UTBots@Home 2023:

Apollo's new AI modules: Person identification and voice processing

Bruno Bock Silva (brunobock@alunos.utfpr.edu.br),
Gustavo Fardo Armênio (gustavofardoarmenio@alunos.utfpr.edu.br),
Enzo Holzmann Gaio (enzoholzmanngaio@alunos.utfpr.edu.br),
João Henrique Cordeiro Pires (joaopires@alunos.utfpr.edu.br),
Larissa Bialski Lima Da Silva (larissabialski@alunos.utfpr.edu.br)
Luiz Guilherme Silvino Greca (luizgreca@alunos.utfpr.edu.br),
Renzo Tognella De Rosa (renzoderosa.tognella@gmail.com)

Gustavo F. Lewin (lewin@alunos.utfpr.edu.br),
Marlon de Oliveira Vaz (marlon.vaz@ifpr.edu.br),
David Segalle (davidsegalle@alunos.utfpr.edu.br),
Victor Boechat Errera (verrera@alunos.utfpr.edu.br),
João Alberto Fabro (fabro@utfpr.edu.br),
André Schneider de Oliveira (andreoliveira@utfpr.edu.br),
Felipe Pierre Conter (felipeconter.cc@gmail.com)

@UTBOTS_UTFPR

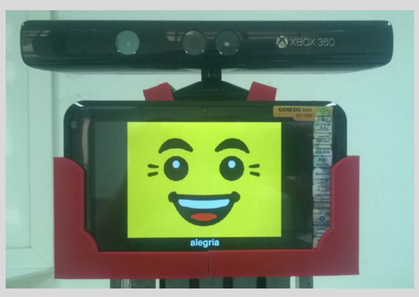
UTFPR – Federal University of Technology – Paraná – Curitiba, Brasil – www.utfpr.edu.br
LASER – Advanced Laboratory of Embedded Systems and Robotics – www.laser.dainf.ct.utfpr.edu.br

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]:
- **1 – Navigation:** applying SLAM algorithms with LIDAR data, movement commands can be sent through ROS to 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 environment estimated and people can be detected and identified through facial recognition;

Hardware

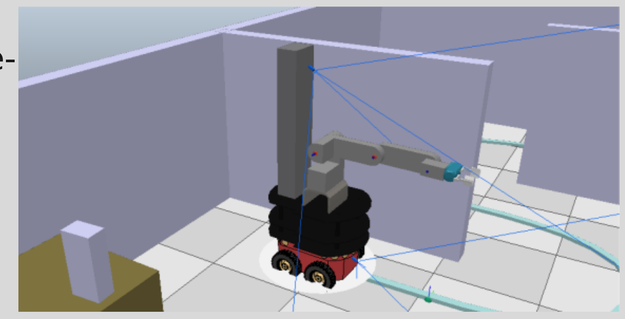
- The Pioneer P3-AT has:
- **1 - Processing:** two embedded PC (Intel Nuc[3] and Nvidia Jetson Nano[4]), which run Linux and ROS;
- **2 - Localization:** A LiDar is used to feed information for a slam algorithm which is capable of mapping in real time for navigation purposes;
- **3 – Vision:** a RGB-D 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 – whisper cpp: it's a package aimed at speech recognition based on machine learning. Enabling the robot to process voice commands;
4 – text to speech: A ROS node was developed that utilizes the Mimic3 speech synthesis engine, integrated with the robot's system to produce natural sounds. Leveraging the capabilities of ROS, the program accurately synthesizes textual input into realistic speech;
5 – face_recognition: Utilizes a HOG algorithm for facial identification and a KNN algorithm to then recognize different individuals;
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 – darknet_ros: integrates the YOLOv3 CNN model for object and person detection with ROS.
8 – 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 object manipulation, as well as the object manipulator itself, along with its ability to interact with people are to be expected in the future.

We would like to thank the financial support of Granozen

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] Nvidia Jetson Nano. Available at: https://www.nvidia.com/pt-br/autonomous-machines/embedded-systems/jetson-nano/product-development/
[5] P. S. PALAR. ROS package ros_display_emotions. Available At: https://github.com/kpiatan/ros_display_emotions.
[6] LASER UTBOT@HOME Homepage. Available at: https://laser.dainf.ct.utfpr.edu.br/doku.php?id=utbots_at_home.
[7] CoppeliaSim V4.3. Available at: http://coppeliarobotics.com