

Adaptive Robot Soccer Defence Strategy via Behavioural Trail

Awang Hendrianto-Pratomo, Center for Artificial Intelligence Technology, Universiti Kebangsaan Malaysia, Malaysia, & University Pembangunan Nasional "Veteran" Yogyakarta, Indonesia

Anton Satria Prabuwono, Center for Artificial Intelligence Technology, Universiti Kebangsaan Malaysia, Malaysia

Siti Norul Huda Sheikh Abdullah, Center for Artificial Intelligence Technology, Universiti Kebangsaan Malaysia, Malaysia

Mohammad Faidzul Nasrudin, Center for Artificial Intelligence Technology, Universiti Kebangsaan Malaysia, Malaysia

Muhamad Syafiq Shohaimi, Center for Artificial Intelligence Technology, Universiti Kebangsaan Malaysia, Malaysia

Teddy Mantoro, Advanced Informatics School, Universiti Teknologi Malaysia, Malaysia

ABSTRACT

Robot soccer is a challenging platform for multi-agent research, involving topics such as real-time image processing and control. A team of robots must work together to put the ball in the opponent's goal while at the same time defending their own goal. A good strategy for the robot defenders can determine who wins the robotic soccer game. Therefore, the goal of this study is to propose a strategy for the defenders using a production rule based on state diagrams. The rule can facilitate easy and rapid comprehension of certain behaviors with respect to two indicators, such as condition and action. The authors determine five key aspects as conditions, including the positions of two defender robots, the position of the goalkeeper and the ball, and coordination between two defender robots and the goalkeeper robot. Each robot has been set its own defence area and specific actions. They conducted three experiments namely simulator testing, real time testing, and ping pong testing to evaluate their proposed defence strategy. The experimental results show that the authors' proposed strategy versus three state of the art strategies can defeat up to 92% of all types of attack modes. Meanwhile, in the ping pong testing, their proposed strategy can still protect any goal entering from different attacking modes even though only one or two robots are active in the defence area.

Keywords: Defender Strategy, Robot Soccer, Robotics, State Algorithm, Strategy Role

1. INTRODUCTION

Robot soccer is a challenging platform for multi-agent research that involves topics such

as real-time image processing and control. Robot soccer was introduced in 1994 with a theoretical background to develop multi-robot adaptive, co-operative and autonomous systems that can solve common tasks (Kim & Shim 1997). Furthermore robot soccer is a rich

DOI: 10.4018/jitr.2012070102

domain for the study of learning issues (Kim, Lee, & Fukuda, 1997).

Each team of robots must work together to put the ball in the opponent's goal while at the same time defending their own goal, and the team must be able to adapt to new situations and the behavior of various opponents (Pratomo et al., 2010). Additionally, they must learn to work together autonomously and cooperatively (Han, Lee, Moon, Lee, & Kim, 2002; Kim, Hwang, & Kwon, 2003; Wang, Liu, Li, & Yang, 2010; Pratomo et al., 2011). Moreover, the robots also must interact and self-organize autonomously to achieve a common goal (Liu, Liang, & Lin, 2004). Apart from cooperative and coordinated behavior, further technical aspects such as precision of movement and optimization of power efficiency must also be taken into account because robot soccer is well-known as a miniaturization of a complex electro-mechanical system (Prabuwono, Burhanudin, & Said, 2008; Hwang, Tan, & Chen, 2004).

The robots can learn any collaborative or adversarial techniques; however, they must first acquire some low-level skills that allow them to manipulate the ball (Pozna, Troester, Precup, Tar, & Preitl, 2009). These low-level skills, for example, dribbling and controlling the ball, though entirely individual in nature, are crucial to develop because these skills are involved in more collaborative tasks, such as sending and receiving passes. In relation to the rich and dynamic nature of the environment in soccer (Zabawi & Omar, 2011), it is either impractical or impossible to directly program the robots to play soccer. Therefore, much of the focus has been shifted to treating the robots as intelligent agents that can learn how to play soccer under different environments and conditions (Hwang et al., 2006; Zhao, Zhang, Wei-Jie, & Li, 2006).

Based on Figure 1, the formation of various strategies that can be used in a robot soccer game depends on the pattern of the game and the types of players. The game pattern that focuses solely on location coordinates will produce a centralized game that is focused on the direction of the ball movement (Plyne et al.,

2008; Xiao-Jun et al., 2006). Every robot plays different roles at different locations.

Kim, Kim, Kim, and Seow (2004) and Pratomo et al. (2011) defined the robot soccer game into three phases: role, action and behavior. In the role phase, a robot determines the area in which it has been placed and whether it should act as an attacker or defender. In this phase, the roles of goalkeeper, defender, midfielder and striker are introduced. In the action phase, the behaviors of the robots are under consideration as well. They will make decisions based on the role that was given to them in the previous phase (Egly, Novak, & Weber, 2005). Among the actions, those that can be used are shooting, blocking, and shaking. The final phase is the behavior phase. In this phase, the robot's behavior is a major concern. The behavior of these robots can be analyzed in relation to the type of the game and the location of other players (Kim et al., 2004).

The objective of this paper is to propose a defensive strategy based on the positioning of the balls, as well as the robots' positioning. This paper comprises five sections, starting with a basic introduction in Section 1. Then the state of the art is presented in Section 2, followed by Section 3, which describes the proposed methods. Next, experimental results and analysis are discussed in Section 4. Finally, we draw some conclusions in the last section.

2. STATE OF THE ART

The strategy of the robot soccer team is very important in terms of winning a soccer game. Attacking and defending are fundamental strategies in a soccer game (Kim et al., 2004). The defending strategy aims to keep the ball from entering the goal area, i.e., to prevent the opponent's team from scoring any points.

Prieto, Nino, and Quintana (2008) shows the predominantly passive behavior of a goalkeeper robot when changing its role from defending the goal area to shooting the ball. At the same time, they also demonstrate a more active behavior when the robot reverts to its initial

19 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/article/adaptive-robot-soccer-defence-strategy/72713

Related Content

Lack of Skill Risks to Organizational Technology Learning and Software Project Performance

James Jiang , Gary Klein, Phil Beck and Eric T.G. Wang (2007). *Information Resources Management Journal* (pp. 32-45).

www.irma-international.org/article/lack-skill-risks-organizational-technology/1319/

Swedish IT Project Managers' Personality Traits Mirrored in the Big Five

Leif Marcusson and Siw Lundqvist (2016). *International Journal of Information Technology Project Management* (pp. 1-14).

www.irma-international.org/article/swedish-it-project-managers-personality-traits-mirrored-in-the-big-five/154969/

Transforming Recursion to Iteration in Programming

Athanasios Tsadiras (2009). *Encyclopedia of Information Science and Technology, Second Edition* (pp. 3784-3788).

www.irma-international.org/chapter/transforming-recursion-iteration-programming/14141/

Project Selection and Initiation

Daniel M. Brandon (2006). *Project Management for Modern Information Systems* (pp. 29-47).

www.irma-international.org/chapter/project-selection-initiation/28177/

Mobile Transaction Models Framework

Andrés Coratella, Miguel Felder, Roberto Hirsch and Eduarudo Rodriguez (2005). *Encyclopedia of Information Science and Technology, First Edition* (pp. 1978-1983).

www.irma-international.org/chapter/mobile-transaction-models-framework/14548/