SPQR@Work

Marco Imperoli, Daniele Evangelista, Valerio Sanelli, Matteo Russo, Alberto Pretto and Daniele Nardi

Department of Computer, Control, and Management Engineering
"Antonio Ruberti", Sapienza University of Rome, Italy.
Website: http://www.dis.uniroma1.it/ labrococo/SPQRWork

ABOUT US

The SPQR@Work team is a spin-off of the S.P.Q.R. RoboCup team of the Department of Computer, Control, and Management Engineering "Antonio Ruberti" at Sapienza University of Rome, created to participate at the RoCKIn@Work and RoboCup@Work competitions.

The SPQR@Work team has been founded as an offshoot of the S.P.Q.R. RoboCup team, that is involved in RoboCup competitions since 1998 in different leagues : *Middle-size* (1998-2002), *Four-legged* (2000-2007), *Real-Rescue robots* since 2003, *Virtual-Rescue robots* since 2006 and *Standard Platform League* since 2008.

THE TEAM

CONTACTS

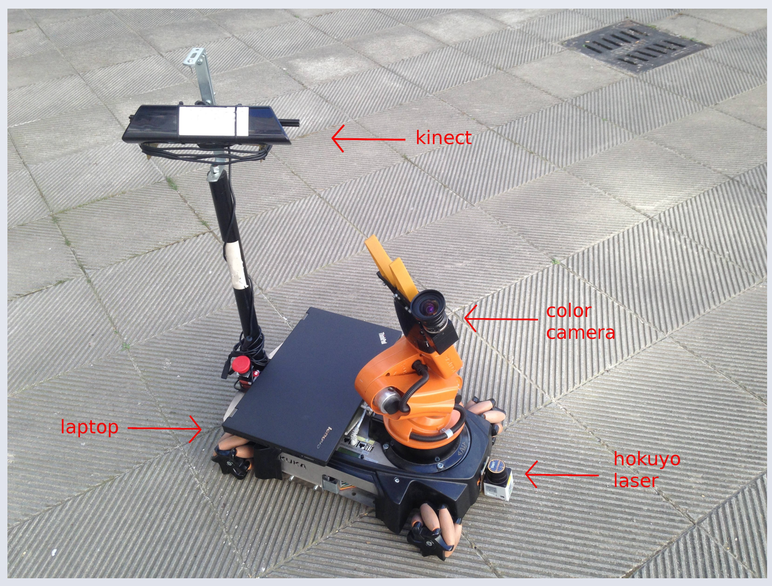
Emails:

marcoimperoli@gmail.com
evangelista.1665872@studenti.uniroma1.it
valerio.sanelli@gmail.com
matteo.russo@unicas.it
{pretto,nardi}@dis.uniroma1.it

Scan the following QR code for the team website:

http://www.dis.uniroma1.it/~labrococo/SPQRWork

THE ROBOT



HARDWARE CONFIGURATION

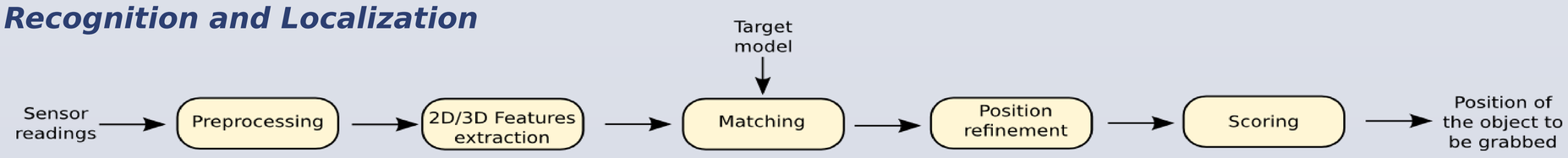
The SPQR@Work robot (in the figure on the left) is a KUKA youBot with the following sensor suite:

