RoboCup Logistics League 2023 Team Description Paper
PYRO 23

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Abstract

This article represents the description article of the RoboCup Logistics team of the PYRO team (PolYtech RObocup team), affiliated with the University of Lille, Polytech, France. The team was founded in 2014 and has participated in the RoboCup Logistics League five times since its inception, with notable appearances at the RoboCup German Open as well. It won the third prize in the RoboCup German Open 2015 Logistics League held in Germany. It won the second prize in the RCLL 2016 held in Montreal, Canada. It also won the third prize in the RCLL 2019 held in Sydney, Australia. Since 2019, the Pyro team has been unable to participate in competitions due to the interruption caused by the Covid-19 pandemic. However, today, the team is regrouping with new members consisting of young students from Polytech Lille and a doctoral student from the CRIStAL research laboratory who are motivated and ready to take on the international challenge. Building upon previous work, this new team will take control of the robots and enhance the hardware and software architecture in the navigation system to improve the overall system's robustness.

Figure 1: Prizes won by Pyro team, France.

1 Introduction

Pyro team is one of the participants in the RoboCup Logistics League(RCLL) whose main goal is to maintain and optimise the material flow in a simplified Smart Factory scenario production. The team has been working to gain a higher ranking in the league by simulating a smart factory where different products should be manufactured using production machines. Due to the multidisciplinary work needed to succeed in the RCLL, the team has been learning from different fields from mechanical engineering to supply chain and production. In 2015, the RCLL introduced the uses of the Modular Production System (MPS) production machines, a platform by Festo Didactic, and has slightly changed the game rules and forced the team to adapt and gather new challenges and solution improvement.

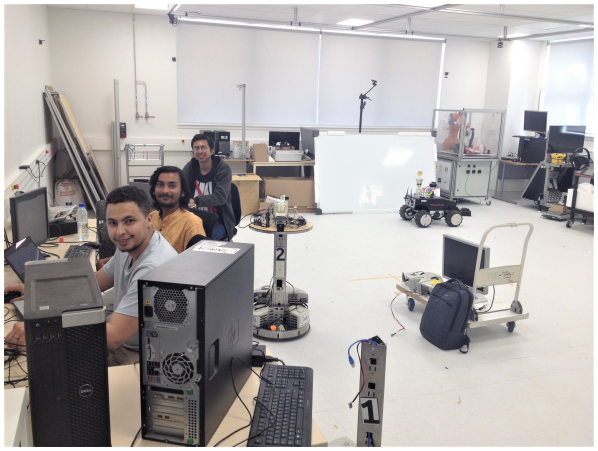

Figure 2: Students working in CRIStAL Lab for testing robots.

2 The RoboCup Logistics League

The RoboCup Logistics League (RCLL) is a worldwide renowned robotics competition that aims to build the idea of smart factories with complete working done by autonomous robots. The purpose is to fulfil production orders of a factory entirely by 3 robots without human interference and within a limited period of time. Robots have to perform actions sequentially such as collection of the workpieces, delivering at the right station, followed by assembly of various workpieces. Meanwhile, the robots also have to ensure that they do not collide with other robots or obstacles. It is also mandatory to note here that a single type of action is not replicated by the other robots and thus it is necessary to allocate unique commands to each robot. The major objectives of the RCLL include autonomous working of the robots such as planning of tasks, navigation throughout the entire grid, delivering at the right stations, and avoidance from other obstacles.

Figure 3: Workpieces of different colours are to be assembled.

Bots need to periodically send data to the Referee Box at all times of the game. This, in return, returns each moment the state of the game, the name of the team, the number of points acquired by the team as well as the products requested in priority during the phase of production. A bad report of a machine or the report of an opposing machine causes penalties, this is why it is necessary to clearly determine beforehand which areas belong to the team. In order to create these different products, each team has several types of machines: a Base Station containing all the necessary bases, two Ring Stations, two Cap Stations, a Storage Space Station and a Delivery Station whose purpose is to collect finished products.

3 The PYRO team Bots

The robot platform used in all the 3 bots is the Robotino3 by Festo Didactic. The Robotino has the following features: omnidirectional movement, a gyroscope and a webcam for detection of QR codes/ identification tags and conveyor belts, infrared distance sensors to avoid collision, and bumpers. A LIDAR sensor is also used infront of the robotino in order to find distance ranges through laser detection. In order to give height to the robot, we mounted a vertical stand on the robotino. There is a gripper device mounted on the top of the stand for product handling. Data is sent to the robotino via Wifi router. Programming of the robots is done through ROS and simulation of the robots is done on Gazebo platform. Our primary objectives are to assist robots perform localization, image processing, and artificial intelligence.

