HSLU Hochschule Luzern

Technik & Architektur
Mechatronics and Automation
Master-Thesis

Master-Thesis Mechatronics and Automation

Image Recognition and Assembly of Small Parts

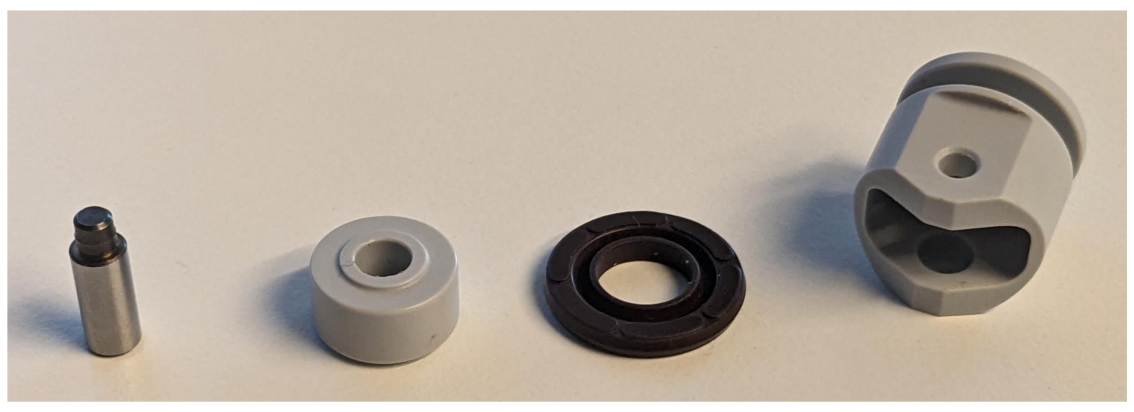

Fig. 1: Display of the air motor parts.

Introduction

This project was conducted in collaboration with Soldati AG, which is specialized in delivering automation solutions. Besides producing special machines for automation, the also have a small production line for air motors. These are operated pneumatically and characteristicly have a high efficiency, which makes them optimal for use in special applications such as explosion sensitive areas. Currently, the assembly process of these air motors is done by manual assembling the parts into an assembly station. In this work, the assembly into the station is to be automated using a robot. The air motors consist of four parts that need to be handled by the robot: a piston, roll, pin, and seal (Fig. 1).

Fig. 2: The test setup with the monocular camera and top illumination (top of the image), the parts on the blue conveyor belt and Stäubli robot.

Procedure

The concept for the automation was divided into the sub-steps needed for the full automation of the process. The sub-steps were evaluated using technology readiness levels. The separation, detection and picking of the parts were determined to be the most critical steps and hence the ones to be developed in this work. A setup to test these steps was created and consists of a monocular camera for top illumination, a conveyor belt to transport the parts, and a Stäubli robot with a custom gripper to pick and place the parts (Fig. 2). The first step is to separate the parts when they arrive as bulk orders. This was done by using a vibration feeding bunker and a conveyor belt. To ensure optimal contrast for parts detection, a blue conveyor belt was chosen. The next step is to detect the parts so that the robot can grip them. For optimal detection, illumination from the top was chosen as this allows for detection of features on the parts. This is needed as some of them (seals and piston) are to be picked from the correct side. To detect the parts, shape models were developed. Figure 3 shows how the shape model can easily identify the pistons and also determine which side is on top (small or large hole). The last step is the picking of the parts. Here a vacuum gripper was used for the piston (Fig. 4) and the pin and a parallel gripper was used for the seal (Fig. 5) and roll.

