External Force Estimation for Textile Grasp Detection

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***Abstract*— Our current work on external force estimation without end-effector force sensor is presented.To verify if a grasp of a textile has been successful, the external wrench applied on the robot is computed online, with a state observer based on a LWPR [3] model of a task.**

I. Introduction

Our Perception and Manipulation group in IRI is interested in investigating techniques that allow robots to adequately perform diverse manipulation tasks with high degree of autonomy. Tasks requiring interaction with humans are of special interest, but also those concerning domestic tasks, such as cloth manipulation. To this purpose, planning algorithms for pick and place tasks have been implemented [1], toghether with grasp point detection using a kinect camera [2], but some tools for successful grasp checking are needed.

For this reason, a local Inverse Dynamic Model (IDM) of the Barrett's WAM robot arm has been developed, in order to obtain the joint torques needed to follow a trajectory. This model has been learned with Locally Weighted Projection Regression (LWPR), and together with a state observer for the external wrench estimation when manipulating cloth, allows us to:

- Move the robot with compliant, safe moves, in order not to harm anyone around it, with a controller based on the LWPR learned IDM and an error compensation PD.
- Detect external actions applied on the arm without a sensor. Not only on its end-effector, but at any point. And compensate them if necessary.
- Weight clothes while manipulating them. This gives us information about what has been actually grasped.

II. Experimentation

As a first result of this work, we performed a cloth-picking task, in which a WAM robot arm picks a garment from a table and, by estimating the force, senses whether the grasping has been successful or not. The results of the sensed cartesian vertical force when grasping one garment, two garments simultaneously or grasping no garment are shown in Fig. 1, where the no garment force has been substracted from the results of all actions, in order to eliminate the offset due to the uncalibrated hand inertia.

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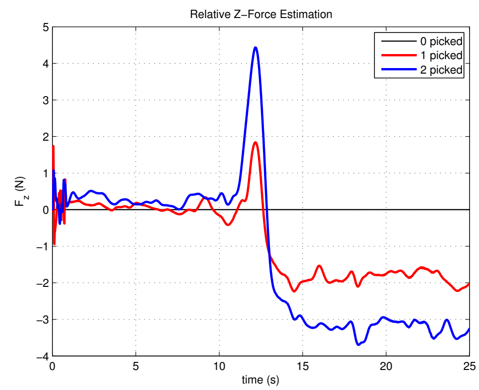

Fig. 1. z-Force along trajectory. Approximating grasp position (time 0s-10s), grasping (time 10s-12s), returning to initial position (time 12s-22s).

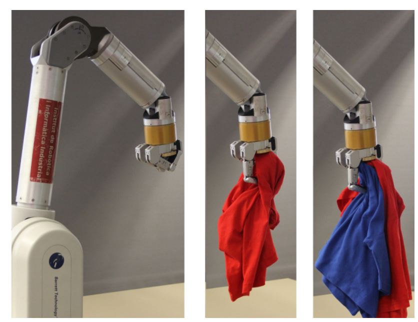

Fig. 2. WAM robot grasping garments.

We clearly see a difference between the three cases, and we can extract information about how many garments were picked. However, there is also a lot of noise on the signal, which is mainly due to motor cogging at the robot's motors and jerk discontinuities in the trajectory.

Despite these perturbances, we can see that the robot can properly estimate whether it has picked a garment or not while moving. In addition, it can sense the force exerted against the table when picking clothes (note the central peak in the graphs).

References

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