Cobotic Induction System for Garment Picking

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Abstract

Robotic manipulation of garments is still facing some limitations due to the deformable nature of fabrics. By integrating a versatile gripper system and machine learning models trained to detect each garment, this work suggests a solution to automate the picking action. The first experiments highlight interesting results about effective grasping.

Scenario

The **garment lifecycle is going to face a disruptive change pushed by the growing importance** of sustainability and circular economy. The return back to practices based on existing products is rising and recycling processes are gaining much attention. Flexible handling systems are required for the profitable management of product selection. **Robotic induction systems** are rising to automate the sorting of garments. Nevertheless, the leading **open challenges** relate to:

- to grasp **garments with different packaging types**, i.e., unpackaged or packaged with undamaged/damaged polybags;
- recognition of **robust grasping point**
- picking **just one garment** at a time

Method Overview

The picking approach is depicted in Fig. 1. By means of a collaborative environment, **the human operator supervises the picking operations and manages** the data to improve learning models. A **dedicated area to** collect the **garments** is the source to feed the picking (#1). **RGB-D Camera** (#2) allows for collecting digital data on visible clothes, such as 2D pictures and 3D point clouds. The **Cobot** (#3) enables safe continuous movements without safety fences. The final necessary hardware is the **grasping system** (#4), which allows reliable grasping of clothes with different fabrics and packages.

The software framework that drives the grasping operations follows a traditional approach with a separate object detection module for identifying garments, and a grasp point extraction logic determines the picking pose.

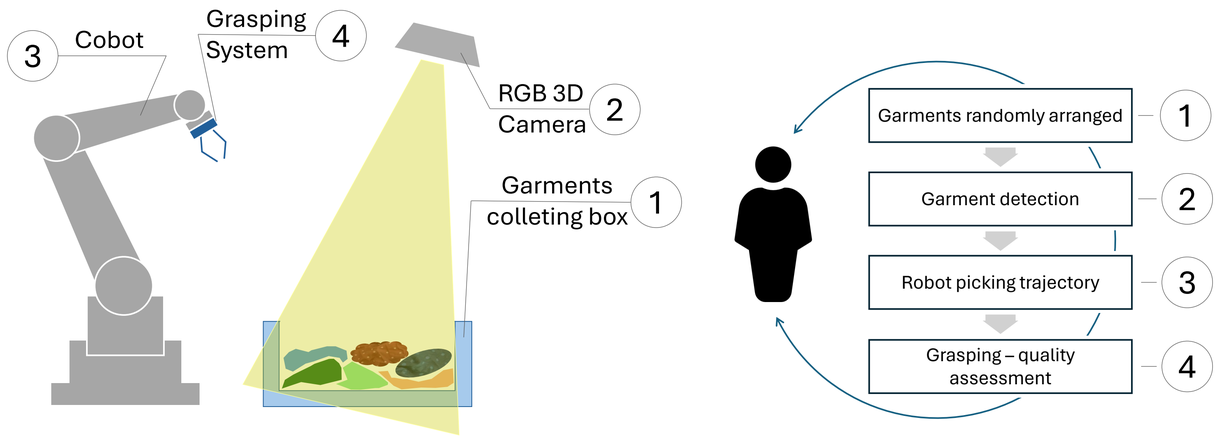

Figure 1 - Picking approach

Results

The configuration of the **CoboSort system** is depicted in Fig.2. Garments are detected using a standard object detection approach based on the **YOLO v5 - XLarge** model structure. The model has been improved along 6 training sessions, for a total of that 1478 pictures of garments. The **accuracy of the model was very high**, but wrong recognition of close garments with similar characteristics still exists.