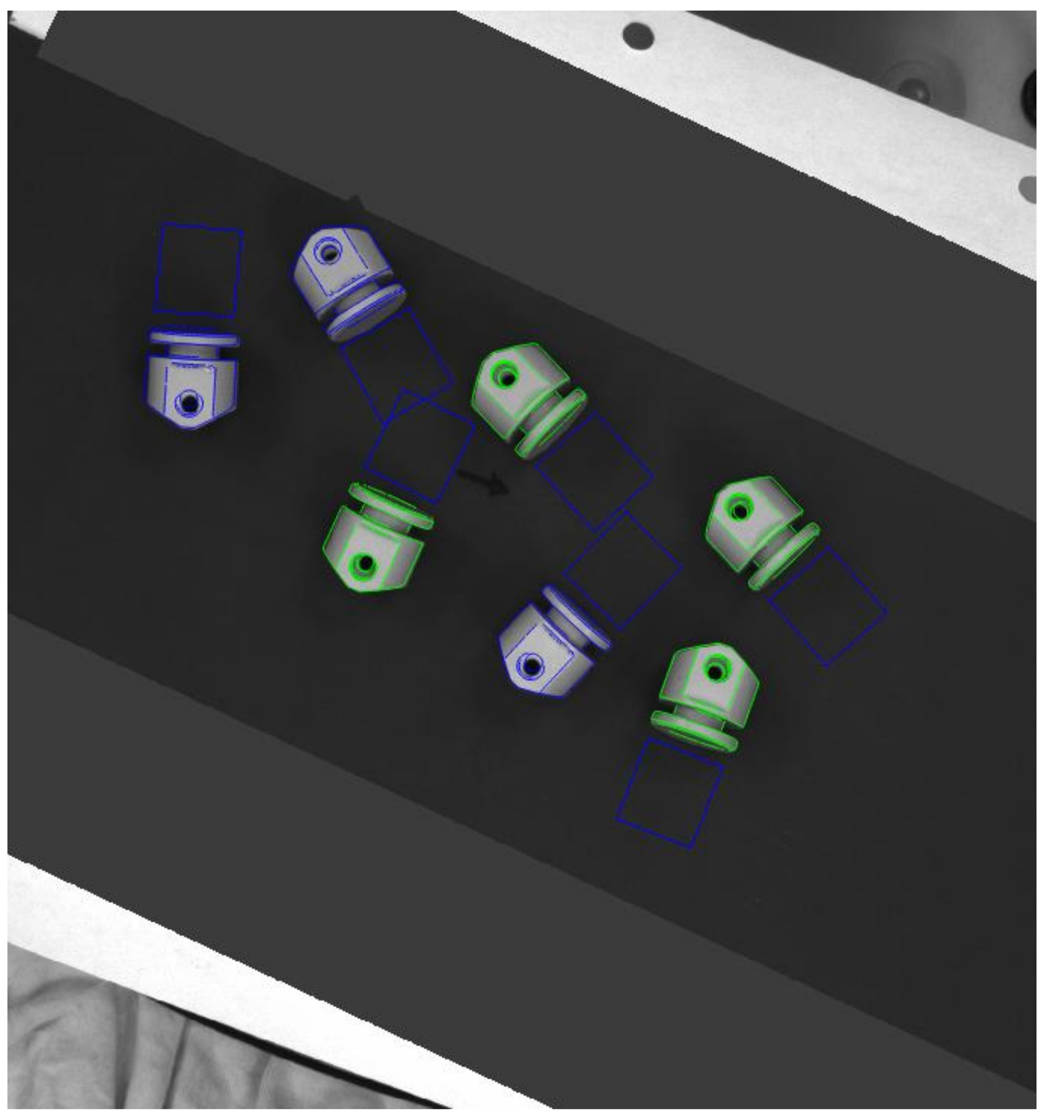

Fig. 3: Display of the detected pistons. The blue parts have the small hole on top and the green parts have the big hole on top. As the robot picks up the parts on the flat side of the piston

