions and orientations to the robot, enabling automated grasping and placement

Results

- The experimental setup, provided by SICK, includes the following components:
  - PLB-51B0102 (3D camera)
  - Inspector 83x (2D camera)
  - A full demonstrator system (Figure 1)
  - Sensors for human detection and emergency stops
- Multiple vision algorithms are evaluated; Mask R-CNN is selected for object detection (Figure 2)
- Orientation estimation is improved by combining Mask R-CNN with an Oriented Bounding Box (OBB) (Figure 3)
- The 3D camera is used for object detection and pose estimation.
- The Inspector83x is used for placement verification using ArUco markers or predefined features (Figure 5)
- Communication between Python (3D camera), RobotStudio® or the robot controller, and SOPAS Air (2D camera) is implemented via sockets (Figure 4).

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