Description of Team Solidus 2018

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Abstract. The aim of this paper is to describe our institute and our Team Solidus. Instead of a big technical research approach, we put the emphasis on the didactic concept including the Robotino integration in the classroom and some of our special technical solutions.

Keywords. Solidus, didactic, classroom, robotino, Java, iot, mqtt, opencv, Industry 4.0, PLC, gripper, a*

1 Introduction

This paper is part of the qualification process to attend the RoboCup 2016 in Leipzig Germany. This paper is organized as follows. Section 2 provides the description of the Technical Institute of Applied Science HFTM. Section 3 presents the Didactic Concept. Section 4 provides the description of the Team Solidus. Section 5 presents the Successes of the team

2 Technical Institute of Applied Science HFTM

As a technical college, the HFT Midland offers education with practical relevance. From the co-operation with the industry and a broadly supporting sponsorship emerges a constantly up-to-date outline of the profession of technicians in the subject areas of machinery construction and systems technology. In this way the close connection to the employment market is secured. Our outline of profession is characterized by competence, namely by the ability to develop solutions for specific problems.

During the study the HFTM offers their students in the state-of-the art laboratory of machinery construction and systems technology the possibility to transfer their theoretical knowledge into the professional practice.

Fig. 1. Machinery construction lab

Fig. 2. Automation technology lab

After two years of full-time study, our qualified technicians are already fully steeled for new professional challenges thanks to their practically orientated education. In comparison to other educations on the tertiary level they reach an extremely high state of practical training and applied education. Our full-time program for technicians in automation is unique in Switzerland.

3 Didactic Concept

Our concept of education was specifically adapted according to the implementation into the professional practice mentioned above. Our theoretical sequences are always short and appropriate. Immediately consequent upon the theory the trained elements are implemented into software and/or realised in a physical device. (Sensors, actuators). Based on different evaluations we took our decision for the Robotino by Festo, which is especially appropriate with all its hardware components. The visual feedback with a real movement of a robot is ideal and appeals to the different skill levels and learning styles. This combination also fits the demands of industry 4.0, which is a main topic of our education concept.

In this way, the base of digital technology is already trained with the bloc based programming language RoboView. Subsequently the course follows: Base of programming in the code based world with JavaScript and some excursions to self-made blocs with LUA. The new concept with the separation of gripper and motion, forces the students to think about communication interfaces between different partners, such as PLC's, axes-controllers and microcontrollers. Classic TCP communication such as specialized M2M Protocols like MQTT, OPC-UA are topics of these studies.

In the area of specialisation ICT, the course «Object Oriented Programming» and «Algorithms» follows, and afterwards the Robotino-Logic will be programmed entirely with Java. At the same time the Linux-course is starting, which bases on the operating system of the Robotino's basic board. With this know-how, the students start the work on the RoboCup project. There are two modules to the student's disposal with 80 lessons each, the process-oriented engineering and the process module with the implementation.

4 The Team Solidus

The HFT Midland provides their second-year-students the opportunity to practise on the topic of robots. For that purpose, Team Solidus was founded in the year 2013.

The team aims to provide the opportunity to ambitious students to deepen their knowledge in the field of robotic engineering and programming. During their study the students can already work on robots practically. The obtained knowledge is necessary to continue developing with the three Robotinos of Festo as well as to adapt them to the professional practice and modify them.

With the means of suitable hard- and software, the robots should be able to move in a certain space autonomously as well as to place objects and find them again.

The ultimate goal of the Robocop Project is to use the learned technology in a comprehensive practice project and to experience the real problems in the hardware world.

The involved peoples in the implementation are exclusively students and our approaches are usually pragmatic but **solid** and not experimental, unproven research or highly mathematical. Therefore, the competition with universities is a very ambitious aim for us.

5 Technology

5.1 Software

Until year 2014, some tasks (driving, odometry and signal detection) were solved with the program RoboView and the graphic programming language.
Due to better stability and maintainability we changed our approach and used exclusively Java. The only exceptions are the tag detection and the light recognition (no more since 2017) where we use OpenCV and therefore we are working with C++.
The game logistic parts as well as the communication and the laser detection and way analytics are programmed in pure Java.
To facilitate the modular and distributing development, all elementary subcomponents (Drive, Cam, Logistic) communicate over MQTT. Because of the usage of the same protocol among the Robotinos and the master we work with MQTT clustering over bridges.

