A REINFORCEMENT LEARNING BASED TEAM FOR THE ROBOCUP 2D SOCCER SIMULATION LEAGUE

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ABSTRACT

The RoboCup Soccer Domain, which was proposed in order to provide a new long-term challenge for Artificial Intelligence research, constitutes real experimentation and testing activities for the development of intelligent, autonomous robots. At the Centro Universitário da FEI we are developing a project to compete at the Robocup Simulation league, aiming to test Reinforcement Learning algorithms in a Multiagent domain. This text describes the team developed for the Robot Soccer Simulation competition. We conclude that Reinforcement Learning algorithms performs well in this domain.

KEYWORDS: Robocup Simulation, Autonomous Robots Simulation , Multiagent Systems, Reinforcement Learning.

1 INTRODUCTION

Modern Artificial Intelligence textbooks such as Russell & Norvig [1] started to present this course from an unifying point of view, allowing the typical problems of the field to be approached by multiple techniques. This is the result of the belief that AI must not be seen as a segmented domain.

According to this tendency, the application domains that are being probed are also changing. In the games sub-field, a traditional AI domain, the creation of a chess player program that is better than a human champion is not a distant goal but a reality: new domains became a necessity.

The RoboCup – Robotic Soccer Cup – domain was proposed by several researchers [2, 3] in order to provide a new long-term challenge for Artificial Intelligence research. Soccer games between robots constitute real experimentation and testing activities for the development of intelligent, autonomous robots, which cooperate among each one to achieve a goal.

The purpose of this paper is to present a project in this domain that is under development at the Centro Universitário da FEI with the aim of studying Reinforcement Learning algorithms in a Multiagent domain integrating undergraduate students with research and providing an active and cooperative learning environment.

This paper, which describes the initial results of this project is organized as follows: section 2 describes the RoboCup Robotic Soccer domain; section 3 presents RoboCup 2D Simulator. Section 4 describes the team developed at the centro Universitário da FEI and section 5 and section 5 presents the conclusions of this work.

2 THE ROBOCUP ROBOT SOCCER DOMAIN

Soccer games between robots are a way to foster a scientific and technological spirit in the younger generations. The development of soccer teams includes more than the simple integration of AI techniques. According to Kraetzchmar [4], "Mechatronic devices, specialized hardware for controlling sensors and actuators, control theory, sensor interpretation and fusion, neural networks, evolutionary computation, vision, multiagent cooperation are examples for fields strongly involved with the RoboCup challenge".

The RoboCup have several competition Leagues that differs among each other due to the size of the robots and the presence or not of a central computer. The physical platform of the RoboCup *Small Size League* is constituted by a field for the game, plan, with the dimensions of 490x390 cm. For each team there is one or more video cameras and respective image acquisition system, one computer, data-communication system and up to 5 robots. The maximum robot dimensions depends on the league and ranges from one that must fit a 180 mm diameter cylinder with a height of 150mm or less (in the Smal Size League) to an area of 2025 cm^2 in the X-Y plane, with a maximum height of 80 cm and maximum weight of 80 kg (in the Middle Size League). The robots in the Small Size League are usually composed by 2 electrical motors controlled by a microprocessor, battery and wireless communication system. Robots in the Middle Size League are usually autonomous, with cameras and computers on board. Figure 1 presents the basic sketch of the system and figure 2 presents the winning team of the 1997 Cup, the CMUnited. The used ball in the games is an orange golf ball.

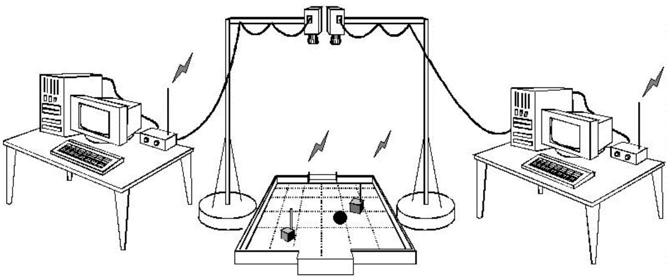

Fig. 1. Basic game setup presented in [5].

The operation of each teams follows one same basic formula: each team carries a image acquisition through its camera and then processes the picture using Computational Vision techniques to discover the position and velocity of all the robots and the ball. With this information, a decision system defines the best strategy to apply and the movements of each robot at a defined moment. In the Small Size League, all this processing is carried through in a central computer. With the decision of the robot movements, a radio based communication system sends for the robots a message describing the movements that must be done.

Among the challenges and problems that can be addresses in this domain, Shen affirms that "robot players in a soccer game must perform real-time visual recognition, navigate in a dynamic field, track moving objects, collaborate with teammates, and hit the ball in the correct direction." [6, p.251]. To reach this goal the robots must be autonomous, efficient, cooperative, with of planning, reasoning and learning capabilities, and able to act under real time restrictions.

