SmartBots@Ulm 2016 Team Description RoboCup Logistics

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Abstract. This paper represents the RoboCup Logistics team description paper of SmartBots@Ulm which is affiliated with the University of Applied Sciences Ulm, Germany. The team has been founded in 2009 and participated in the German Open in Magdeburg since then in the RoboCup@Home league. With this upcoming year the team changed its focus and for the first time participates in the RoboCup Logistics league.

1 Introduction

The RoboCup team of the University of Applied Sciences Ulm has been founded in April 2009 and has participated in the RoboCup since 2010 each year. During this time the small student teams, which are basically driven by participants of the master course Information Systems, could achieve remarkable successes for example second place in 2011 and 2013 in the RoboCup@Home league at the German Open in Magdeburg.

One of the important aspects which distinguishes the SmartBots@Ulm team from other participants is probably the fact that the teams consist only of master students. This implies a high fluctuation of team members on a half year basis and leads to demanding challenges related to team formation and incorporation of new team members. Due to the in-house developedSmartSoft software framework and algorithms these challenging circumstances had bee handled quite well in the past.

The Service Robotics Research Center at the University of Applied Sciences Ulm, Germany (http://servicerobotik-ulm.de) hereby puts the research focus on model-driven software engineering for robotics, lifelong localization, mapping and object recognition.

The Robocup@Home team used the published solutions and open source tools from the Service Robotics Research Center and extended them for the

RoboCup@Home competition. The Robocup@Home requirements fit well, since the overall focus of the Service Robotics Research Center is the development of methodologies for building robust service robotic systems. The major approach hereby is to extend and merge so far separated techniques under the objective of suitability for daily use. Real-World robotic scenarios can be found at our Youtube-Channel (http://www.youtube.com/roboticsathsulm). While the Service Robotics Research Center is focused on the methodologies, the Robocup@Home team applied them for the Robocup@Home challenges.

After six exciting years participating at the RoboCup@Home league the team decided to change the practical focus which results in a swap to the evolving RoboCup Logistics league. As reasons for this significant change can indeed be named the partnership with the Service Robotics Research Center, FESTO, theSMARTSOFT framework which is available for the Robotino robots [4], the attractiveness of the Logistics league and the consensus regarding the research area, especially towards Industry 4.0.

As in-depth preparation for the World-cup, we participated in the RoboCup Logistics Winter School at the RWTH Aachen. There we met other teams from around the world to get a deep understanding of the rulebook and to exchange ideas for the upcoming Robocup.

In the following, a overview of the used robot platform as well as the used software framework and its components is given. We give a short introduction into the SMARTSOFT framework which forms the underlying fundament. Subsequently, a description of the basic idea behind several of our software components is given.

2 Robots and Development Environment

Figure 1 shows our three Robotinos in the real-world lab environment which is part of the service robotics research lab [1] at the University of Applied Sciences Ulm. All three Robotinos are equipped with the same hardware and match the original components from FESTO for the Robocup Logistics league. The Robotinos are currentely operated by Ubuntu 12.04 and are equipped a SICK LMS100 2D laser scanner in addition to the nine infrared distance sensors and the Logitech colour camera as well as the mandatory mounting tower with the mounting platform. The FESTO gripper[3] is mounted on top of the mounting platform.

3 Software Framework

To the the complexity of robotic systems operated in RoboCup logistics league, a component based framework integrated in a model-driven software development toolchain is considered as mandatory. This allows the transformation of

[1] http://www.servicerobotik-ulm.de

Fig. 1. Robotinos and real-world testing environment.

hand-crafted single-unit lab systems to industrial-grade systems which are systematically composed out of components with explicitly stated properties. Furthermore, this fosters reuse by separating robotics knowledge from short-cycled implementation technologies.

All theses conditions are covered by the SmartSoft Framework which is developed at the Service Robotics Research Center which is part of the University of Applied Sciences Ulm. The SmartSoft framework has been continuously developed. Many research and industrial projects with different robotic systems are realized with this framework. The SmartSoft component approach for robotics software is based on communication patterns as core of a robotics component model. The framework assists the component developer, the application builder and the end user in building and using distributed components in such a way that the semantics of the interface of components is predefined by the communication patterns, irrespective of where they are applied. Dynamic wiring of components at run-time is explicitly supported by the wiring pattern which makes the major difference to other approaches. This allows to implement loosely coupled and distributed systems based on standardized components whose interaction can be adjusted according to the current context and requirements. Figure 2 shows the SmartSoft approach as integrated into the Robotino robots. It is publicly available as open source [5].

