SPQR RoboCup 2013
Standard Platform League
Team Description Paper

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1 Introduction

SPQR[1] is the RoboCup SPL team of the Department of Computer, Control, and Management Engineering "Antonio Ruberti" at "Sapienza" University of Rome. Such group has been involved in different RoboCup leagues since 1998. In particular, it entered the following competitions: Middle-size (1998-2002), Four-legged (2000-2008), Real-rescue-robots (2003-2006), @Home (2006), Virtual-rescue (2006) and Standard Platform League (Nao Division) (2008-present). The actual members of the SPQR team are: Daniele Nardi (current President of the RoboCup Federation, member of the RoboCup Trustees and RoboCup Symposium co-chair in 2004), Luca Iocchi (Exec member of RoboCup@Home since 2008 and RoboCup Symposium co-chair in 2008), Fabio Previtali (Ph.D student), Guglielmo Gemignani (Ph.D student), Gabriel Ulici, Martina Deturres (research assistant), Francesco Riccio, Chiara Picardi and Lorenzo Tognalini (master students). The SPQR team members published a total of sixteen papers in various RoboCup Symposia (including a best paper award in 2006), in addition to many other publications about RoboCup related activities in other international journals and conferences related to artificial intelligence and robotics.

This report describes the main research activities that have been carried out until today as well as those that will be completed during the next few months.

2 B-Human Software Architecture

During the development of the code used for the past RoboCup competitions (ranging from middle-size, to legged, rescue and @Home robots), we have gained a substantial experience and we have developed a set of reusable modules. Until today, exception made for the AIBOs, every robot and robotic application has been developed using the OpenRDK[2] [1] open source framework (formerly, Open-source Robot Development Kit), which is supporting the NAO platform since 2008.

This year we decided to focus our efforts on developing distributed data fusion and multi-robot cooperation and coordination algorithms in order to investigate

[1] `spqr.dis.uniroma1.it`
[2] `openrdk.sf.net`

new and challenging issues in our research field. Since the OpenRDK framework has been discontinued and the development of high level behaviours has become too problematic due to various problems identified in lower level parts of the system, we have decided to use, as a base for our robots, the code released in 2012 by the B-Human team[3] [3]. In particular we will be using the walking, vision and localization engines while developing coordination strategies and distributed perception novel techniques as well as new high level behaviours for the defender, the goalie, the striker and the supporter roles.

3 Behaviors

3.1 Striker

The main strategy of the striker player will be designed through a high-level robot programming tool. The attacker plan will have three sub-routines, one for each high-level behaviour such as: look for the ball, approach it and finally kick towards the goal.

An action (or sub-routine) will be executed if and only if a set of conditions, that are dynamically updated, are verified. In order to better understand this point, consider the following example: during the action *go to ball*, the code for approaching the ball will be executed if and only if the robot has seen the ball. If the condition at some point does not hold any more, the executor will interrupt the current action and then it will execute the *search for the ball* action. Interrupts are a very convenient tool for specifying the control flow.

A similar approach will be adopted to select the right kick depending on the particular situation (considering several parameters). The kick selection will be performed at a high level and the robot will be able to choose among three types of kick (both left and right): forward kick, side kick and back kick.

3.2 Goalie

The goalkeeper will implement a special behaviour that will contain decisions based on the estimation of the direction of the ball as well as its position and velocity. Also for the goalkeeper, we will implement different specific actions to be executed in order to catch the ball: find the ball, track it and finally try to save the majority of the opponent scoring attempts.

We will also develop two types of saves (both left and right): the close and the far save. The decision on which save should be used will also be taken at a high level considering the ball velocity and its direction. Moreover, if the keeper estimates that the ball is going out, it will keep its position. After the save, the goalie will return to its standard position inside the penalty area.

[3] `b-human.de`

3.3 The Supporter and the Defender Roles

The supporter and the defender roles will implement simple behaviours, specialised based on the positions of the robots. In particular, such behaviours will select the most suitable positions of the robots based on various parameters of the game (e.g. ball, striker and goalie position, game score, time passed from the kick off, etc.).

4 Distributed Coordination and Action Synchronization

Considering the new rules that will be adopted in the next RoboCup competition, the *Distributed Data Fusion* aspect will certainly be a breakthrough in the development and the realization of the next winning teams. In this event, in fact, both the field size and the number of playing robots have been increased, making, from now on, coordination and cooperation a vital requirement to reach a good level of playing. Hence, in this setting, two multi-robot issues will be considered for an effective team play: dynamic task assignment and distributed data fusion among robots.

4.1 Dynamic Task Assignment

Role switching and robot positioning are important characteristics needed by an effective team strategy; in order to realize such a key aspect, suitable distributed methods must be used. Our approach is based on a distributed coordination protocol using utility functions [2], that has been successfully tested in past years also for heterogeneous teams. We are planning to extend our basic coordination, by implementing a larger set of strategies and allowing different sets of roles to be adopted according to the game context (e.g. coordination when searching for the ball opposed to coordination when the ball position is known).

Finally, we are also planning to use different types of game strategies. For example, if the team is losing the game an aggressive strategy will be chosen for trying to win the game, while if the team is winning a defensive strategy will be adopted in order to defend the result.

4.2 Cooperative Global Tracking using Multiple Sensors

We have developed a methodology to merge information from multi-sensor sources and teammates estimations in a distributed system. The methodology uses Distributed Particle filter-based algorithms that have been proved to be effective to model non-linear and dynamic processes in Multi Agent Systems.

In complex scenarios, where mobile agents are involved, it is crucial to disseminate good belief among them, in order to avoid degradation on the global estimation. A cluster-based data association has been used to boost the performance of a Distributed Particle Filter. Moreover, a two-tiered architecture has been developed: a local layer, associated to a single-agent Particle Filter is used to track multiple objects in the local frame; and a global layer, where the distributed estimation is performed.

References

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