Team Description Paper - Rinobot Simulation2D

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Abstract. This paper presents the Rinobot Simulation2D team, developed by the Rinobot Team at the Federal University of Juiz de Fora (UFJF) for the RoboCup Soccer Simulation 2D League. The team is built on the CYRUS Soccer Simulation 2D framework, which itself extends the HELIOS base architecture. The work focuses on higher-level decision-making improvements, especially in shooting selection and penalty-kick execution. The shooting model formulates target selection as an optimization problem over candidate points on the goal line, while the penalty strategy combines strict shot validation, one-kick shooting, and geometric reachability analysis for goalkeeper interception prediction. Experimental evaluation includes benchmark matches against the CYRUS baseline, controlled penalty shootouts, and competition performance in IronCup 2026. The reported results indicate consistent gains in match outcomes, highly effective penalty execution, and strong overall offensive and defensive performance. These findings suggest that the proposed methods improve the practical effectiveness of the team in both controlled and competitive simulation settings.

Keywords: RoboCup Soccer Simulation 2D · Multi-agent systems · Soccer simulation · Decision making · Penalty kick strategy

1 Introduction

The Rinobot Team is a robotics research group based at the Federal University of Juiz de Fora (UFJF), Brazil. In 2026, the team started its activities in the RoboCup Soccer Simulation 2D League with the development of the **Rinobot-Team** simulation team, which competes under the name **Rinobot-Team** in official matches.

The project focuses on artificial intelligence, multi-agent systems, and decision-making algorithms applied to simulated soccer environments. The implementation builds on established open-source frameworks from the RoboCup community, especially HELIOS and CYRUS [1–3].

2 Base Architecture

The Rinobot Simulation2D team is based on the open-source CYRUS Soccer Simulation 2D framework, which itself builds upon the HELIOS base architecture [1, 2].

This framework provides:

– world model representation,
– communication protocols,
– chain-action decision framework, and
– basic player behaviours.

This allows development to focus on higher-level decision-making rather than low-level mechanics.

3 Proposed Methods

3.1 Shot Decision Model

The shooting decision is formulated as an optimization problem over candidate target points on the goal line. The target point is computed as

$$y_{\text{target}} = s \cdot (\mathit{goalHalfWidth} - \mathit{margin}), \tag{1}$$

where $s \in \{-1, +1\}$ is selected opposite to the goalkeeper position and *margin* is a safety offset to avoid shots outside the goal. The sign variable is defined by

$$s = \begin{cases} +1, & \text{if the goalkeeper is positioned in the lower half,} \\ -1, & \text{if the goalkeeper is positioned in the upper half.} \end{cases} \tag{2}$$

Each candidate shot is evaluated based on distance, angle, interception risk, and goalkeeper reachability, and the selected shot is the one maximizing the scoring function:

$$\arg\max_i \ \mathit{score}_i. \tag{3}$$

3.2 Penalty Kick Strategy

The penalty-kick behaviour is implemented in `bhv_penalty_kick.cpp` and is organized into three layers:

– strict shot attempt (`Bhv_StrictCheckShoot`),
– one-kick corner shot (`doOneKickShoot`), and
– geometric reachability test (`getShootTarget`).

Ball trajectory is simulated using

$$v_{t+1} = \gamma v_t, \tag{4}$$

while goalkeeper reachability is defined as

$$r(c) = v_g^{\max} \cdot c + d_{\text{buf}}, \tag{5}$$

where c is the simulation cycle, $v_g^{\max}$ is the maximum goalkeeper speed, and d_{buf} includes catch area and uncertainty. The buffer term is computed as

$$d_{\text{buf}} = v_g^{\max} \cdot \min(5, \mathit{posCount}) + \mathit{catchArea} + \epsilon. \tag{6}$$

Shots are accepted only if no interception is predicted. The system selects the minimum velocity that avoids interception.

4 Experimental Results

4.1 Match Performance

We conducted a benchmark consisting of **20** full matches against the CYRUS baseline under identical `rcssserver` configurations.

Table 1. Match results against CYRUS baseline

Outcome	Count
Wins	17
Draws	1
Losses	2

Score distribution: 2–0 (4), 1–0 (13), 1–1 (1), 0–3 (2).
These results indicate a consistent improvement over the baseline.

4.2 Penalty Kick Evaluation

We evaluated the penalty strategy in **50** shootouts (3 kicks per team).

- Shootout wins: **50/50**
- Goals scored: **150/150** (100% conversion)
- Goals conceded: **0/150**
- Average shootout score: **3–0**

These results indicate that the trajectory-based penalty model is highly effective.

4.3 Competition Results

The proposed methods were also evaluated in a competitive setting during the **IronCup 2026** tournament.

The team competed under the name **Pimentao_Verde**, which corresponds to the internal implementation of the Rinobot Simulation2D team. Table 2 presents the detailed match results obtained during the competition.

Overall performance during the competition was composed of 11 wins, 3 draws, and 2 losses. Across all matches, the team scored a total of **63 goals** and conceded **6 goals**, indicating both strong offensive capability and defensive robustness throughout the competition.

While competition outcomes may be influenced by opponent diversity and varying match conditions, these results provide additional evidence of the effectiveness of the proposed methods in realistic scenarios.

Table 2. IronCup 2026 match results

Team	Opponent	Score	Result
Pimentao_Verde	Robocin	0–2	Loss
Pimentao_Verde	RobotBulls	4–0	Win
Pimentao_Verde	Red Dragons	8–0	Win
Pimentao_Verde	Titãs da Robótica	0–0	Draw
Pimentao_Verde	ITAndroids	4–3	Win
Pimentao_Verde	ThunderLeague	4–0	Win
Pimentao_Verde	ThunderLeague	4–0	Win
Pimentao_Verde	Titãs da Robótica	0–0	Draw
Pimentao_Verde	RobotBulls	5–0	Win
Pimentao_Verde	ITAndroids	5–0	Win
Pimentao_Verde	Robocin	1–0	Win
Pimentao_Verde	Red Dragons	6–0	Win
Pimentao_Verde	Titãs da Robótica	0–1	Loss
Pimentao_Verde	Titãs da Robótica	0–0	Draw
Pimentao_Verde	ThunderLeague	8–0	Win
Pimentao_Verde	ThunderLeague	4–0	Win

5 Conclusion

This work presented the Rinobot Simulation2D team with improvements in shooting and penalty strategies. Experimental results demonstrate significant gains. Future work includes reinforcement learning and opponent modeling.

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