The SmartSoft idea is completely independent of the implementation technology. The reference implementation we use in RoboCup Logistics is based on ACE/SmartSoft [8]. The open source SmartSoft framework with several robotic components (Base, Laser, Motion, Mapper, ...) as well as the SmartSoft

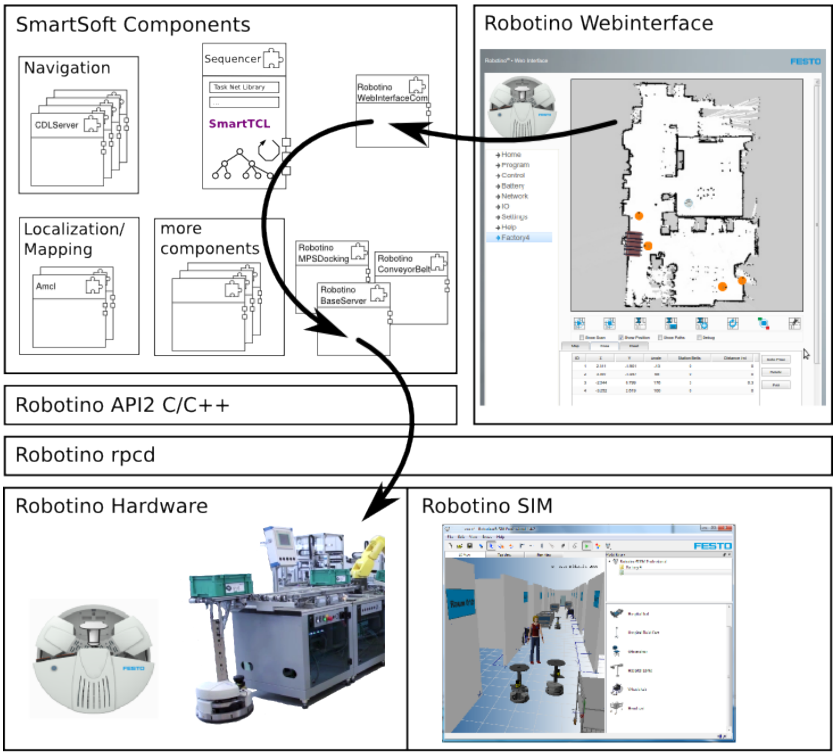

Fig. 2. The Robotino-SmartSoft integration.

MDSD Toolchain are available for download [9]. Robotino-specificSmartSoft components are publicly available as open source via OpenRobotino wiki [4].

4 Software Approach

The idea behind our work is to extend the well working set of SmartSoft-components (which already compriseSmartSoft Robotino components) with additional components providing capabilities needed in the Robocup Logistics scenario.