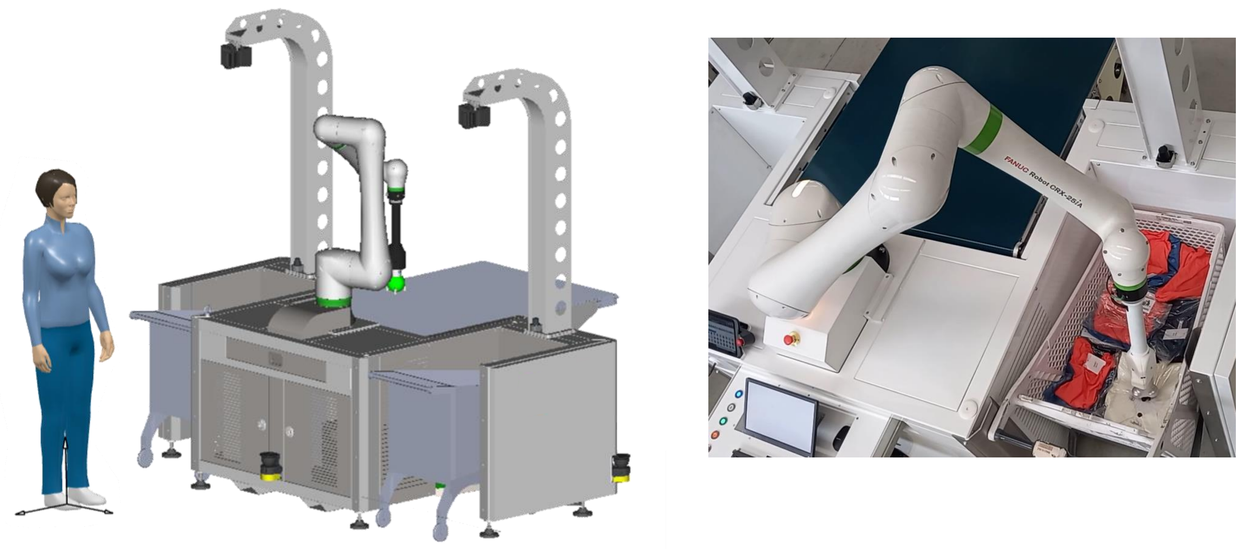

Figure 2 – CoboSort system – 3d model, left side, real implemented solution, right side

To solve these corner cases, 800 more annotated pieces of clothing were added to the training, reaching the final performances reported in Tab 1.

Table 1 – Model detection performances values

Precision	Recall	mAP@0.5	mAP@0.5:0:95
0.9816	0.98256	0.97925	0.85183

Figure 3 depicts the three stages of the picking action. A stress test of the system on 10 trials for a total of 650 items returned 7 instances of double grasping, with a success rate of 99%. The average time to complete the picking operation is 13 seconds.

Figure 3 – Picking trajectory: the three main points involved

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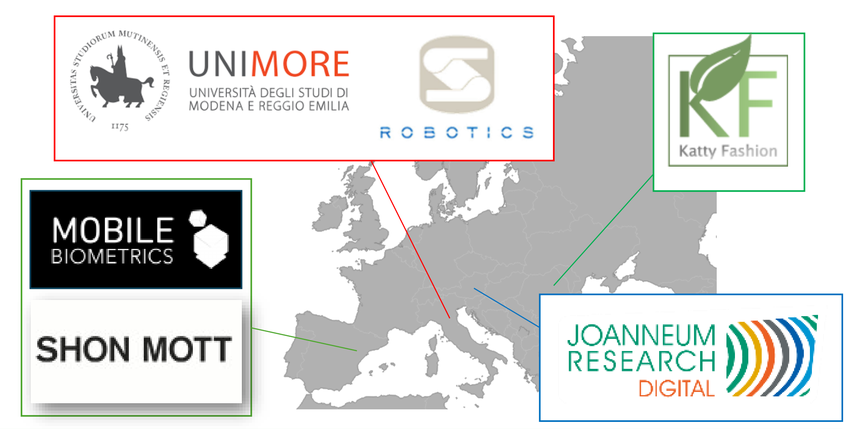

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