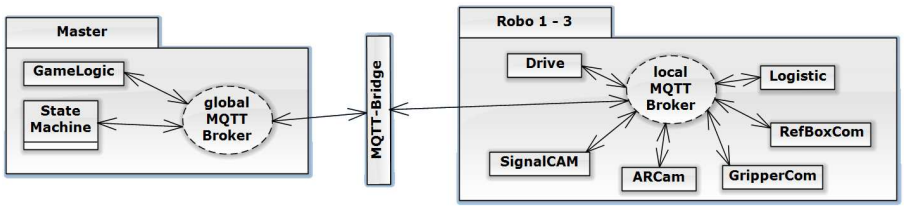


Fig. 3. Communication diagram

The positioning is mainly based on odometry, with small corrections resulting from the laser scanner and the AR-Tags. Environmental recognition and edge detection is made with Douglas Peucker and Ransac algorithms.

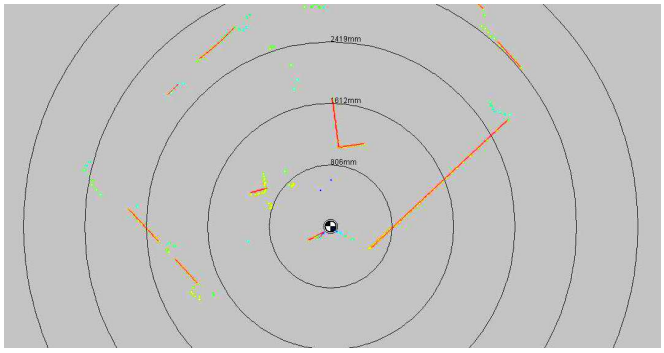


Fig. 4. Environment recognition

To avoid the obstacles, we use a dynamic map with static machines and temporary robots. For path and logistic planning, we have further algorithms (A*).

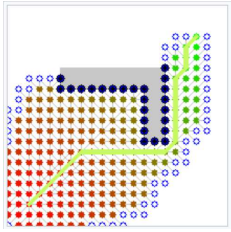


Fig. 5. Environment recognition

This year we want to visualize the field and the events on it. So far we are not finished yet and cannot show anything in this paper yet.

5.2 Hardware

This year we are starting with a total new concept. We separate the motion of the robot and the gripper from each other. The main idea is to make a rough positioning and detection of the station by the motion part of the robot. The precise positioning and grabbing of the part is done by the new separate gripper module. For that we use 3 electrical axes which are able to adjust the gripper to the right position, even when the Robotino doesn't stand correctly in front of the station. The three axes are controlled by a PLC and 3 motion-controllers. The sensorial part of the gripper is made by optical captures over the IO-Link protocol.

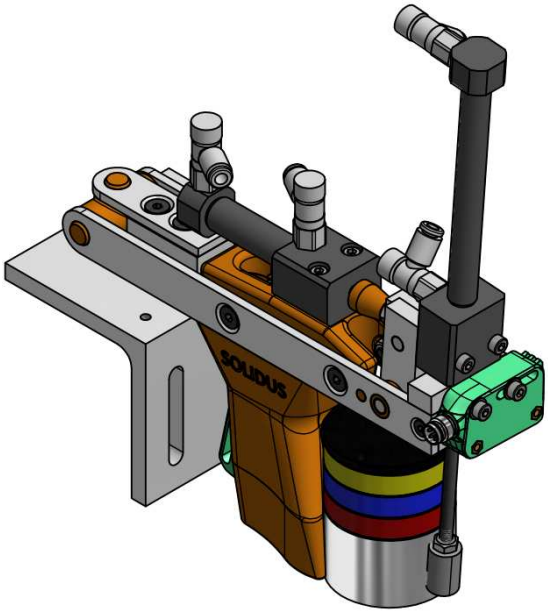
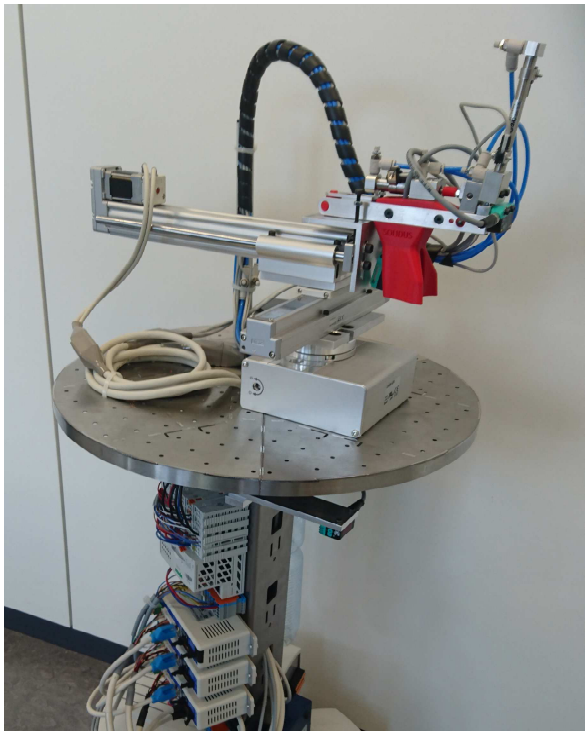


