Robot manipulation in human environments: Challenges for learning algorithms

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Abstract. Manipulator robots are widening their range of activities in factories, as well as finding increased application in human-centered domains such as healthcare, education, entertainment and services. For robots to become handy co-workers and helpful assistants, quick and user-friendly ways to endow them with flexible manipulation skills are needed. At the Perception and Manipulation Lab of IRI (CSIC-UPC), we are addressing several of the learning challenges arising in this context [1,2]. Namely, manipulator robots should be *easy to teach* by non-experts [3] and acquire skills from demonstrations [4], they need to be *intrinsically safe* [5], able to appropriately *deal with forces* [6] and to perceive and manipulate *deformable objects* [7-10], tolerant to *noisy perceptions and inaccurate actions* [11, 12], and they must exhibit a *high adaptability* [13,14] to non-predefined and dynamic environments, as well as the capability of learning to plan [15]. The cited works will be showcased along the presentation and support for their development is acknowledged from the European projects PACO-PLUS, GARNICS and IntellAct, the Spanish projects PAU and PAU+, and the Catalan grant SGR-155.
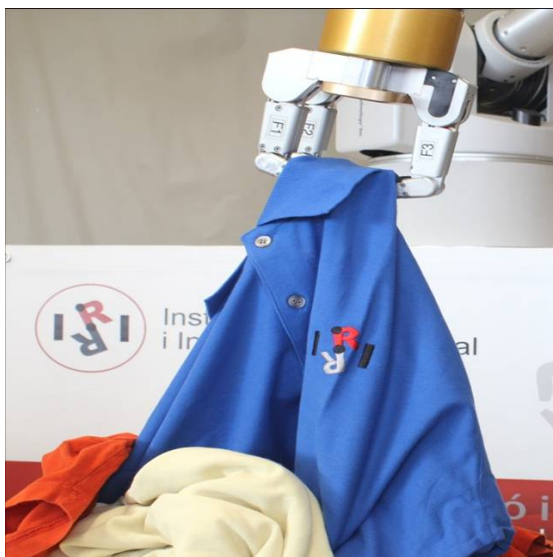
Setups for robot perception and manipulation of deformable objects at IRI (CSIC-UPC): a) perceiving and handling clothes [9,10,12], b) measuring the chlorophyll of plant leaves for phenotyping [7,8].

References

[1] Kemp C.C., Edsinger A. and Torres-Jara E. (2007): "Challenges for robot manipulation in human environments". *IEEE Robotics and Automation Magazine*, 14(1): 20-29.

[2] Smith C., Karayiannidis Y., Nalpantidis L., Gratal X., Qi P., Dimarogonas D.V. and Kragic D. (2012): "Dual arm manipulation: A survey". *Robotics and Autonomous Systems*, 60(10): 1340-1353.

[3] Agostini A., Torras C. and Wörgötter F. (2011): "Integrating task planning and interactive learning for robots to work in human environments", *Intl. Joint Conf. on Artificial Intelligence (IJCAI'11)*, Barcelona, pp. 2386-2391.

[4] Rozo L., Calinon S., Caldwell D., Jiménez P. and Torras C. (2013): "Learning collaborative impedance-based robot behaviors". *27th Intl. Conf. of the Assoc. for the Advancement of Artificial Intelligence (AAAI-13)*, Bellevue, Washington, pp. 1422-1428.

[5] Colomé A., Pardo D., Alenyà G. and Torras C. (2013): "External force estimation during compliant robot manipulation". *IEEE Intl. Conf. on Robotics and Automation (ICRA'13)*, Karlsruhe, Germany, pp. 3535-3540.

[6] Rozo L., Jiménez P. and Torras C. (2013): "A robot learning from demonstration framework to perform force-based manipulation tasks". *Intelligent Service Robotics*, 6(1): 33-51.

[7] Alenyà G., Dellen B. and Torras C. (2011): "3D modelling of leaves from color and ToF data for robotized plant measuring". *IEEE Intl. Conf. on Robotics and Automation (ICRA'11)*, Shanghai, pp. 3408-3414.

[8] Alenyà G., Dellen B., Foix S. and Torras C. (2013): "Robotized plant probing: Leaf segmentation utilizing time-of-flight data". *IEEE Robotics and Automation Magazine*, 20(3): 50-59.

[9] Ramisa A., Alenyà G., Moreno-Noguer F. and Torras C. (2012): "Using depth and appearance features for informed robot grasping of highly wrinkled clothes". *IEEE Intl. Conf. on Robotics and Automation (ICRA'12)*, St. Paul, Minnesota, pp. 1703-1708.

[10] Ramisa A., Alenyà G., Moreno-Noguer F. and Torras C. (2013): "FINDDD: A fast 3D descriptor to characterize textiles for robot manipulation", *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS'13)*, Tokyo, pp. 824-830.

[11] Foix S., Alenyà G., Andrade-Cetto J. and Torras C. (2010): "Object modeling using a ToF camera under an uncertainty reduction approach". *IEEE Intl. Conf. on Robotics and Automation (ICRA'10)*, Anchorage, Alaska, pp. 1306-1312.

[12] Monsó P., Alenyà G. and Torras C. (2012): "POMDP approach to robotized clothes separation". *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS'12)*, Vilamoura, Portugal, pp. 1324-1329.

[13] Ulbrich S., Ruiz de Angulo V., Asfour T., Torras C. and Dillman R. (2012): "Kinematic Bézier maps". *IEEE Trans. on Systems, Man and Cybernetics: Part B*, 42(4): 1215-1230.

[14] Ulbrich S., Ruiz de Angulo V., Asfour T., Torras C. and Dillman R. (2012): "General robot kinematics decomposition without intermediate markers". *IEEE Trans. on Neural Networks and Learning Systems*, 23(4): 620-630.

[15] Martínez D., Alenyà G., Jiménez P., Torras C., Rossmann J., Wantia N., Aksoy E.E., Haller S. and Piater J. (2014): "Active Learning of Manipulation Sequences". *IEEE Intl. Conf. on Robotics and Automation (ICRA'14)*, Hong-Kong.