POLITECNICO DI TORINO

POSTER DAY - PHD in Mechanical Engineering

Development of a methodology for the human-robot interaction based on vision systems for collaborative robotics

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Cycle: XXXII
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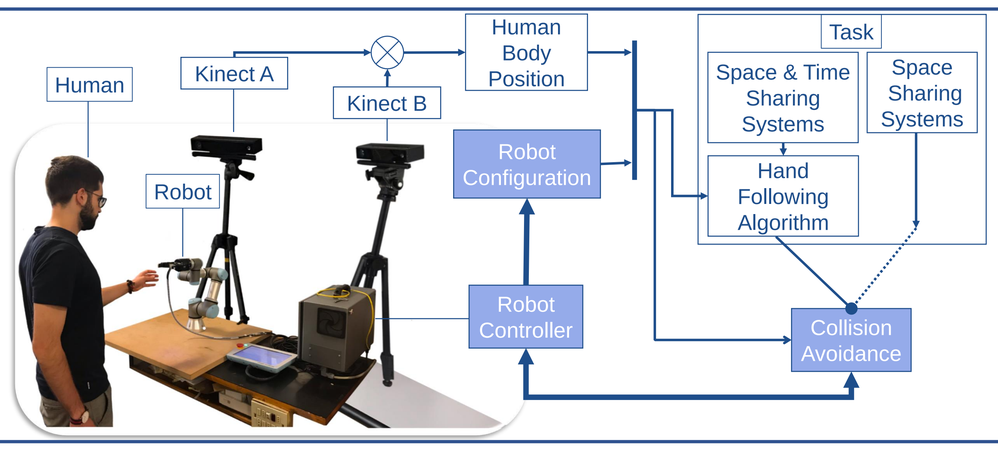
Field of research: Collaborative Robotics

Introduction



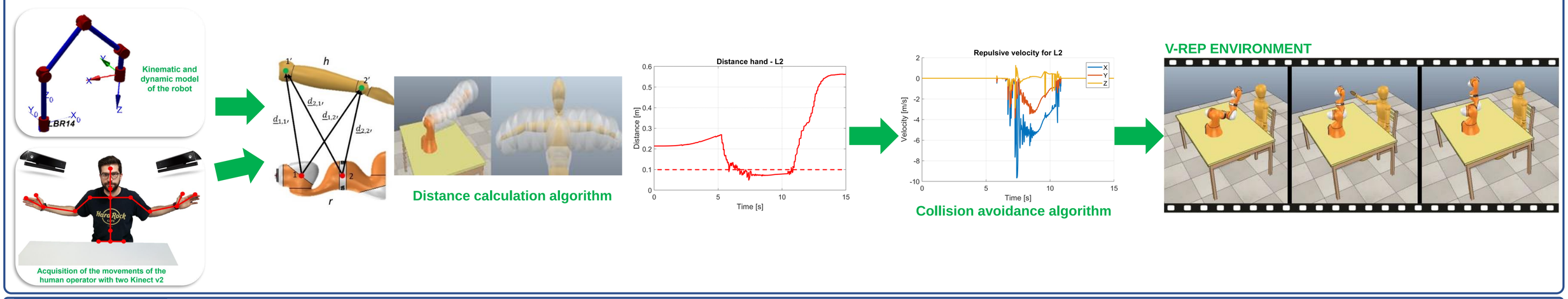
The collaborative robotics implies the possibility for humans and robots to work side by side with no need of physical fences, in order to execute in the same time coordinated tasks. Crucial elements of this scenario are:
- the acquisition of the movements of the human operators;
- the calculation of the relative positions of the human operators and the robots;
- control algorithms to drive the robot and ensure the safety of the humans.

During this year I focused my attention on these topics:
- kinematic and dynamic model of robot;
- collision avoidance algorithms;
- control algorithms.

Collision avoidance algorithms: simulation results

- Simulation environment composed of two parts, the MathWorks environment and the V-REP software (for visualization purpose);
- distance calculation algorithm: distances between 9 characteristics points on the robot and 21 points on the human body. The points are considered the centres of spheres;
- collision avoidance algorithm: repulsive velocities in the operative space that push the robot away from the human operator are calculated on the distances previously obtained. The joint velocities are then calculated and send to the controller of the robot.

