Description of Team Solidus

Technical Institute of Applied Science HFTM
Biel/Bienne, Switzerland
alain.rohr@hftm.ch,
thomas.zuercher@hftm.ch
stefan.brandenberger@hftm.ch
https://www.facebook.com/hftmrobotics
http://www.hftm.ch/ger/Meine-HFTM/Team-Solidus

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

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 MQTT are topics of these studies.

In the area of specialisation ICT, the course «Object Oriented Programming» and «Algorithms» follows, and afterwards the Robotino 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 or highly mathematical.

Therefore, the competition with universities is a very ambitious aim for us.

TEAM SOLIDUS HFTMittelland

5 Technology

5.1 Software

Until last year, some problems (driving, odometry and signal detection) were solved with the program RoboView and the graphic programming language.
From now on we use exclusively Java. The only exceptions are the tag detection and the light recognition where we use OpenCV and therefore we are working with C++.
The game logistic parts as well as the communication and the laser detection 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.

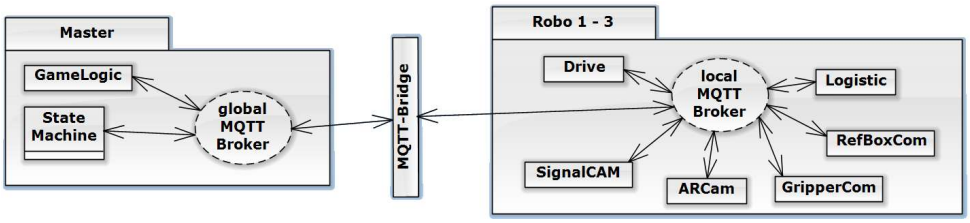


Fig. 3. Communication diagram

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

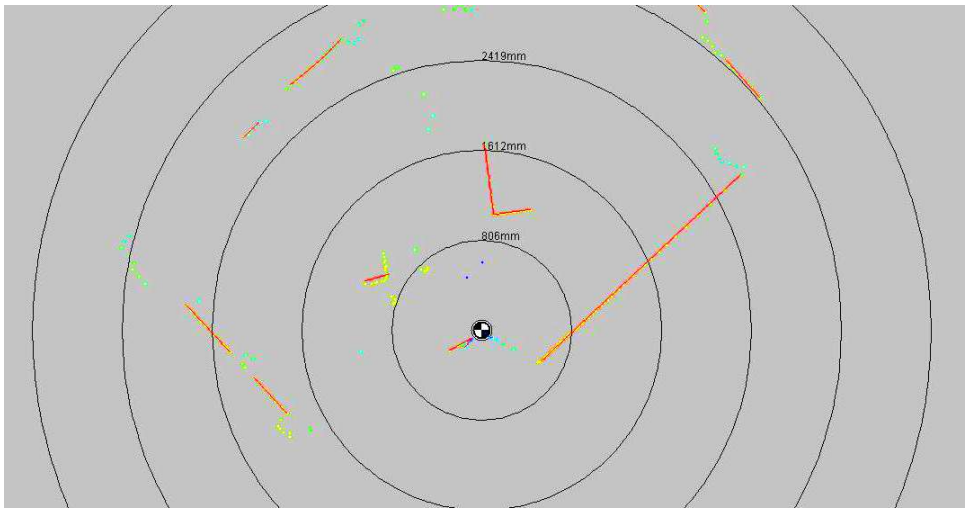


Fig. 4. Environment recognition

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.

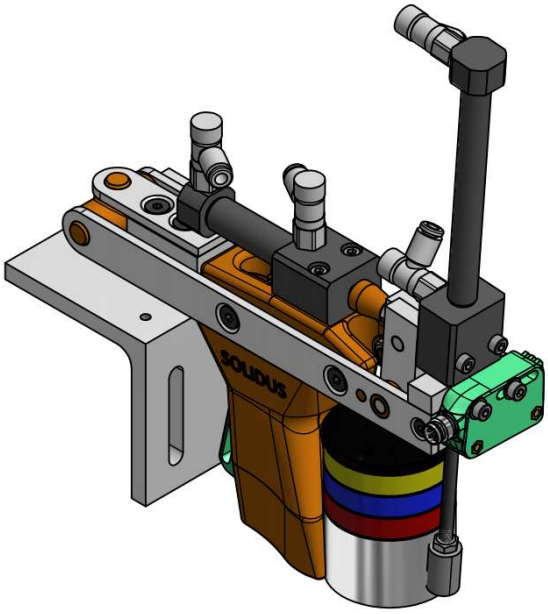
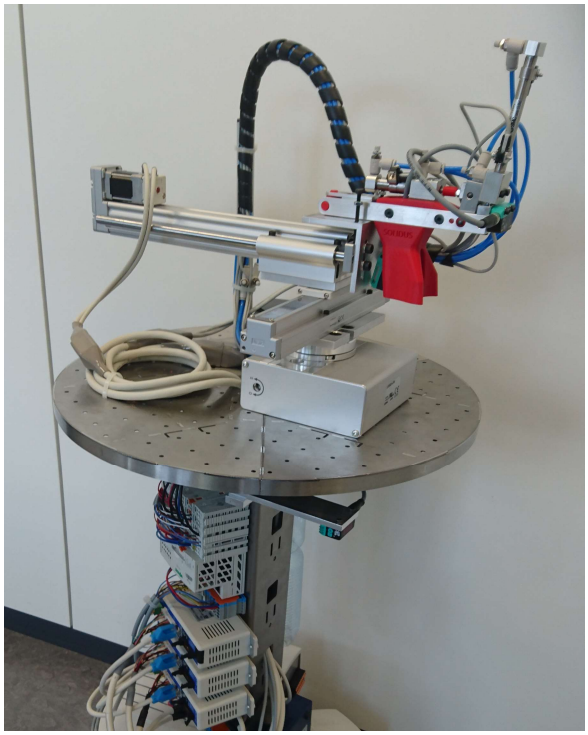


