Dionysus Team Description Paper

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Abstract. The Dionysus3D team competes in the RoboCup 3D Soccer Simulation League, focusing on developing a systematic architecture for intelligent and skilled robotic agents. Our work is built upon the open-source contributions of the FC Portugal team, incorporating their foundational code while introducing modifications to enhance kicking and movement actions. Additionally, we have developed advanced strategies more suited to our specific team dynamics. This paper presents an overview of our team's advancements, including the implementation of a dynamic zonal defense and offense strategy, the migration of kicking actions from the UT framework to the FCP framework, and innovative improvements in goalkeeper save mechanisms.

Keywords: Zonal Defense Strategy · Migration of Actions · Goalkeeper Save Improvement.

1 Introduction

The Dionysus3D team was founded in 2020, and supported by the Robotics Club at the School of Internet of Things Engineering, Jiangnan University. In 2024, the team was reorganized, inheriting the legacy of the Afue team and beginning active participation in both national and international RoboCup competitions. Over the past two years, through collaborative efforts and technical advancements, the team has made significant progress. This Team Description Paper (TDP) presents an overview of our team's development, focusing on key innovations and the strategies we have implemented.

As the RoboCup 3D Soccer Simulation League continues to evolve, a new underlying framework, the FCP framework, has gained widespread adoption. Thanks to the open-source contributions of the FCP team, we were able to build upon this framework to advance our work. Our team's key contributions include: (1) The implementation of a dynamic zonal defense and offense strategy. (2) The migration and improvement of kicking actions from the UT framework to the FCP framework. (3) The enhancement of the goalkeeper's save mechanism. These advancements aim to enhance both our offensive and defensive capabilities, improving our overall performance in RoboCup competitions.

2 Zonal Defense Strategy

Initially, our system utilizes a strategic approach where players calculate their optimal positions in real-time, taking into account both the pre-defined formation and the ball's current position [1]. This method facilitates the implementation of zonal defense, where each player is assigned to cover a specific area of the field rather than an individual opponent. The primary goal of this formation is to ensure robust defensive coverage while maintaining positional discipline, enabling the team to effectively counter various offensive strategies. The simplified strategic approach is shown in Figure 1.

As the ball approaches a player's designated zone, the system dynamically adjusts the player's behavior based on the proximity of the ball and the contextual game situation. This adaptation allows the defensive strategy to become increasingly responsive as the ball draws closer, where the intensity of the defense can be modulated according to factors such as ball speed, angle, and the positioning of opposing players. Consequently, this dynamic approach to defense ensures that the system can react more effectively to fast attacks, counter long shots, and disrupt offensive plays aimed at breaking through defensive lines, such as through crowded areas or quick transitions.

By continuously updating the defensive strategy based on both spatial and situational awareness, the system effectively mitigates the risks associated with high-speed offensive maneuvers and complex tactical plays, such as through-the-ball or long-range shooting attempts. This dynamic and context-sensitive defensive methodology enhances the robustness and adaptability of the overall team strategy, offering significant advantages in maintaining a solid defensive posture throughout the match.

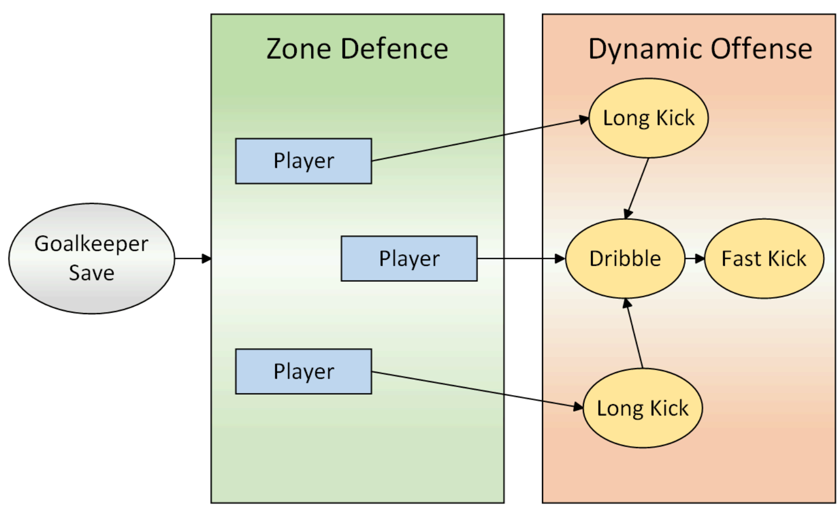

Fig. 1. Strategy diagram.