- A frontal Hokuyo laser scanner, to be used for navigation and obstacles avoidance tasks
- A Kinect RGB-D sensor: the area viewed by the kinect includes the working area of the arm, in order to perform object manipulation tasks without robot motions
- An on-board laptop running Linux Ubuntu 14.04, to be used to run all the software modules (e.g., navigation, object recognition, etc...). The internal youBot Intel Atom PC is not used
- A color USB3 high-resolution camera on the 5th joint of the manipulator for accurate object localization

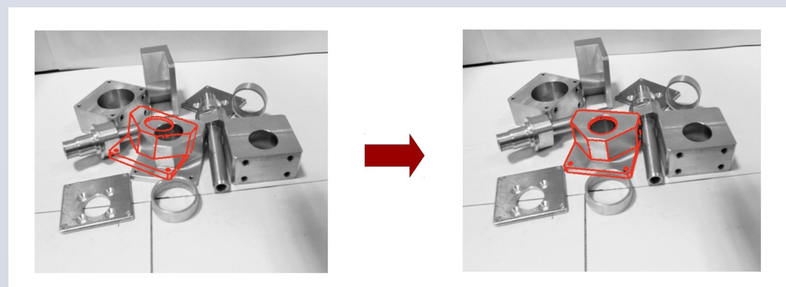
The team is now actively working in improving the hardware configuration of the KUKA youBot, in particular modifications will involve both the sensors installed on the robot and the structural layout itself. A new Hokuyo laser scanner will be installed in the rear of the robot in order to improve navigation and obstacles avoidance. For the object recognition and localization a new sensor will replace the current Kinect RGB-D sensor: Intel realsense f200 (https://software.intel.com/en-us/realsense/f200camera). A novel gripper design is under development. The new mechanism is able to grasp bigger objects with a maximum finger opening equal to 135 mm. Motion is actuated by a Robotis AX-12A Servomotor, which offers higher torque when compared to the stock motor and allows for improved accuracy thanks to its embedded encoders and control. Furthermore, the layout of the KUKA youBot base platform will be enhanced in order to increase the workspace.

RESEARCH ACTIVITIES OF THE SPQR@Work TEAM

Object Recognition and Localization

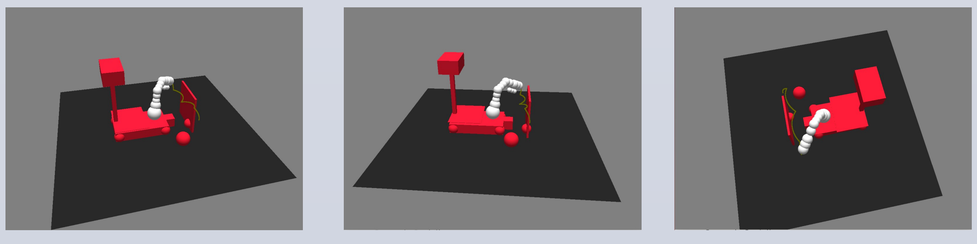


A robust and efficient method for object detection and 3D pose estimation that exploits a novel edge-based registration algorithm: D^2CO[1]. The object position is refined employing a non-linear optimization procedure, where the cost being minimized is extracted directly from a 3D image tensor composed by a sequence of distance maps.



[1] Marco Imperoli and Alberto Pretto. D^2CO: Fast and robust registration of 3D textureless objects using the Directional Chamfer Distance. In Lazaros Nalpantidis, Volker Kruger, Jan-Olof Eklundh, and Antonios Gasteratos, editors, Computer Vision Systems, volume 9163 of Lecture Notes in Computer Science, pages 316-328. Springer International Publishing, 2015.

Object Manipulation and Grasping



The arm motion planner we propose is able to plan accurate trajectories assuming that the best way to grasp an object disposed in an crowded environment is to let the gripper follows a straight line in the Cartesian space towards the object of interest. Each planned path is guaranteed to be free from collisions, and very accurate object grasping and placing are performed.

Robot Navigation and Planning

Ad hoc *local* planner based on artificial potential fields, designed for holonomic mobile robots. The idea is to use an existing navigation framework as a primary navigation system, focusing on the planning reliability and safety. Our local planner is then used only for refinement purposes, improving the accuracy.