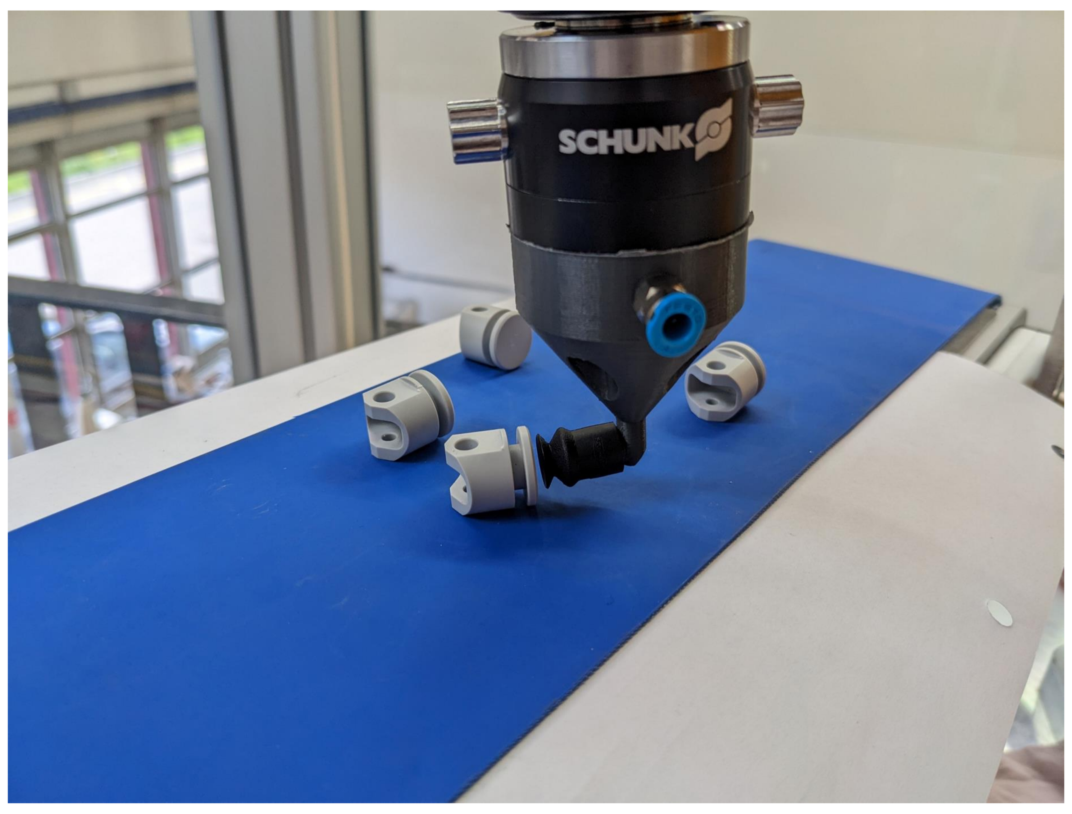

Fig. 4: The piston getting picked with a vacuum gripper.

Results

The test setup was used to develop and test the detection algorithms and procedures. The algorithms for all four parts were tested and verified successfully. During detection, the location, orientation and arrangement of the parts was determined. This information was transferred to the robot using a transformation with respect to the camera calibration coordinates. The robot was able to pick the parts precisely. In conclusion, the concept for the automation was successfully developed and the most critical parts were demonstrated in detail.

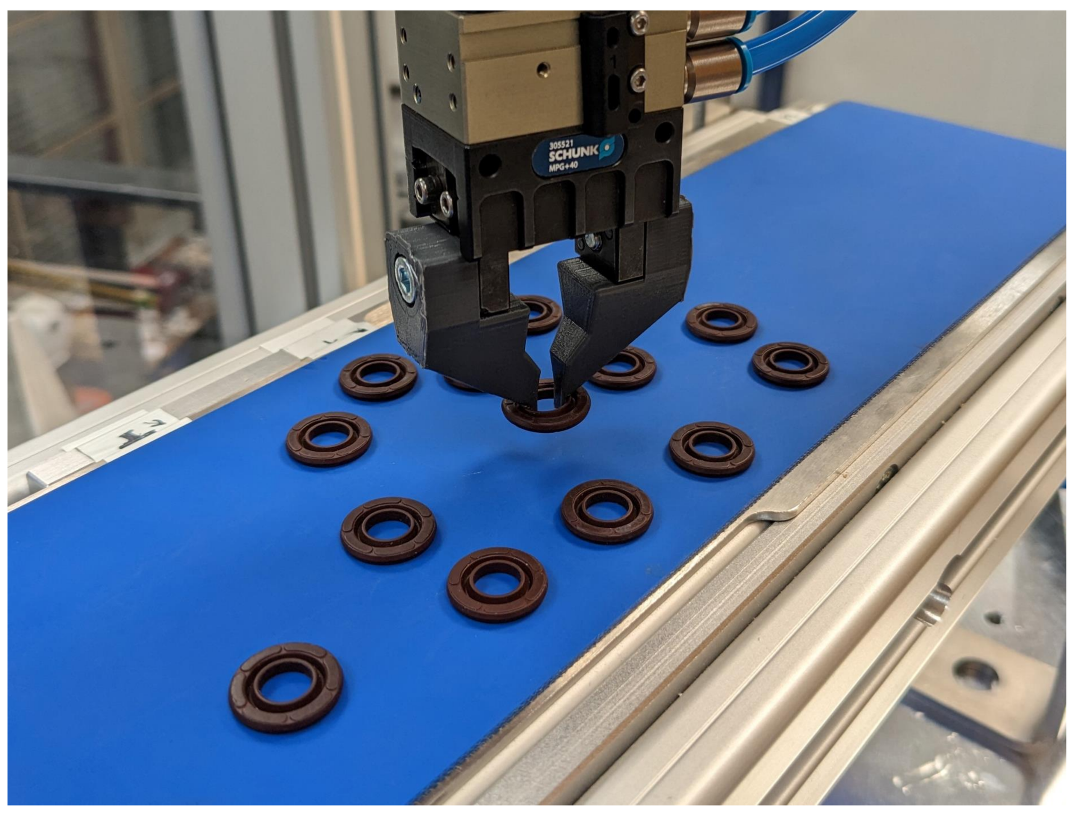

Fig. 5: The seal getting picked with a parallel gripper.

Marius Huber

Advisor:
Prof. Dr. Adrian Koller

Expert:
Prof. Dr. Christian Bermes

Industry Partner:
Luca Soldati
Soldati AG

Soldati
DENKT AUTOMATISCH MIT.