

# Khalifa University Robotics Athletes (KURA): Team Description Paper for RoboCup 2026 Humanoid Adult Size League

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**Abstract.** Khalifa University Robotics Athletes (KURA) is a student robotics team from Khalifa University, Abu Dhabi, UAE, competing in the RoboCup Humanoid Soccer leagues and regional competitions. The team focuses on advanced humanoid control, perception, and autonomous decision-making in highly dynamic soccer environments. KURA has achieved strong results in both Kid Size and Adult Size competitions, including second place in RCAP 2025 (Adult Size 3v3 and Kid Size 4v4), fourth place at WHRG 2025 (Beijing), and second place in RoboCup 2024 (Kid Size League). This paper summarizes lessons learned from previous RoboCup participations, outlines the current Adult Size system, and highlights our main research contribution for RoboCup 2026: model-based passing combined with potential-field-based positioning.

**Keywords:** Humanoid robotics · RoboCup · Behavior trees · Multi-robot coordination

## 1 Introduction

Khalifa University Robotics Athletes (KURA) is a student robotics team representing Khalifa University, Abu Dhabi, UAE. The team conducts applied research in humanoid robotics and uses RoboCup Humanoid Soccer as a benchmark for real-time decision-making and perception.

In recent years, KURA achieved 2nd place in RCAP 2025 (Adult Size 3v3 and Kid Size 4v4), 4th place at WHRG 2025 (Beijing), and 2nd place in RoboCup 2024 (Kid Size League) demonstrating the team's success in understanding and expanding on the humanoid robotic platform for soccer.

## 2 Lessons Learned from Previous RoboCup Competitions

Having originally participated in the RoboCup Kid Size League in 2024 and since moving to Adult Size League competitions highlighted how contacts, falls, longer walking distances, and the decisive role of coordinated team play are all crucial factors in humanoid soccer.

A key lesson is that team coordination is often the deciding factor in 3v3 matches. Without robust communication and shared states, players may chase the same ball, block each other, or leave the goal unprotected. Our experience led us to introduce dynamic role assignment for attacker, support, and goalkeeper, and to focus on more reliable passing behaviors between robots.



Fig. 1. Showcase humanoid T1 3v3 in WHRG 2025.

### 3 Adult Size System Overview

Our current Adult Size system follows a modular hardware and software architecture built around ROS 2 and a behavior-tree-based decision layer. The Adult Size KURA robots comply with the Humanoid League Adult Size requirements by using the Booster T1 platform. On-board sensing includes an RGB camera and IMU, and actuation is provided by serial actuators in a classic humanoid configuration. The software stack is comprised of perception, state estimation, motion control, and team behavior. Perception is based on color and geometry based detection combined with learning-based modules. The robots use a camera model calibrated to field dimensions, and include automatic visual calibration routines. Odometry, visual features, and line and goal-post detections update a localization module that runs continuously during matches.

## 4 Major Challenges and Planned Changes for RoboCup 2026

### 4.1 Major Challenges

Based on our experiences in RoboCup 2024, WHRG 2025, and RCAP 2025, we identify the following main challenges for RoboCup 2026:

- **Attack path planning under congestion:** The Adult Size field and 3v3 format often lead to frequent congestion around the ball. Therefore, we must plan collision-free, efficient paths for attackers and supporters.

- **Dynamic role assignment in 3v3:** Roles must adapt quickly and smoothly to ball position, player availability, and GameController states without oscillations or conflicts.
- **Teammate and opponent differentiation:** Robustly distinguishing teammates from opponents using vision and communication is necessary for passing, marking, and tactical positioning.

## 4.2 Planned Major Changes and Own Contributions

To address these challenges, we plan several major developments for RoboCup 2026, with a focus on passing, coordinated positioning, and adapting our current 3v3 plans to be better suited for 5v5.

*Model-based passing and potential-field positioning.* Our main research contribution will be a model-based passing module combined with potential-field-based path planning. We are developing a parametric relation between kick command parameters and the resulting ball speed and travel distance on the Adult Size platform. This allows us to choose kick parameters for a desired pass distance. In parallel, a potential-field-based planner models opponents and field boundaries as repulsive sources and open, tactically useful regions as attractive sources. One robot moves into an open low-potential region while another uses the calibrated kick model to pass the ball there, enabling coordinated attacking plays.

*Dynamic role assignment in 3v3.* A refined dynamic role assignment mechanism will score each robot for roles such as striker or defender, using: distance and orientation to the ball, current GameController state, penalties, and reliability of localization and communication. Scores are exchanged through network messages, and the behavior tree updates `player_role`, `attacker_id`, and `shadow_id` accordingly.

*Teammate and opponent differentiation.* We will integrate camera-based jersey detection with communication signals (player IDs and roles) to reliably differentiate teammates and opponents. This will enable safe and purposeful passing to the identified teammates.

## 4.3 Implementation Status at Submission Time

At the time of submission, the planned changes are at the following stages:

- **Attack planning:** Dedicated attack path planner, including potential-field representation is in progress.
- **Passing model:** Data collection for the kick-distance, and model development including initial parameter fitting in progress.
- **Defense:** Parallel goalkeeping behaviors with basic blocking implemented.
- **Roles:** Dynamic 3v3 role assignment as a prototype integrated into the behavior tree. To be improved and expanded to 5v5.

- **Perception:** Team/opponent differentiation as an on-robot color- and ID-based prototype.
- **Infrastructure:** Extended BrainTree behavior tree used in RCAP 2025 and being refined.

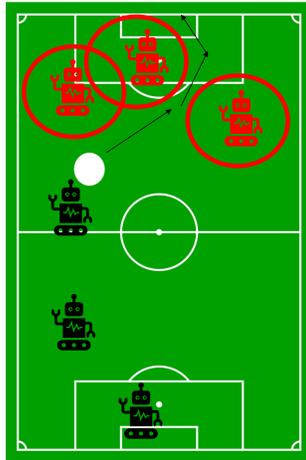
## 5 Impact on League and University/Community

### 5.1 Impact on the Humanoid Soccer League

KURA contributes to the Humanoid League through advanced multi-agent strategies and infrastructure. Our work on dynamic role assignment, attack path planning, and parallel goalkeeping provide concrete examples of scalable multi-robot coordination for Adult Size 3v3 matches and have been proven effective in competitions in RCAP 2025 Abu Dhabi with both Adult Size and Kid Size teams.

### 5.2 Impact on Khalifa University and the Community

Within Khalifa University, KURA serves as a platform for teaching students about perception, control, software engineering, and embedded systems through project and thesis work. Course projects in robotics and AI use KURA software components and data for hands-on assignments. Beyond the university, demonstrations at events and local schools use humanoid soccer robots to promote interest in STEM disciplines across the UAE.



**Fig. 2.** Sample 3v3 situation illustrating KURA’s dynamic roles with potential-field-based path planning and parallel goalkeeping.