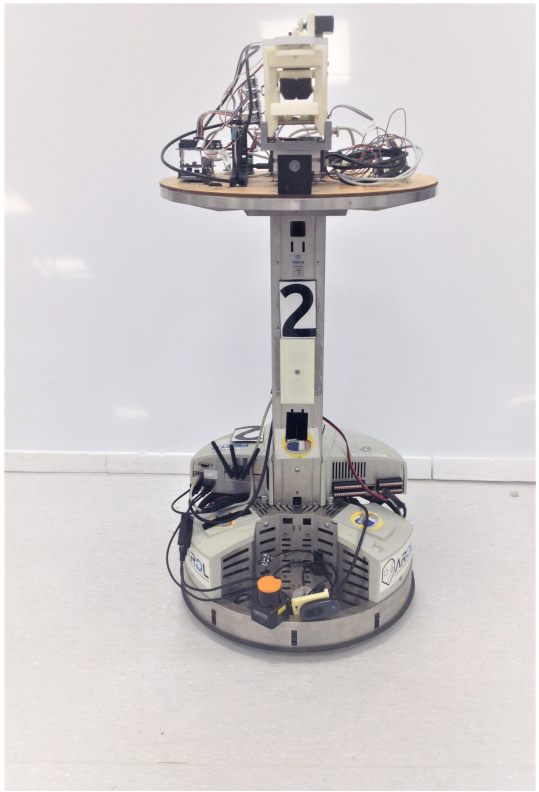

Figure 4: Robotino3 Festo

3.1 Interface with ROS: Robot Operating System

ROS provides a work environment that can be implemented on robots in order to facilitate the development of team projects, by bringing libraries, tools and an architecture adaptable to many platforms. Moreover, it can manage several robots simultaneously in a secure way in order to respect the safety standards already in place within the framework of the competition. As a development environment, a presentation of its operation is required.

Figure 5: Design of various Bots.

The operation of ROS is based on the following key elements: nodes (node), topics and services, as well as “environment” variables: settings. Here is a schematic diagram of the communication between these elements:

The nodes exchange with each other via a system of topics. When a node publishes on a topic it is called ”publisher” and when a node listens to a topic it is called “subscriber”. The same node can be subsciber and publisher.

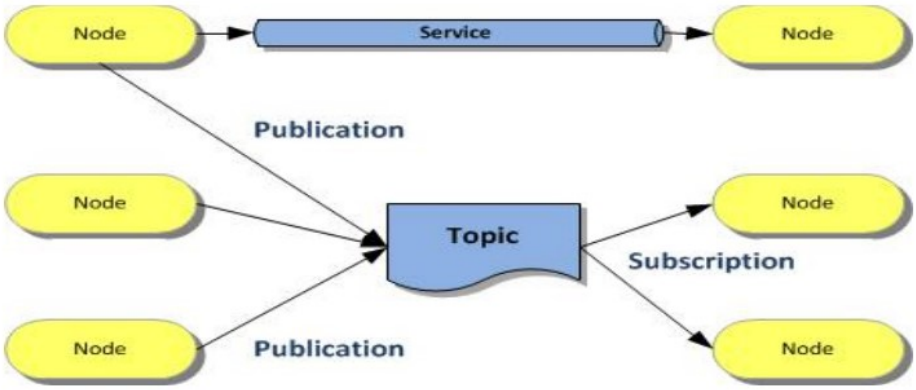

Figure 6: Communication between various nodes

3.2 Gripper

Our gripper system consists of one linear axes and a two-fingered gripper, as shown in Figure 2. It is fixed at a certain height on a stand. The motions are controlled by Arduino, which receives commands from the Robotino. The stepper motor is used to move the gripper stand forward and backward while the 2 servo motors are used for opening, closing and gripping the workpiece.

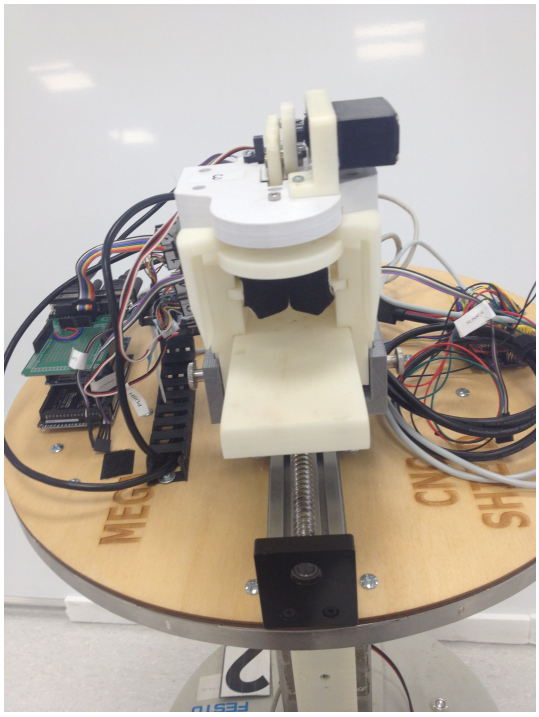

Figure 7: Gripper mounted on top of the stand

4 Conclusion

Our project is divided into two parts: The first is the realization of task builder, and the second, the task runner. These two parts form the brain and the spine of the three robotinos. They will direct the other nodes in order to allow the PYRO team to earn the maximum number of points. From a technical point of view, this project requirs both knowledge of algorithms, and software-to-object design without forgetting the part of robotics. The possibility of being able to test the interface locally with a simulator is also a real plus for development. This project also enables us to carry out real work team, particularly at the level of the development branches on GitHub. In terms of outcome, the project is carried out with respect to the specified loads and on time. We also faced few challenges on the new RefBox implemented for this year's competition but we are exploring methods to find appropriate solutions and do the necessary modifications in the previous codes.

We intend to continue our participation in the next RoboCup competitions and in this context add other functionalities to the interface. The website of the Pyro RoboCup Team can be found at http://pyroteam.github.io/activities.html