
Multi-Agent Collaboration with Strategic Positioning, Roles and Responsibilities

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Abstract

The Robot World Cup (RoboCup) is an attempt to foster AI and intelligent robotics research by providing a standard problem where a wide range of technologies can be integrated and examined [Kitano, 1997].

Our approach to the first RoboCup Pacific Rim Series (PRS) competition is to emphasize on multi-agent collaboration with strategic positioning, roles and responsibilities. Through these concepts, we will be able to develop our agents' behaviour to excel in this dynamic environment.

1. Introduction

For RoboCup's Simulation competition, agents are to compete through the RoboCup simulator, called Soccer Server [Noda, 1995], [Noda *et al.*, 1997].

There are many approaches to client implementation, such as Robot Learning Based on LfE Method [Asada *et al.*, 1995], Genetic Programming [Luke *et al.*, 1997], Decision Tree [Stone *et al.*, 1998], and many more. As soccer emphasizes on teamwork, we decided to

implement our agent based on multi-agent collaboration [Matsubara *et al.*, 1996], [Noda *et al.*, 1996].

The following sections describe a framework for our agents' behaviour, by means of strategic positions, roles and responsibilities. Section 2 kicks off with our team structure. It is followed by strategic positioning, roles and responsibilities in Section 3. Having seen that, we will describe our agents' behaviour in Section 4. Finally, in Section 5, conclusion and future work are presented.

2. Team Structure

Our proposed multi-agent soccer team is composed of eleven agents, including a goal-keeper agent, and has a strategic formation, just like real human soccer, which is 3-5-2. The formation is represented by three digits, in the sequence of defenders-midfielders-forwards. Therefore, our team will consist of 3 defenders, 5 midfielders and 2 forwards.

Also like human soccer, each agent has a strategic position that defines its default position and movement range inside the soccer field. We classified our strategic position into two categories: initial and game-play. Initial strategic positioning is for play modes that will be initiated with a kick off, such as starting or

resuming of a game and after a goal is scored (see Figure 1). Game-play strategical positioning can only come into effect after initial strategical positioning has been initiated (see Figure 2).

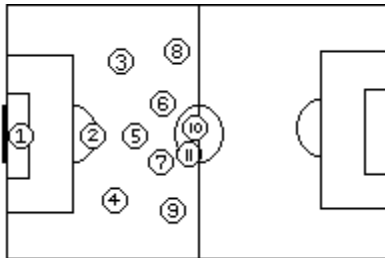


Figure 1: Initial strategical positioning

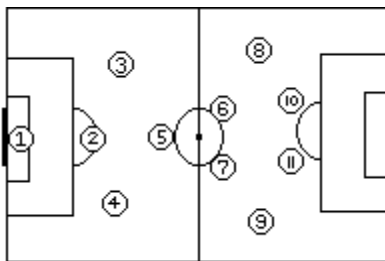


Figure 2: Game-play strategical positioning

The strategical formation, associated with the strategical position, defines the role and responsibilities of each agent.

3. Strategical Positioning, Roles and Responsibilities

Strategical positioning, roles and responsibilities are inevitable in soccer domain. In order for a team of agents to perform to its fullest potential, they must carry out their responsibilities based on their roles and strategical position in the field.

A role defines the part that an individual agent is to play in a scenario. Responsibility defines the

actions that are to be performed by the agent for a particular role. For example, for the role of a goal-keeper, its responsibilities in a soccer game are to position in the goal-mouth, prevent the ball from going past him, and distributes ball to team mates. Table 1 shows all the roles that we have adopted, and the responsibilities of the agent that has taken up that role.

Role	Responsibilities
Goal-keeper	Positions in goal-mouth, prevents ball from going past, and distributes ball to team mates.
Defender	Positions in front of our penalty area, tackles for ball, and passes ball to midfielders. Wing-backs will in-charge of kick-ins in their own half.
Midfielder	Feeds forwards with ball and goes for the ball. Wingers will in-charge of corner-kicks and kick-ins in the opposing half.
Forward	Hard-press opposing defense for ball, strikes ball at goal.

Table 1: Responsibilities of different roles

4. Conclusion and Future work

Each agent perceives the field information differently, based on its strategic position. These information receive through the Soccer Server, is also limited by the agent's perceptual range.

Another important aspect that affects the agent's behaviour, is the movement range (see Figure 3). Each agent has its own movement range based on its role and responsibilities. When keeping an eye on the ball, the movement range will determine whether the agent should go for the ball, or leave it to its team mates.

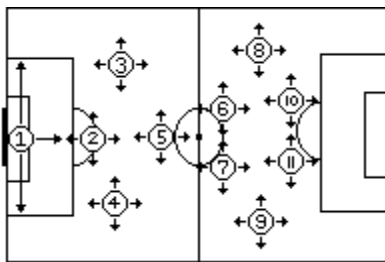


Figure 3: Movement range

When the ball is beyond its movement range, and the agent is in its strategic position, it will broadcast the ball position to the rest of its team mates if it can see the ball. This will enable its team mates to react to the ball within the shortest possible time.

5. Conclusion and Future work

In this paper, we presented our approach to multi-agent collaboration, based on strategic positions, roles and responsibilities. These provide the foundation to agents' behaviour and team work.

This project is implementing a team of soccer playing agents that will represent KRDL's first softbot team for RoboCup Pacific Rim Series (PRS).

The next stage is to develop an offside-trap by means of opponent-modeling. This is made possible, by effective communication among defending agents. As *dynamic formation* is advantageous over *static* one, we are on our way to develop *dynamic formations* to cope with catching-up logic when trailing by a goal or larger margin.

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