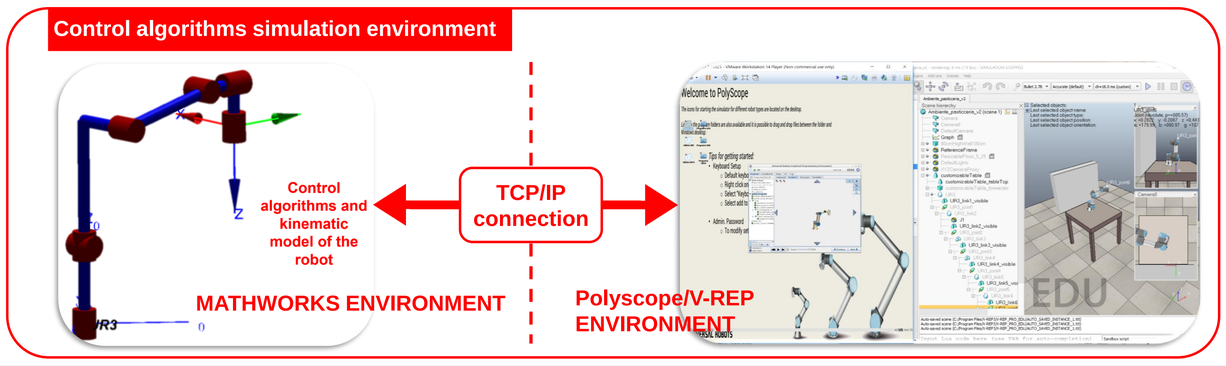
MATHWORKS ENVIRONMENT



Control algorithms

- An external PC and the robot communicate by an Ethernet connection with a TCP/IP communication protocol;
- the external PC receive fb data from the robot and calculate the joint velocities necessary to perform the required task (e.g.: the collision avoidance);
- the joint velocities are sent to the robot controller with 62.5Hz of frequency;
- an optional V-REP environment can be used to obtain additional visual information.

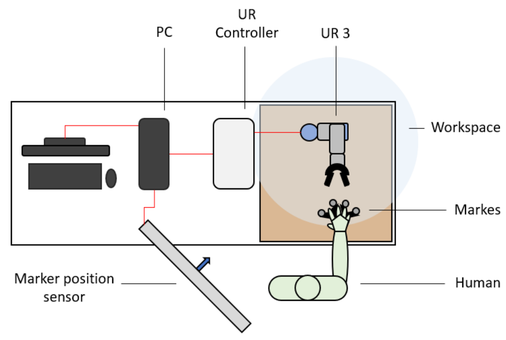
Control algorithms simulation environment

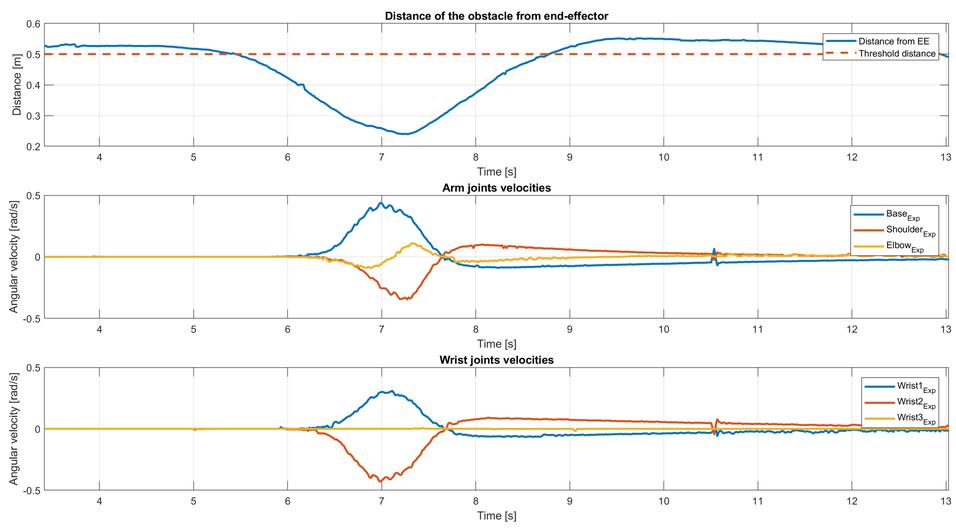


Experimental results

- An Optitrack V120:Trio system estimates the positions of markers in the workspace space;
- the distances between the end-effector of the robot and the markers are calculated;
- the collision avoidance algorithm generates repulsive velocities so to move the robot and avoid collisions with the markers;
- the collision avoidance can be obtained also with all the links of the robot and exploiting a possible kinematic redundancy of the robot.

Use the QR code to watch the video of this test.





Using the QR codes below you can watch the videos of the tests of:
- collision avoidance with the arm of the robot
- collision avoidance exploiting the kinematic redundancy

Future Works

- Increasing the frequency of the control system so to reach the maximum frequency of the robot controller, 125 Hz;
- defined new collisions avoidance strategies and test them in order to make a comparison between the actual collision avoidance strategy and the new ones;
- integration of the control and collision avoidance algorithms with the motion capture and hand following algorithms.

Papers:

- Scimmi, L.S., Melchiorre, M, Mauro, S., Pastorelli, S.: Multiple Collision Avoidance between Human Limbs and Robot Links Algorithm in Collaborative Tasks. Proceedings of the 15th International Conference on Informatics in Control, Automation and Robotics, ICINCO 2018, Vol.2, 2018
- Melchiorre, M, Scimmi, L.S., Mauro, S., Pastorelli, S.: Influence of Human Limb Motion Speed in a Collaborative Hand-over Task. Proceedings of the 15th International Conference on Informatics in Control, Automation and Robotics, ICINCO 2018, Vol.2, 2018