RoboCup@Home 2022 - RoboFEI@Work Team Description Paper

Khaled Hazime Guimarães, Miguel Lopes de Moraes, Juan Gabriel C.F Pinheiro, Mauricio Amaro de Souza, Alex Alves Pereira, Danilo Hernani Perico
dperico@fei.edu.br

Centro Universitário FEI, São Bernardo do Campo, SP, Brazil

Abstract. This article introduces the RoboFEI@Work team. This project started in 2022 developing a robot based on KukaYoubot for industrial purposes. It has a navigation system using (SLAM) and a vision system using (MobileNet/Yolo). Our participation in the competition will be to put our robot to the test and improve imposed systems.

1 Introduction

The use of home services robotics has grown steadily over the years, robotics has developed a new niche and a new market. Gradually the robots took over homes and offices generating a better quality of life for humans. [1]

This research group aims to implement a new group for the RoboFEI team, the RoboFEI@WORK, the idea is to work on industrial problems, but our team has similar tasks to those proposed by robocup@Home. Enabling an iteration with our team in this competition.

The RoboFEI@WORK was created in 2022 at the FEI university as a research team for the industrial problems. To solve the proposed tasks, we developed a robot using Kuka Youbot as a base, its entire internal system was changed, enabling better interaction between students and the project. It consists on a series of software capable of navigating in certain spaces and recognizing people and objects.

The objective of this document is to present this new team and main characteristics, demonstrating the capabilities that this robot has and the main works done.

The video of the robot can be found here: `https://youtu.be/5ui18oPHxUk`. The website of the team is `https://fei.edu.br/robofei/`.

2 Focus and interests

The focus of this team is to develop a better interaction between machines and humans in the industry, working in the best way together. Our interest is to develop and design a robot that can act on this problem, the tasks generated by RoboCUP@Work have their similarities with RoboCUP@Home, allowing our interaction with this event.

3 Description of the approach used to solve RoboCup@Home challenges

In this section will be presented the means of vision and navigation of the robot.

3.1 Robot Vision

The vision system allows the robot to identify and recognize objects and humans. Using the Microsoft Kinect sensor and ROS[2], it can process images taken from the real world. Thus it is possible for the robot locates any type of object, given the need for the task. In Robocup@Work, the robot needs to locate utensils positioned in strategic places, being an important tool for our robot, so it is possible for the robot to locate and search given a certain task.

The group uses MobileNet[3] and Yolo[4] tools to develop computer vision. MobileNet is a class of convolution and a simplification of neural networks designed to facilitate image processing. It works by dividing the image into pieces and passing each piece to a neural network, from a database the algorithm will produce a percentage of what the photo looks like [5]. YOLO is a single pass object detection method that uses a convolutional neural network as a feature extractor. This tool only needs to look at the image once to send it to the neural network, being a more fast for certain actions.[6]

From these tools, the robot can identify certain people and objects, enabling its interaction with the environment around it. Thus, given a certain task, the robot can perform better using its vision.

3.2 Robot Navigation

Navigation makes it easier for the robot to move through unknown/known spaces, given a certain environment the robot can move between points. During the RoboCup@Work competition the map is generated by the robot. Therefore, given a certain task, our robot can be driven to operate it.

When the robot is in an unknown location, it must know the environment where it is located, mapping and at the same time defining its position in the space. This technique is known as Simultaneous Localization and Mapping (SLAM). In the navigation, the robot has the capacity to choose the best possible route and avoid possible obstacles. For this to happen, it determinates parameters where there is the slightest path error and the robot is constantly correcting it.

SLAM is a technique used in several mobility areas to build maps of environments at the same time as their location. Through sensors, SLAM can estimate the position and orientation in spaces.[7]

4 Work in progress

Through this section it is possible to see some works in progress of our team. It is worth mentioning, that the robot is still under construction, as described in section 1; we are using the Kuka Youbot base, but the electronics are still being redone along with all the codes of the robot.

4.1 Manipulator

Our group developed a manipulator capable of solving the proposed tasks. Made from a 3D printer, its structure has dynamixel engines, the idea is for the manipulator to support the weight of the objects given by the tasks. The Figure 1 show the manipulator.

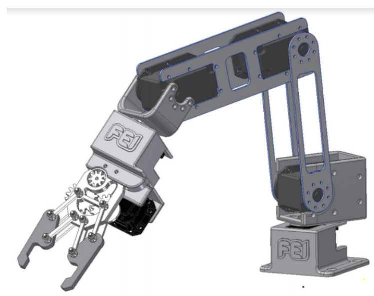

Fig. 1: developed manipulator

4.2 Other Works

Our group is developing a better application of the methods described by section 3.1 for the detection of objects and people, aiming to improve what we already have and apply new concepts produced.

5 Conclusion

Thus, this work presented the teams development towards its participation in this years LARC in Brazil. The team commits to participate in the competition and improve our knowledge and put our robot to the test, in order to improve your software and hardware in the future.

References

1. B.-J. You, M. Hwangbo, S.-O. Lee, S.-R. Oh, Y. Do Kwon, and S. Lim, “Development of a home service robot’issac’,” in *Proceedings 2003 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2003)(Cat. No. 03CH37453)*, vol. 3, pp. 2630–2635, IEEE, 2003.

2. "ROS.org | Powering the world's robots." `http://www.ros.org/`. Accessed on: May, 10h 2019.
3. A. G. Howard, M. Zhu, B. Chen, D. Kalenichenko, W. Wang, T. Weyand, M. Andreetto, and H. Adam, "Mobilenets: Efficient convolutional neural networks for mobile vision applications," *arXiv preprint arXiv:1704.04861*, 2017.
4. J. Zicong, Z. Liquan, L. Shuaiyang, and J. Yanfei, "The smach high-level executive [ros news]," Nov 2020.
5. A. G. Howard, M. Zhu, B. Chen, D. Kalenichenko, W. Wang, T. Weyand, M. Andreetto, and H. Adam, "Mobilenets: Efficient convolutional neural networks for mobile vision applications," 2017.
6. J. Ma, L. Chen, and Z. Gao, "Hardware implementation and optimization of tiny-yolo network," in *International Forum on Digital TV and Wireless Multimedia Communications*, pp. 224–234, Springer, 2017.
7. G. Grisetti, R. Kümmerle, C. Stachniss, and W. Burgard, "A tutorial on graph-based slam," *IEEE Intelligent Transportation Systems Magazine*, vol. 2, no. 4, pp. 31–43, 2010.

Robot Technical Specifications

Hardware Description:

- Base: Mecanum Wheel Robot platform.
  - Sensors:
    - Microsoft Kinect.
  - Actuators:
    - Omnidirectional wheels.
    - Maxon motor.
- Manipulator.
  - Actuators:
    - dynamixel motor;

Software Description:

- OS: Ubuntu 20.04;
- Middleware: ROS2 Galactic;
- Localization/Navigation/Mapping: SLAM;

Fig. 2: Robot base