EWS Bascorro Extended Abstract
RoboCup 2026 Humanoid Soccer League Kid-Size

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Abstract. EWS Bascorro is a Kid-Size RoboCup Humanoid Soccer team from Universitas Diponegoro, Indonesia, operating two OP3-derived humanoid robots and developing a third model for RoboCup 2026. This is our first RoboCup Humanoid League participation. Our current system uses ROS 2 Humble with OP3-style walking/keyframe motions, YOLOv8-Tiny perception for ball and goal posts, and an FSM-based behavior layer. For RoboCup 2026 we focus on active vision, metric ball estimation via image-to-ground projection, and vision-based localization fused with odometry.

Keywords: Humanoid soccer · RoboCup · OP3-derived platform · ROS 2 · Active vision · Localization

1 Introduction

RoboCup humanoid soccer requires robust autonomy under dynamic motion, partial observability, and limited onboard sensing.

This is our first RoboCup Humanoid League participation. Bascorro targets a reproducible ROS 2-based baseline for KidSize humanoid soccer, with a research focus on stabilizing perception through active vision and on vision-based localization using field features in a sim-to-real workflow.

2 Challenges and Planned Changes for 2026

Our main challenges are locomotion stability during turns and contact, perception intermittency under motion blur and occlusions, and drift when relying only on odometry. Current status (Jan 2026) includes an OP3-style gait with keyframe motions, YOLOv8-Tiny perception, ball-only active vision, and a localization pipeline under development. Planned upgrades include stability tuning, metric ball estimation, extending active vision to goal posts, and a visual particle-filter baseline fused with odometry.

3 System Overview

3.1 OP3-Derived Hardware Platforms

Bascorro operates two OP3-derived humanoids and is developing a third model for RoboCup 2026. All platforms follow the ROBOTIS OP3 kinematic structure and software interfaces, while we manufacture the mechanical structure and select actuators/electronics independently to improve robustness and maintainability.

The current two platforms use XM-540 legs, an MPU9250 IMU (accel/gyro only), and an RGB USB camera, with an Intel NUC for high-level computation and OpenCR 1.0 interfacing the Dynamixel chain and IMU. One platform uses MX-64 arms with an MX-28 head, while the other uses MX-28 head/arms. The mechanical structure uses aluminum 1060 with PLA+ parts.

The third-generation model (under development) targets a 20-DoF configuration with an MX-28 head/arms and MX-64 legs, a BNO055 IMU, and a single 4S 6000 mAh battery with a 1-in/2-out distribution module. We are replacing OpenCR with a compact custom microcontroller unit (minsis) and introducing CFRP legs and TPU front support to reduce mass and improve impact tolerance, while continuing to use aluminum 1060 with PLA+ for other structures (and TPU in select parts).

3.2 Software Stack and Simulation

Our software runs on **Ubuntu 22.04 + ROS 2 Humble**. We use **Webots** for simulation-based iteration of perception, odometry, and integration testing, and **RViz2** for visualization and debugging. The baseline control stack is built around OP3-compatible walking and motion primitives, with perception outputs driving an FSM-based soccer behavior layer.

4 Vision and Active Vision

4.1 Object Detection

We use a YOLOv8-Tiny detector [1] trained on a custom dataset to detect **ball** and **goal posts**. The perception node publishes bounding boxes and confidence scores per frame.

4.2 Planning Space: Current and Planned

Current status. Current behavior largely uses **image-space cues**: the robot turns to center the ball in the image and uses bounding-box scale as a coarse proxy for distance.

Planned for RoboCup 2026. We plan to estimate the ball position in **Cartesian (robot-relative) space** by projecting the detected pixel into a ray and intersecting with the ground plane, producing an (x, y) estimate for approach and kick alignment.

4.3 Active Vision

Active vision uses head pan/tilt to keep the ball near the image center; when lost, the robot executes a search scan biased to the last-seen direction. Goal-post tracking via active vision is planned.

5 Localization

5.1 Vision-Based Field Feature Localization (Under Development)

We are developing a vision-based localization pipeline inspired by public methodology and software from UTRA RoboSoccer (soccerbot) [2]. We adapt the public `soccer_perception` and `soccer_object_localization` modules, extract field markings, project them onto the ground plane, and convert them into 2D observations for a particle filter. We fuse these observations with odometry using an AMCL-style filter (Nav2 AMCL baseline) [3].

Current status. At submission time, this module is under development; our immediate target is a stable baseline that supports relocalization and pose tracking under walking-induced noise and partial observations.

Planned improvements. We plan to increase feature coverage via edge/line extraction (e.g., Canny + line fitting) and to explore more discriminative observation models that penalize geometrically inconsistent hypotheses [4]. We will validate the pipeline under realistic odometry noise and walking motion.

6 Motion and Behavior

Walking uses an OP3-style parameterized gait, with kicking/recovery as predefined keyframe motions. Behavior is FSM-based (search, track, approach, align, kick, recovery) driven by perception confidence and fall detection. Team communication is not implemented in the current baseline; a later milestone is lightweight inter-robot state sharing [5].

GameController integration (planned). For RoboCup 2026 we will integrate the official GameController protocol and expose its state to the behavior FSM. The plan is to map GameController states and set-play phases to explicit FSM modes (initial/ready/set/playing/finished, kickoff, penalty, and goal events), enforce motion constraints accordingly (e.g., standing during set), and log transitions for post-match analysis [6].

7 Impact and Own Contributions

We aim to contribute a reproducible OP3-compatible KidSize baseline (simulation + hardware evaluation) and strengthen robotics training at Universitas Diponegoro through hands-on ROS 2 development. Research-focused contributions for RoboCup 2026 include a Webots test environment for repeatable motion tuning, calibrated image-to-ground projection for metric ball (x, y) estimation, and field-feature observations for particle-filter localization.

8 Open Source and Reuse

Our software is partially open source; selected stable modules and tooling are published at `https://github.com/ProgramBascorro`, with additional releases planned as modules stabilize. We reuse and adapt the ROBOTIS OP3 open-source ecosystem and reference UTRA RoboSoccer's public perception and localization modules [2].

9 Conclusion

We described Bascorro's OP3-derived KidSize platforms and ROS 2 Humble software stack. For RoboCup 2026 we focus on active vision, metric ball estimation, and field-feature localization with reproducible sim-to-real validation.

References

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