Fig. 6&7. Selfmade gripper



6 Successes of the Team

6.1 Robocop 2013 Eindhoven

In spite of initial difficulties our team succeeded – as a newcomer in the RoboCup Logistics League – in asserting themselves against other teams and finish the competition on the seventh rank.

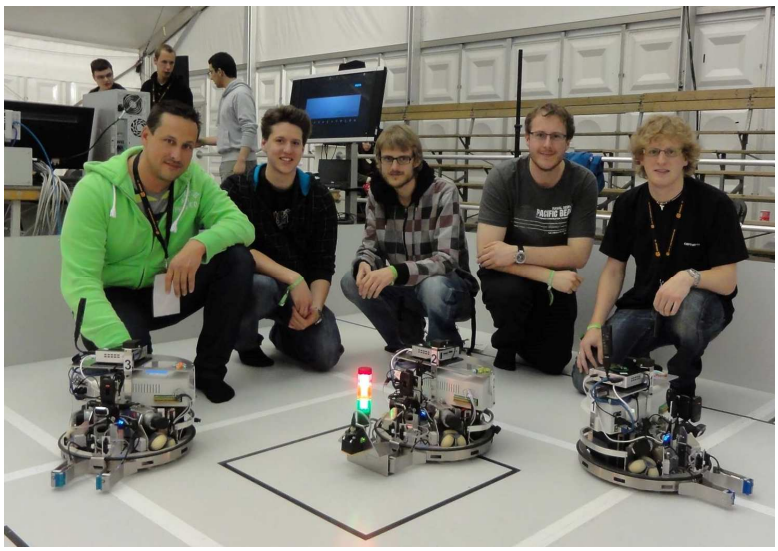


Fig. 8. Team Solidus 2013

6.2 RoboCup 2014 João Pessoa Brazil / German Open Preparation

After a complete switch of team members and more difficult rules with dynamic products, our new team made an enormous commitment and a great deal of „overtime“.
Finally, they managed to achieve first time the pedestal (Place 3) in Magdeburg at the German Open. Due the high travel expenses, a reduced team with four students and two assistants went to Brazil. Fighting with difficult lighting conditions compared to the German Open we achieved the fifth position. After two years, we could establish us in the midfield and hope now to reach front ranks in future.

Fig. 9. Team Solidus 2014

6.3 RoboCup 2015 Hefei China

Changing many rules and introducing new MPS-Machines, China was not only a technical challenge. The travel to Hefei and also daily from the hotel to the Anhui Exhibition Centre was everyday a new challenge. Due to few teams, finally we finished the RoboCup with a second Place. This was a great satisfaction for the whole Team.

Fig. 10. Team Solidus 2015

6.4 RoboCup 2016 Leipzig Germany

This year we decided to get some mechatronic students on board who developed an industrial gripper. We could celebrate a fought 2nd place and the victory in the open challenge (because of the Gripper). This was the greatest success of the team so far and still almost at home.

Fig. 11. Team Solidus 2016

6.5 RoboCup 2017 Nagoya Japan

This year we were challenged enough with the new field, the zone changes and a new coordinate system. Nevertheless, we were able to save us a podium finish again.

Fig. 11. Team Solidus 2018

7 Rulebook Confirmation

We confirm that our 3 robots, all software systems and the behaviour of the robots and team members will satisfy the requirements and rules given in the RCLL Rulebook 2018.