FC Portugal 2002 Team Description: Flexible Coordination Techniques

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Abstract. FC Portugal team research focus is on the definition of flexible coordination mechanisms applicable on partial cooperative, partially competitive scenarios. In previous RoboCup competitions we defined and implemented a flexible agent architecture capable of easy adaptation to new competition rules and different domains. This gave us a stable platform to introduce and test new team coordination mechanisms.
FC Portugal 2002 is strongly based on this stable platform and on the code of its predecessor (FC Portugal 2001). Minor bugs were corrected and adaptations to the simulation league new rules were included. However, FC Portugal 2001 code flexibility is now explored to its limits through the definition of flexible configurable tactics and the use of the on-line coach. The on-line coach has a library of flexible soccer tactics that may be used during the game depending on game statistics and opponent modeling information.

1 Introduction

Although having the best goal average in the competition (scoring 150 goals in the 13 games played), FC Portugal finished third in RoboCup 2001. Development of FC Portugal 2002 builds on the previous version by exploring the team flexibility and the coordination techniques introduced by the team in RoboCup previous editions, refining and finishing their implementations and upgrading some of the low level skills. Changes in the competition rules introduce new opportunities for research namely in the domains of agent communication and agent adaptability.

2 Coordination Techniques

FC Portugal team coordination techniques include the following:

- **Situation Based Strategic Positioning (SBSP).** This coordination mechanism [1,2] enables a team of agents to move in a coordinated way in a field, based on common a-priori knowledge and simple environment knowledge.
- **Concept of Global Situation.** A situation is a high-level analysis of the field that must be simple enough to be performed by all agents, resulting in common global knowledge. In soccer the situation is something like attack, defend, our goalie free kick, going from defense to attack, etc. Although in the soccer simulated domain, this concept is not of primordial importance for the SBSP positioning system, in other domains like battlefield or rescue, situations are very important for positioning agents.

- **Distinction between Active and Strategic situations.** In Seattle most of the teams used directly or indirectly the distinction between active and strategic situations [2], enabling them to use well defined formations and positioning systems based on SBSP.
- **Definition of what is a Strategy for a Competition.** FC Portugal flexibility lies essentially on our formalization of what is a strategy for a competition with a team with opposite goals [1,2,4]. This strategy is composed of tactics with activation rules (based on opponent modeling information and game statistical information). Tactics include several high-level parameters like the team mentality, pressure or the level of risk taken and also several formations to be used in different game situations (attack, defend, free kicks, etc.). Formations assign to players SBSP parameters but also a given player type. Player types have three components: strategic, ball possession and ball recovery characteristics.
- **COACH UNILANG – A Standard Language to Coach a (Robo)Soccer Team.** Coach Unilang [3] improves team coordination by letting the on-line coach define the team strategy and perform the tactical changes in the team during the game. This way a deeper analysis of the game may be performed before changing the tactic because the coach has a global and error free view of the field and is not under the real-time constrains of the players. Both high-level and low-level coaching are possible through coach instructions. High-level coaching includes change tactics, formations used in each situation and changing player behavior. Low-level coaching includes defining formations, situations, player behavior and positioning with high detail.
- **Dynamic Positioning and Role Exchange (DPRE) based on utility functions.** FC Portugal DPRE mechanism [1,2] is based on previous work from Peter Stone et al [5] and enables the agents to switch their positioning (place in the formation) and roles (viewed as player types) inside a given tactic and formation whenever that action leads to an improvement of the team global utility. Each role (player type) assigns a player different characteristics like tendency to be either positional or aggressive, tendency to be more offensive or defensive, etc. Changing positioning inside the formation also implies the change of this role. Since we have homogeneous agents in our team, it is rather straightforward and very useful to do this. For heterogeneous agents role adequacy must be also considered.
- **ADVCOM – Intelligent Communication using a Communicated World State.** In 2001, ADVCOM was used mainly to decide if a player should talk by judging the relevance of his message [1,4]. The same principles can be used to decide the inclusion or not of a given piece of information in the 10 bytes available in 2002. Agents compare their own world states with a world state updated only by heard messages. The difference between these world states measures the relevance of that piece of information to others. Two new commands were added to the soccerserver to allow visual communication between players and priority to messages coming from a specific player. We are also planning the use of both of these mechanisms in an appropriate way.
- **Intelligent Perception using a Strategic Looking Mechanism (SLM).** Due to the limitation of communication bandwidth, the SLM mechanism will be very useful in RoboCup 2002. In a complex domain such as soccer if the communication bandwidth is constrained (disallowing other agents to transmit their own world states), sensors must be used in a intelligent way to enable an agent to maintain an accurate world state. Agents have a limited view angle, but they can turn their neck to choose which direction to look. FC Portugal SLM intelligent perception mechanism determines the direction the agent looks according to the situation and the confidence it has on the