Fig. 5&6. Selfmade gripper



6 Successes of the Team

6.1 Robocop 2013 Eindhoven

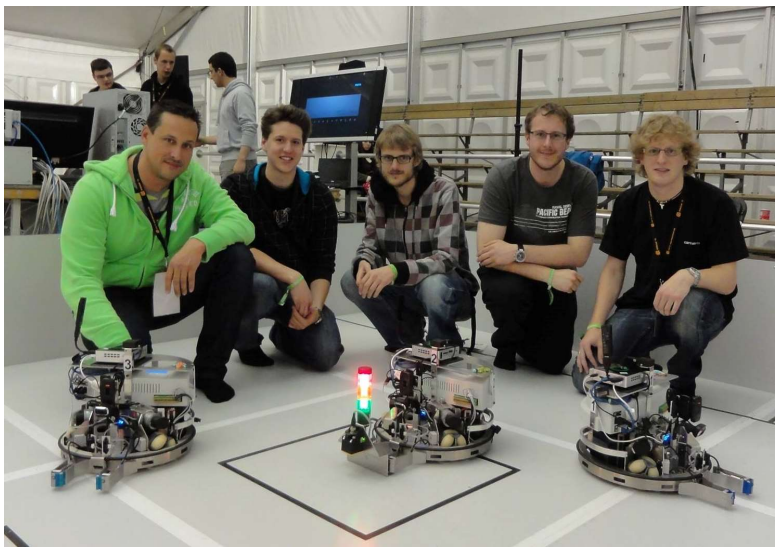


Fig. 7. Team Solidus 2013

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.

6.2 RoboCup GermanOpen 2014

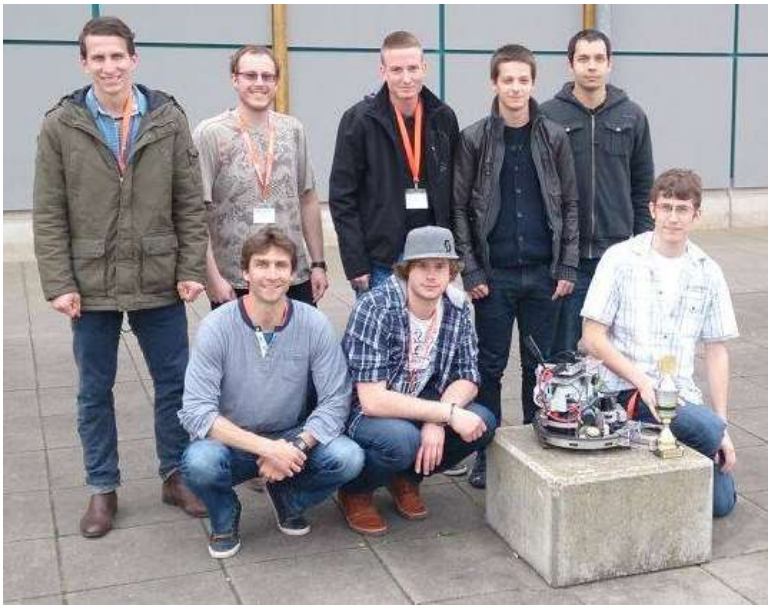


Fig. 8. Team Solidus 2014

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). All this gave the Team Solidus the basis to be able to compete in the RoboCup 2014 in Brazil.

6.3 RoboCup 2014 João Pessoa Brazil

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 GermanOpen we achieved the fifth position. After two years, we were able to establish us in the midfield and hope now to reach front ranks in future.

6.4 RoboCup 2015 Hefei China

Fig. 9. Team Solidus 2015

China was not only a Technical challenge. The travel to Hefei and also during the RoboCup from the hotel to the Anhui Exhibition Centre was everyday a new challenge.

Finally, we finished the RoboCup with a second Place. This was a great satisfaction for the whole Team.