UTBots@Home 2022:

Pionner 3-AT (A.K.A. Apollo) current and future developments

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Introduction

– The Pioneer P3-AT (A.K.A Apollo) robot was prepared for the competition. Working with **ROS(*Robot Operating System*)[1]**, it was configured for deployment in some of the tasks presented in **Robocup@Home** [2]:

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1 – Navigation: applying SLAM algorithms with lidar data, movement commands can be sent through ROS tio the specific robot drivers;

2 – Voice Synthesis and Recognition: Human-robot interation is possible via voice commands. The robot converts voice inputs to text, classifying it into known commands/questions. This may trigger an action by the robot, including voice responses;

3 – Object Recognition and Manipulation; Person Recognition: Objects can be found, classified and have their position in the ambient estimated and people can be detected in a certain frame;

Hardware

The Pioneer P3-AT has:

1 - Processing: an embedded PC (Intel Nuc[3]), which runs Linux and ROS;

2 - Localization: laser-scanner sensor (YDLIDAR X4), that provides informations about it's surroundings;

3 – Vision: a RGB-D camera (Kinect V1), which collects RGB frames and pointcloud data;

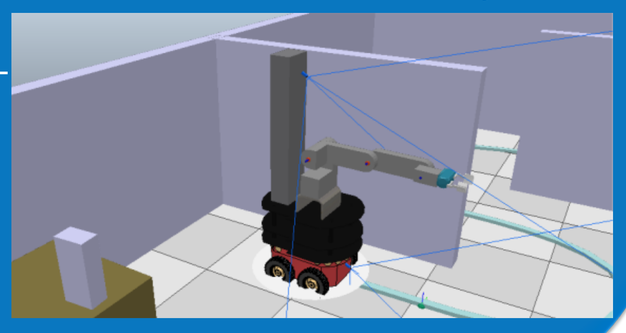
4 – Visual Interface: a LCD screen, for human-robot interaction, that shows the robot's "face"[4];

5 – Manipulation: a manipulation arm (Beckman Coulter ORCA Robotic Arm) for mechanical tasks.

ROS Packages and Software Solutions

Different elements work together and compose the ROS software suite for the robot:

1 – ydlidar: provides the LIDAR scan in a topic, making the device driver and specifics transparent to ROS;
2 – move_base: receives LIDAR and odometry data, sends navigation tasks to the robot;
3 – espeak_ros: its a ROS package that enables access to the espeak text-to-speech library, enabling the robot to "talk";
4 – ROS Voice Message: android app responsible for the voice recognition task, making the spoken sentence available in a ROS topic in the ROS master. We filter the sentences and feed them to a classifier, responsible for determining which behavior this sentence will trigger, if any;
5 – dynamic_reconfigure: allows voice synthesis parameter reconfiguration without the need to restart ROS nodes;
6 – ros_display_emotions: responsible for publishing the robot's "face" in a image topic, that is then displayed by the tablet. Several actions may trigger a change in the emotion shown by the robot.
7 – freenect_launch: publishes the RGB and pointcloud from Kinect in ROS topics;
8 – darknet_ros: integrates the YOLOv3 CNN model for object and person detection with ROS.
9 – 3D Simulation:a complete simulated environment was developed in order to evaluate the packages, using the CoppeliaSim[6] Simulator.



Conclusions and Future Work

Apollo is capable of fulfilling several core tasks of the Robocup@Home category successfully.

Upgrades in the person, object and voice recognition tasks, as well as improvements to the manipulator arm and the position estimate are to be expected in the future.

References

[1] ROS-Robotic Operating System. Available at: http://www.ros.org.
[2] Robocup@Home. Available at: http://www.robocupathome.org/.
[3] Intel Nuc. Available at: https://www.intel.com.br/content/www/br/pt/products/details/nuc.html.
[4] P. S. PALAR. ROS package ros_display_emotions. Available At: https://github.com/kpiatan/ros_display_emotions.
[5] LASER UTBOT@HOME Homepage. Available at: https://laser.dainf.ct.utfpr.edu.br/doku.php?id=utbots_at_home.
[6] CoppeliaSim V4.3. Available at: http://coppeliarobotics.com.