positions/velocities of all the objects in the field. For each possible looking direction, a utility measure is calculated that estimates the usefulness to look on that direction and the best one is selected.

Our research in team coordinating techniques is not limited to the RoboCup domain and all methodologies developed are applicable to other domains in which spatial coordination is needed. These domains include battlefield scenarios, RoboCup rescue, RoboCup robotic leagues, etc.

3 Individual Decision-Making

Our team considers 3 different modules in the player's behaviour decision mechanism. In strategic situations the player moves to a position that maximizes his utility for the team (his strategic position) using the SBSP module [1,2]. The ball possession module [1,4] is activated when the player is able to kick the ball. Ball recovery module [1,4] is responsible for behaviour selection in active defending situations.

SBSP module has been comprehensively described in previous papers [1,2], and did not suffer conceptual changes. However, the coach tactical library now contains new tactics with different formations implemented.

The ball possession module is also fairly stable and considers the following types of actions: shoot to goal, pass, forward, dribble and hold. Each of these types of actions has several options in a given situation. Our decision mechanism is based on the evaluation of each of the options by the composition of several high level metrics.

The ball recovery module must select one of the following lower level behaviors: ball interception; ball passive interception; player tackle; approach ball position; cover goal; cover center, mark player or mark pass line. Two new ball recovery actions were added: tackle and mark player. Tackle addition is concerning with the changes in the server (that now allows a tackle action). The mark player behavior was added in an attempt to improve the team defense efficiency. Decision rules to select the recovery behavior to use remain mainly unchanged from our previous team [4].

4 Low Level Skills

FC Portugal introduced in Melbourne the use of on-line optimization techniques for low-level skills. In Fukuouka we plan to extend the use of optimization techniques to all major low-level skills, including interceptions, kicks and dribbles. RoboCup 2001 showed that the adaptation of low-level skills to changes in the rules can lead to big competitive advantages. The dribbling ability of Tsinghuaeolus surprised many older teams. FC Portugal 2002 extends its optimization techniques to the development of new dribbling and holding skills.

5 Results and Discussion

FC Portugal 2002 refines the previous version with fine tuned coordination techniques, improved low-level skills and intelligent use of 2002 changes in competition rules.

The flexibility of our team coordination mechanisms was clear in RoboCup 2001, namely in the final 3 games played where the team even played without a goalie. However, most of the coordination mechanisms were not well tuned resulting in poor attack efficiency against teams well tuned to play against FC Portugal. This way, FC Portugal, although having

many attacking situations and some scoring chances, was unable to score against Tshinghuaeolus and Brainstormers and suffered a goal against each of these teams in the first dangerous counter-attack suffered.
In Fukuoka we will put our efforts on the scientific aspects of the team trying to generalize the coordination mechanisms introduced to other domains. Our approach to the competition will consist on using FC Portugal 2001 code [4], correcting some minor bugs and adding some simple new features (mainly related with the team defense, dribbling ability and adaptation to the new rules). However, we will also fine-tune the team coordination mechanisms to the soccer domain. A library of tactics including several new formations and player types will be available to the on-line coach that will perform high-level analysis of the games and use COACH UNILANG [3] to change the team tactic according to its analysis of the course of the game.

Acknowledgments

We would like to thank the financial support from IEETA/University of Aveiro, FEUP/LIACC/University of Porto. Our thanks goes also to Peter Stone, Patrick Riley and Manuela Veloso for making available the CMUnited99 low-level source code that saved us a huge amount of time at the beginning of the project.

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