

# Rhoban Football Club – Team Description

## Humanoid Middle League, Robocup 2026, Incheon, South-Korea

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**Abstract.** This extended abstract presents some current ongoing work of the Rhoban team for the RoboCup 2026.

## 1 Previous participations and lessons learned

Rhoban participated 11 times to the humanoid kid-size league since 2011. The team won the competition in 2016[2], 2017, 2018, 2019[6] and 2023[1], and also received the best humanoid award in 2017 and 2023.

Through these years of participation, we developed Sigmaban, our own humanoid robot based on high-reduction MX-64 and MX-106 dynamixel actuators. Designing such a robot involve CAD drawing, parts manufacturing (such as milling or 3D printing), custom electronics design and embedded systems.

## 2 Team impact and contributions

### 2.1 Footsteps planning

Our footsteps are currently planned using a custom Reinforcement Learning (RL) formulation. We published this work in [5] and made the code of this planner open-source and independent from our main code to make it available as a separate software component usable by other teams. This environment can take in account near obstacles such as opponent robots, and exploit the robot specifications to generate optimal footsteps.

### 2.2 FRASA Stand-up agent

Our previous stand up strategy was based on a key-frame based approach, where the robot was supposed to reach a sequence of key poses to stand up. This

approach was not robust enough, and we developed a new strategy based on an RL approach. This approach, called FRASA, is described in [4]. FRASA is an end-to-end RL approach allowing the robot to stand up from any lying position and to recover during a fall. This approach has been successfully transferred to the real robot and was used in the 2025 Robocup competition in Brasil.

### **2.3 End-to-end RL walking**

For the Robocup 2025 we developed a RL-based walking controller that directly maps proprioceptive inputs to joint position commands.

### **2.4 End-to-end localization**

The current localization approach relies on features detection (using YOLOv8[10] network) that are fed to a custom particle filter. The annotation process is however tedious, and the features we annotate are mere proxies to the real quantity that we want to estimate: the pose of the camera on the field. Thanks to laboratory ground truth (in our case, HTC Vive trackers), we are able to auto-label images and efficiently build datasets where the camera pose is known. We created a first dataset containing 15k such images, and are exploring the possibility of training a end-to-end neural network for camera pose estimation for the case of RoboCup soccer fields.

### **2.5 Modelling actuators with high frictions**

We developed a new modelisation of the actuators of the robot, that better takes into account the friction of the motors. This modelisation is described in [3]. This modelisation allows a better simulation of the robot, which is particularly useful when using RL. Indeed, the simulation is used to train the RL agent, and a better simulation can help to minimize the sim-to-real gap, and thus improve the transferability of the RL agent on the real robot.

### **2.6 Robot designing pipeline**

To facilitate the design of our robots, we developed a pipeline to facilitate the transfer of CAD designs to control tasks. The design of the robot is done using Onshape[7], a cloud-based CAD software. We developed the tool onshape-to-robot[8] that allows to export the CAD design to URDF, SDF or MuJoCo XML files that can be used in simulation.

We also developed PlaCo[9], a tool dedicated to the planning and control of robots. This tool simplify the formulation of planning and control problems as convex QP problems for robotic systems.

## 2.7 Community involvement

We are actively involved in the Robotics community. We organized a Workshop on Humanoid Soccer Robotics (WHSR) at Humanoids 2024. The details of this workshop can be found at <https://whsr-2024.github.io/>.

## 3 Major challenges for 2026

The Rhoban team is currently undergoing a significant transition phase, moving from Sigmaban robots to a commercial humanoid platform while simultaneously designing a new custom robot. The following points outline our strategic roadmap for the RoboCup 2026 competition.

### 3.1 A Platform-Agnostic and Modular Software Stack

We are currently implementing a major rework of our software stack to make it modular and platform-agnostic. By decoupling the high-level decision-making and RL-based motor control from the low-level hardware abstraction layer, we aim to ensure that our algorithms can be deployed seamlessly across different humanoid platforms. We plan to have a first version of the new architecture ready by the time of the RoboCup 2026 competition.

### 3.2 Expanding Reinforcement Learning to Complex Motor Maneuvers

Building on the success of the FRASA stand-up agent and our RL walking controller, our goal is to generalize Reinforcement Learning for all high-dynamic motor behaviors. Specifically, we are working on:

- **Dynamic Kicking:** Moving beyond static key-frame kicks to RL-generated strikes. This will allow for adaptive kicking strategies that can respond to in-game dynamics.
- **3D Recovery:** Extending our stand-up strategies to allow the robot to recover from any arbitrary 3D orientation, removing the current limitation to the sagittal plane [4]

### 3.3 Closing the Sim-to-Real Gap via Systematic Identification

The performance of RL policies is strictly bounded by the fidelity of the simulation. Following our recent work on extended friction models [3], we are performing a system identification of actuators found in commercial platforms. By accurately modeling these actuators we intend to minimize the "reality gap," allowing for more stable policies that require minimal fine-tuning on the physical robots.

### 3.4 Next-Generation Hardware: Transitioning to Quasi-Direct Drive

We are designing a new robotic platform. Moving away from high-reduction Dynamixel actuators, this new design explores the use of Quasi-Direct Drive (QDD) and harmonic drive systems. We also plan to use new transmission systems such as timing belts and linkages to reduce the inertia of the robot's end effectors.

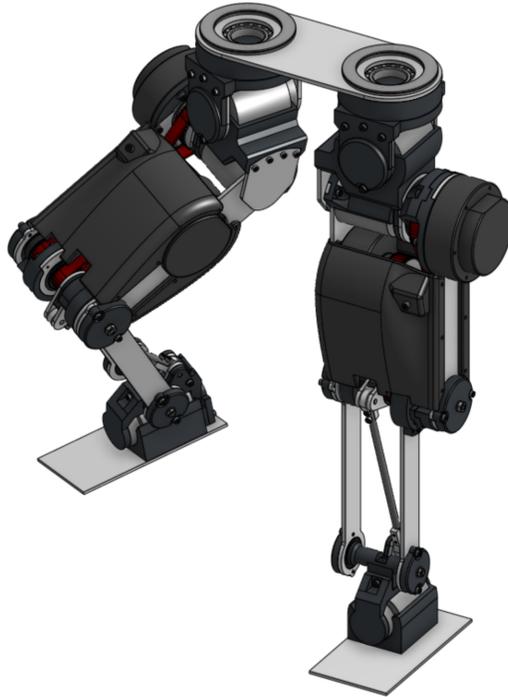


Fig. 1: Concept design of our new humanoid robot featuring Quasi-Direct Drive actuators and lightweight transmission systems.

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