Damavand Soccer Simulation 2D Team Description Paper

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Abstract. The RoboCup competition is an international platform where teams compete in various robotic challenges with the ultimate goal of developing autonomous robots that can play soccer against each other. The Soccer Simulation 2D game is one of the challenges in which teams develop algorithms to control virtual soccer players in a two-dimensional simulated environment. In this paper, we present our team's work in developing advanced algorithms for marking, blocking, shooting, dribbling, and other soccer-related behaviors. Our algorithms are designed to work collaboratively to create effective team strategies and tactics for winning matches in the Soccer Simulation 2D game. Through rigorous testing and experimentation, we have optimized our algorithms to improve our team's performance and increase our chances of success in the competition. Our research in this field has the potential to contribute to the advancement of autonomous robotic systems and the development of intelligent machines capable of performing complex tasks.

Keywords: RoboCup · Soccer Simulation · Machine Learning.

1 Introduction

Soccer, a team-based sport, has been popular since 1860. It is a real-time, strategic, and partially observable game where players cooperate to score more goals than the opponent. In addition to cooperation, players need to manage different tactics and technical strategies against different opponents. To encourage the use of robotic intelligence and AI to solve problems, the World Cup Robot Soccer Initiative was founded to create a realistic environment similar to authentic soccer[1–3]. The first RoboCup was held in 1997, offering three competition tracks: real robot league, software robots, and expert robot competition. The Soccer Simulation 2D league (SS2D) is one of the oldest leagues in RoboCup. It provides a wide range of research challenges, as it has no physical limitations and is a simulation. Researchers are inspired to compute in SS2D each year. We are a new junior team participating in the RoboCup competition. We studied released TDPs to improve our team's capabilities in offensive and defensive actions and worked hard to optimize our code. Although many teams use the agent2d-base released by the Helios team, we decided to use the Cyrus2D base code because it is more powerful than Helios Base[34–36]. In this paper, we briefly will explain our developed ideas such as Marking, Shooting, Dribbling, and Blocking.

2 related works

Numerous studies have been conducted in the field of soccer simulation 2D. This section provides an overview of some of the research ideas that soccer simulation teams have implemented in recent years. YuShan optimized the kick and block model in 2015 and analyzed formations, chain-action, and pass-chain patterns [4]. In the same year, CYRUS focused on defensive decision-making and communication between agents to eliminate environmental noise [5]. Helios conducted the game analysis using the EMD algorithm and clustering techniques in 2015 and 2016 [6, 8].

In 2016, the CYRUS team worked on shooting algorithms using neural networks and further optimized the shoot via pattern recognition[7]. Helios 2017 proposed a pruning method using a clustering algorithm to improve action planning [10]. Meanwhile, CYRUS attempted to predict opponent behaviours using machine learning techniques[9].

YuShan 2018 improved chain action by introducing an inference model to defence and using data mining to analyze teams.[11] In the same year, Helios improved the knowledge sharing between players to increase the achievement probability of planned action sequences [13]. Cyrus Team predicted players' behaviour using a multi-agent system and a neural network [12].

In 2019, YuShan used data mining to optimize chain action further and improve shooting [16]. Cyrus used an Actor-Critic Reinforcement learning algorithm to improve defensive actions [15]. Also, Helios, focused on using clustering methods to measured the similarity between teams. [19].

In 2021, YuShan utilized data mining and analysis to make profiles for each team [17]. Cyrus predicted the teammate ball owner's action using a neural network [18, 27], and Helios put agents into positions based on their characterizations and abilities. Additionally, they developed a new analysis tool[19]. FRA-United applied a reinforcement learning algorithm to improve marking behaviour in SS2D and overall enhancing each agents positioning [22, 33, 26]. Oxsy used the observation coach to create an RSA accumulator to model opponents' strategies[20, 21]. In the last year, YuShan used the LambdaMART algorithm to improve offensive movements [24]. Persepolis team improved the agent's core actions to enhance chain-action performance [30, 29]. Helios 2022 focused on the impact of Anonymous mode on players' performance [25], and Cyrus used their pass prediction module to create an unmark positioning module [23, 28].

3 Shooting Behavior

Shooting accuracy is necessary to increase the probability of winning a game. In the Damavand team, we developed a new shooting behavior consisting of three parts. The first part calculates the likelihood of missing a specific part of the goal due to player action and partial noise. The second part evaluates each point on the goal by considering the likelihood of interception by the opponent goalie or players. This part also considers the position count of the ball and opponents, leading to the Behind Score factor. The Behind Score factor uses the goal difference and game time to adjust the position count coefficient in the evaluation equation. When the team has scored fewer goals than the opponent, the Behind Score factor helps by lowering the position count coefficient, and vice versa. The last part of the behavior connects points that are close together with a close validation score, finds the most extensive continuous connected points, and returns the center point to the kicker for a shot. A broader angle will be selected if two or more significant areas of connected points with identical values exist.

4 Marking Behavior

In the defensive strategy implemented in this study, each player is assigned a specific defensive role. Two extra players are positioned to cover vulnerable areas when critical situations arise. Each player is assigned to defend an opponent player, and the distance between opponents and our goal and the density of teammates around opponents are analyzed to assess the criticality of the situation. Based on the level of risk the opponent poses, certain players are positioned between the opponent and the goal to decrease the likelihood of conceding a score.

5 Dribbling Behavior

A Deep Neural Network (DNN) model was employed to predict the x-position target, y-position target, and dribble distance of agents' dribbling decisions. In total, approximately 500,000 dribble instances were generated from 1,000 matches. While the x-target and y-target of the dribble are commonly used for predicting dribbling behavior, we included the dribble distance as an additional label because the initial position is not considered when predicting the target location. The dribble distance is defined as the Euclidean distance between the ball's starting position and the target location. On average, the combined dribble distance was approximately three meters, with long dribbles averaging six meters, short dribbles covering a distance of 2.2 meters, and queued double dribbles having an average distance of 1.6 meters and 1.2 meters, respectively. We evaluated our model with the mean absolute error (MAE) and R2-score. After analyzing the model, we found out that the offensive players are predicted better due to the fact that defensive players do not dribble as much as the offensive players in a game. We implemented our dribble perdition module to predict opponents' and teammates' movements to create better positioning.

6 Blocking Behavior

In the RoboCup Soccer Simulation 2D league, one important defensive strategy for preventing the opponent's team from scoring is to employ a blocking technique. Blocking involves legal movements by a player to obstruct the path of another player with their body, with the aim of impeding their progress and reducing the likelihood of the opposing team scoring a goal.

To effectively implement this strategy, our team focuses on positioning the closest player to the opponent who is in possession of the ball. This involves each player analyzing the positions of all players on the field and identifying the closest player to the ball-holder opponent. Once the closest player has been identified, the player then measures the relative position of themselves and the opponent and determines the best possible location to move to in order to block their path effectively.

This approach is based on the principles of both individual and team defense and requires a high level of coordination and communication between players to execute effectively. By prioritizing the positioning of the closest player to the ball holder and using effective blocking techniques, our team aims to minimize the number of successful goal attempts by the opposing team, thereby increasing our chances of winning.

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