Project name: A multifunctional gripper for housekeeping tasks  
Project Acronym: HomeGrip  
Advisor: Júlia Borràs Sol

Interested students can contact me at jborras@iri.upc.edu

1 Description

Housekeeping tasks are central in domestic service robotics. For this reason, many grippers and robotic hands have been developed to grasp a great variety of daily living objects of different shapes and textures, but almost entirely, either rigid or semi-rigid. However, an important percentage of housekeeping tasks involves cloth-like objects as for instance our dressing clothes, fabric bags, tablecloths, cleaning clothes, etc. This project proposes the development of a gripper that can appropriately deal with textiles, without losing functionality on rigid objects. We plan to install the grippers in our two TIAgo robots (Fig. 1).

Such type of grippers will be very relevant for the upcoming years of service robotics and cloth dexterous manipulation.

2 State of the art

In the last decade there has been many studies on grasping of what is called daily life objects, that have grown together with the interest and development of service robotics [1, 2]. The main focus of these studies has always been put on rigid objects or other flexible objects such as sponges or food packages, but none of them on textiles. Textile objects have unique challenges for grasping and manipulation and that is the reason why, despite their importance, there is almost no study on how to grasp them, and just some grippers specially designed for it [3, 4, 5, 6, 7, 8, 9, 10]. However, most of these grippers solve only partial problems or particular specific tasks on cloth manipulation. In addition, they can rarely be used to grasp other objects.

![TIAgro robots from PAL Robotics](image)

Figure 1: TIAgo robots from PAL Robotics

![Examples of grippers specially designed for cloth manipulation.](image)

Figure 2: Examples of grippers specially designed for cloth manipulation. (a) The Clopema EU project gripper, with small, flat and thin fingertips [3]. (b) Two parallel grippers joined by a prismatic actuator that moves them apart [11]. (c) A humanoid complex hand design with 2 fingers, a thumb and a palm [12]. (d) Underactuated hand with a simpler design, optimized for grasp cloths that are laying flat on a table [4].
A simple inspection of humans performing cloth manipulation shows how many different grasps we realize when we manipulate cloth. However, most of the popular cloth manipulation works such as [13, 14] use simple parallel grippers that can only perform a pinch grasp (Fig. 3). We propose to explore design possibilities to grasp cloth in different ways, but without losing functionality to grasp other common objects. This is a research line worth investigating as a proper grasp can ease the manipulation task and reduce the trajectory complexity. Important contributions are expected because cloth grasping has been mostly unexplored to the moment.

3 Work plan

We propose to design a gripper able to execute different geometric grasps, based on our taxonomy of textile grasps that we have developed in previous works (Fig. 4). The project will be organized in 3 phases

1. **Gripper design**
   The design of the gripper will be oriented to maximize the number of grasps from the textile object taxonomy that can be executed (). We will depart from a some partial designs that we already developed and other common gripper designs for rigid object grasping. We will consider different materials with different flexibility and friction coefficients.
   *Outcome*: CAD design of the full gripper, accounting for motors, cable distribution, placing of the electronics, etc.

2. **Prototype building**
   We will start building working parts (like a single finger) and the arm attachment to have a partially working prototype. This will allow us to detect issues and correct them. This phase will include testing of the electronics and motors for the single finger version of the gripper. Then, we sill proceed to building the full prototype.
   *Outcome*: A working prototype.

3. **Testing**
   The last step will consist in the evaluation of the gripper prototype for grasping both rigid objects and cloth-like objects. We will elaborate a protocol of testing in accordance to the benchmark that is being developed at the Perception & Manipulation Lab to validate and compare cloth manipulation.
   *Outcome*: A measured grip success ratio of both rigid and textile objects, together with the used protocols. Depending on the outcome, we will then aim at a publication to one of the robotic conferences IROS or ICRA.

4 Conditions

This work will be covered by an INIREC grant, with an expected dedication of 15h per week, around 9 months of duration, remunerated with 393.75€ per month.
Figure 4: The taxonomy considers 12 pure grasps, 3 of which can also be executed bimanually and 2 of them, when executed with two hands, are considered grasp combinations (semi-shaded area). The taxonomy will serve as a design inspiration of the gripper.

The student will be given the opportunity to work with the full equipment of IRI, specially with the workshop, several 3D printers, laser cutters and the supervision help of our workshop responsible.

Come visit our lab, and we will tell you more about our projects. Interested students can contact me at jborras@iri.upc.edu.

References