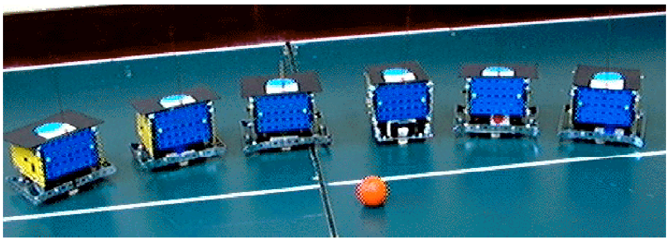

Fig. 2. The CMUnited'97 Small Size Team. [7]

Veloso et al. [7] affirms that "Robotic soccer is a challenging research domain which involves multiple agents that need to collaborate in an adversarial environment to achieve specific objectives. The fast-paced nature of the domain necessitates real-time sensing coupled with quick behaving and decision making. The behaviors and decision making processes can range from the most simple reactive behaviors, such as moving directly towards the ball, to arbitrarily complex reasoning procedures that take into account the actions and perceived strategies of teammates and opponents".

This allows the competition among teams with diverse approaches and the measurement of their results, which can be done in an objective way: score and final position in the championship. In this domain the real time nature of the restrictions of is obvious: a system must be fast enough. If it take some seconds between the perception and the action the team will lose the game.

Finally, the Robot Soccer domain have been acquiring more importance each time in the area of Artificial Intelligence because possesses all the features found in other real complex problems, such as automation robotic systems, that can be seen as a group of robots carrying through an assembly task, or even space missions with multiple robots [8].

3 ROBOCUP 2D SOCCER SIMULATOR

The RoboCup Soccer Server [9] is a system that enables autonomous agents programs to play a match of soccer against each other (Fig. 3). A match is carried out in a client/server style: A server, SoccerServer, provides a virtual field and calculates movements of players and a ball. Each client is an autonomous agent that controls movements of one player. Communication between the server and each client is done via TCP/IP sockets. Therefore the clients can be written in any kind of programming systems that have TCP/IP facilities, such as UNIX or Microsoft Windows.

The SoccerServer consists of 2 programs: a server program that simulates movements of players and a ball, communicates with clients, and controls a game according to rules and; a monitor program that displays the virtual field from the server on the monitor using the X window system.

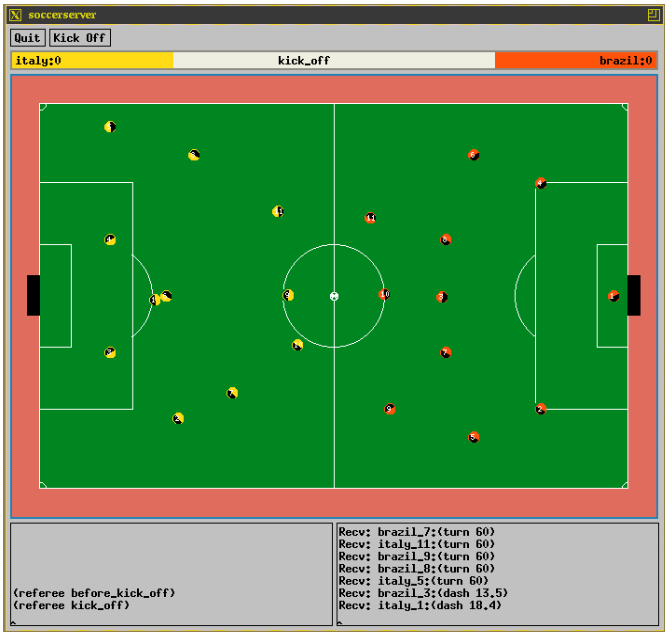

Fig. 3. The RoboCup Soccer Server - Screenshot [9]

4 THE FEISIM'05 TEAM

For being the most popular Reinforcement Learning algorithm and because of the large amount of data available in literature for a comparative evaluation, the Q-Learning algorithm [10] was chosen as the one to be used by the team.

To implemet the team, we divided the field of play in a 20 x 20 grid of positions where the player can be located, and only 8 directions to where the agent can be facing. Each player was implemented as a simple Q-Learning agent. The team performed the learning task playing agains a opponent with a random strategy.

The parameters used were: learning rate = 0.1, the exploitation/exploration rate is 0.9 and the discount factor = 0.99. The rewards used were +100 when the the learner scores a goal, -10 when the team has a goal scored agains it -1 when it executes any action. All the experiments presented were encoded in C++ Language and executed in a Pentium 4 computer and Linux operating system.

5 CONCLUSION

We conclude that Reinforcement Learning algorithms can be used to create RoboCup Soccer Simulation teams.

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