3 Dynamic Offense Strategy

Our offensive strategy revolves around creating a coordinated formation composed of multiple players who work together to achieve optimal attacking play [2]. This strategy relies on dynamic role assignment through real-time decision-making, which ensures that players can adapt to the flow of the game and maintain efficient passing and receiving opportunities. By dynamically allocating roles, such as the ball carrier, passers, and potential receivers, the system fosters smooth transitions between different offensive maneuvers, allowing for quick ball circulation and effective positioning.

The key goal of this approach is to facilitate fluid passing sequences while ensuring that players are always in positions to support each other. As a result, the system enhances team cohesion, allowing for both short and long-range passes to be executed with precision. Furthermore, this dynamic role distribution enables players to exploit gaps in the opposing defense, providing multiple attacking options and increasing the chances of breaking through defensive lines.

By continuously adjusting the players' positions and roles based on the ball's location and the defensive setup, this strategy ensures that the team remains flexible and can respond to different tactical scenarios. This adaptable offensive approach maximizes the team's offensive potential and contributes to a more balanced overall strategy throughout the match.

Fig. 2. Offensive Alignments.

4 Migration of Actions

In our development process, we retained several kicking actions from the UT framework, including fast kicks and long shots, to leverage the existing base

[3]. Since reinforcement learning methods had not been effectively implemented, team members managed to migrate some of these kicking actions by transferring the kicking parameters from the UT framework, and manually adjusting and testing them. This approach successfully achieved partial migration of these actions.

Building upon the keyframe-based kicking actions from the underlying UT framework, we fine-tuned and modified the parameters to develop two new kicking actions:

1. **11m Long Kick:** This kicking action was primarily inspired by the UT framework's long kick from Apollo3D. However, the main challenge with this action is the transition from the UT framework's joint parameters to those of the FCP framework. This transition causes a brief "pause" before the kick, leading to a long wind-up motion and severely affecting the fluidity of the kick. To mitigate this, we adjusted the parameters to reduce the delay, improving the smoothness of the action.

Fig. 3. 11m Long Kick.

2. **4m Fast Kick:** This action was derived from the fast kick in the early version of our school's code, Afue. The primary advantage of this action is its rapid execution, propelling the ball forward quickly within a relatively short distance. The fast kick allows players to quickly follow up and maintain control over the ball, ensuring that they can press the ball while keeping it within a manageable range.

Fig. 4. 4m Fast Kick.

5 Goalkeeper Save Improvement

Building upon the foundational FCP framework, we developed a comprehensive goalkeeper-saving logic aimed at improving the team's defensive capabilities.

The primary criterion for determining the necessity of a save is the distance to the ball, which is calculated dynamically based on the current ball trajectory and player positioning. When the ball is within a specific threshold distance, the goalkeeper evaluates whether to attempt a save, considering not only the proximity of the ball but also the velocity and angle of the shot.

In addition to this basic decision-making mechanism, we implemented a set of fuzzy control strategies to manage the transition between kicking and saving actions. These fuzzy strategies allow for a smooth and context-sensitive shift between the two actions, taking into account factors such as the ball's speed, the goalkeeper's current positioning, and the likelihood of successfully intercepting the ball. By employing fuzzy logic, the goalkeeper's behavior becomes more adaptive, enabling more accurate and timely decisions during high-pressure situations.

This marks the first successful implementation of an effective saving mechanism within our team. In previous iterations, the goalkeeper often employed a more aggressive approach, frequently charging at the attacking player in an attempt to disrupt the offensive play. However, this tactic had significant drawbacks, particularly when facing opponents with strong long-range shooting capabilities. The aggressive strategy was less effective at preventing shots from a distance, often leaving the goal exposed and allowing for easier scoring opportunities. The new approach, leveraging both distance-based decision-making and fuzzy logic, provides a more nuanced and efficient method for goalkeeping, enhancing the team's overall defensive stability.

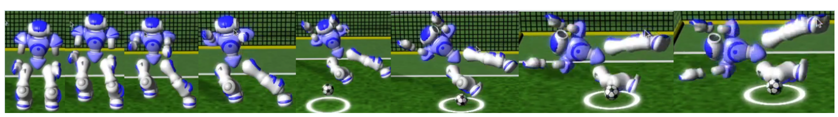

Fig. 5. Goalkeeper Save.

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