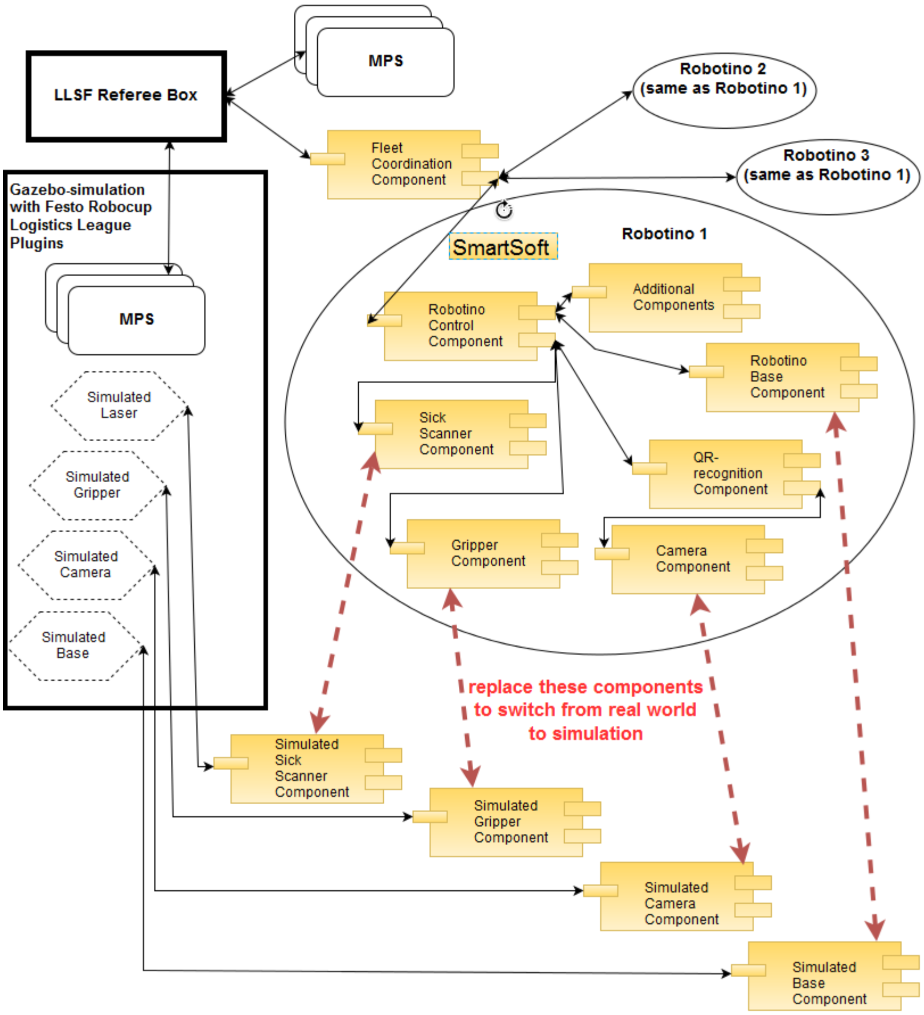

Fig. 3. SmartBots@Ulm component approach for Robocup Logistics League

The overall resulting software architecture is illustrated in figure 3. It shows how the SmartSoft world operating the Robotino robots is connected with the Robocup logistic league infrastructure software. This setting connects to the original LLSF refbox (Referee Box) and the Gazebo simulation without any modifications in these software blocks. By just exchanging fourSmartSoft components (base server, gripper server, camera server, laser server), one can switch from real-world experimentation to the simulated environment.

Since we switched from Robocup@Home league to Robocup logistics league the development started not before late 2015. Additionally we are challenged by the fact that we have at least partial team members exchange again in spring 2016. Even tough the team is relatively large with nine members, most of them had to get acquainted first with the used model-driven framework which however soon pays off with respect to tremendously saved time at system integration.

4.1 QR-Recognition

To recognize QR codes, the library ALVAR[2] is applied. It is typically used for creating virtual and augmented reality applications but its features for identifying QR codes served our purpose. To work properly the image of the QR code must be recorded within a distance from 15 to 50 centimeters and must not exceed an angle of 60 degrees. This functionality is wrapped in the SmartSoft QR-recognition component.

4.2 Gripper

Currently the standard Robotino 3 electric gripper of Festo[3] is in use. Using another gripper or modifications is being considered since little tolerance is given when grabbing an object. The control of the gripper is integrated into theSmartSoft gripper component.

4.3 Referee Box implementation

The referee system Refbox is a given software to which we need to cnontact to from within theSmartSoft world. ASmartSoft component provides required interfaces.

4.4 Simulation

Since we currently have only access to the base-version of the multi purpose stations we have to backup our development with simulation. As many other teams we use Gazebo for this task with the Festo Robocup Logistics League plugins. As described above, the simulation can also be seamlessly accessed from theSmartSoft world.

4.5 Other Approaches

As mentioned before we build on the knowledge of years of participation in the Robocup@Home league. Therefore we can use the already existingSmartSoft components for navigation (mapping, path planning, motion control, SLAM) and for task coordination that were used previously in the Robocup@Home league and the research work of our university.

5 Conclusion

In this paper we introduced our SmartBots@Ulm team which competes the first time in the Robocup Logistics league. We also described our robot platform and development environment of our university. Additionally, an introduction to our used robotics framework SmartSoft is given, which is a key element in our system. Furthermore some brief descriptions of our current software approaches are presented.

6 Acknowledgment

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