

NomadZ Call For Participation 2026

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Abstract. NomadZ is a student robotics team from ETH Zürich, founded in 2012. After competing in the RoboCup Standard Platform League with NAO V6, the team is transitioning to the Humanoid League (Middle Size Division) starting from RoboCup 2025. Current development is conducted in simulation using the Booster K1 humanoid robot, with plans for future hardware acquisition. Existing SPL algorithms are being systematically ported and adapted to the new humanoid platform and hardware configuration. Our focus lies on modular ROS 2-based system design and simulation-to-real transfer for humanoid soccer.

1 Team information

We are Team NomadZ ⁵ from ETH Zürich. The team was founded in 2012 by the Computer Vision Lab (CVL) and the Automatic Control Laboratory (IfA) of the Department of Information Technology and Electrical Engineering.

Our team is composed of 17 students and alumni who work together to develop the main football framework, while academic projects run to investigate advanced research questions. The academic projects can last between 280 to 400 hours depending on the amount of credits they provide, and are managed by scientific supervisors: Paula Stocco and Rawan Hoteit from the Automatic Control Lab (IfA) and Yan Wu from the Computer Vision and Learning Group (VLG). Professor John Lygeros (IfA) and Professor Siyu Tang (VLG) officially head the organization, which is supported by NCCR Automation.

2 Challenges

Until 2023, NomadZ competed using a legacy codebase derived from the B-Human 2013 release. In recent years, we transitioned to a modular robot soccer framework based on ROS 2, culminating in a ground-up redesign of the software stack in 2024. This framework integrates concepts from other RoboCup teams

⁵ Website: <https://nomadz.ethz.ch/>

Teamleader: Leandro Scaglioni

Video Presentation: <https://www.youtube.com/watch?v=24FIYix84js>

and widely used open-source robotics packages and serves as the basis for our current development.

Following the transition to the Humanoid League, we adopted the official Booster K1 RoboCup demonstration code⁶ as an initial baseline. Building on this foundation, we are progressively porting proven SPL components while developing new functionalities required by the larger humanoid platform. A key challenge during this process is maintaining system robustness as the architecture evolves, which we address through systematic testing and validation in simulation.

2.1 Perception

In the Standard Platform League, perception was strongly constrained by the NAO V6 sensing and computing hardware. Rolling-shutter cameras, color saturation issues, and the absence of an onboard GPU limited robustness under dynamic lighting and motion, forcing reliance on heuristic pipelines that required extensive tuning and calibration. Although lightweight learning-based models were deployed for selected subtasks, computational constraints prevented the use of more expressive state-of-the-art deep learning methods.

The transition to a humanoid platform with onboard GPU capabilities enables a fundamentally different perception approach. While the previous SPL pipeline relied largely on heuristic image processing, current development prioritizes deep learning-based perception as the primary front-end. The Booster RoboCup demo provides a baseline using YOLOv8 for object detection, which we extend by investigating more efficient transformer-based models such as RF-DETR. Our goal is to fine-tune such models for RoboCup-specific scenarios and extend detection toward instance-level segmentation while maintaining real-time performance. At the same time, we retain our vision-based self-localization pipeline from SPL, leveraging robust geometric field features to ensure continuity and reliability. All perception components are currently validated in simulation.

2.2 Behavior

NomadZ’s high-level behavior system is based on a behavior tree framework originally developed and validated in the Standard Platform League and is being directly ported to the Humanoid League system to ensure continuity during the transition. In SPL, limited onboard computational resources constrained behavior complexity and prevented the deployment of more expressive learning-based decision-making methods. While behavior trees provided a reliable and interpretable solution, they limited the exploration of adaptive multi-agent strategies.

With increased computational capabilities on larger humanoid platforms, we plan to investigate whether learning-based or hybrid behavior strategies can be deployed on real robots. Building on our previous publication[5][3] with reinforcement learning-based multi-agent policies, we aim to assess how such approaches,

⁶ Booster Robocup Demo

or their underlying principles, can be integrated into the existing behavior framework for humanoid soccer.

2.3 Motion Control

Motion control in SPL was fundamentally constrained by the NAO V6 hardware interface, which exposes only position control and provides no access to joint velocities or torques. Combined with mechanical backlash, joint wear, and frequent hardware degradation, these limitations introduced significant uncertainty and made systematic experimentation with advanced control methods impractical, widening the gap to state-of-the-art humanoid locomotion research.

With the transition to a larger humanoid platform, our motion control efforts focus on learning-based approaches that better exploit richer actuation and sensing capabilities. We are developing reinforcement learning-based policies to execute the diverse motions required for humanoid soccer, including running, recovery, kicking, and goalkeeping. Both task-driven and imitation-based learning paradigms are explored, with development and evaluation currently conducted in simulation to enable stable training and systematic benchmarking prior to future hardware deployment.

3 Implementation

Current motion control development focuses on migrating training and simulation from earlier platforms to the Booster K1 humanoid using NVIDIA Isaac Lab. Reinforcement learning pipelines for locomotion and dynamic motions are operational in simulation, with ongoing work on stabilizing walking policies and improving reward design prior to integration with higher-level control.

For perception, the existing code has been validated using real camera data, and a synthetic data generation workflow is being established using Unity. Field environments have been ported into the engine, with current efforts focusing on motion blur modeling, ground-truth annotation, and fine-tuning efficient transformer-based perception models.

Behavior implementation currently centers on porting ROS2 behavior nodes from Webots-based simulation to Isaac Sim. Existing behavior tree logic from SPL has been integrated into the new simulation environment, enabling consistent interaction with updated perception and motion modules while supporting scalable testing in humanoid-specific scenarios.

4 Impact

NomadZ consistently contributes to outreach and public engagement activities, advocating RoboCup and robotics to a broad audience through live demonstrations and educational events. In recent years, the team has regularly participated in nationally and internationally visible events, aiming to inspire students and

the general public and to promote humanoid robotics beyond the competition setting.

In Fall 2025, NomadZ hosted one of its projects during the Zukunftstag , an ETH Zürich initiative designed to expose children to STEM disciplines. In the same semester, the team participated in outreach activities at the CLOCK Conference, engaging local students with a background in robotics and engineering. For the third consecutive year, NomadZ also took part in the Swiss Robotics Day 25, a nationally recognized conference that allowed the team to reach a wide audience and actively promote RoboCup. In addition, NomadZ participated in the AI for Good Global Summit for the second year in a row, further advocating the role of robotics and AI for societal benefit. All of these activities have been made possible with the support of NCCR Automation.

Beyond public outreach, NomadZ has a strong impact on education and research-oriented training at ETH Zürich. The team provides students with hands-on experience in humanoid robotics, offering mentorship in software development, system integration, and experimental evaluation. Through its RoboCup activities, NomadZ regularly supports Bachelor theses, semester projects, and Master’s theses, enabling students to work on real-world challenges in perception, motion control, learning, and multi-robot systems. The full list can be found on our website. Following the projects, NomadZ also have a proven track of publications [1][2][4], showing our research contribution from previous years. Even during phases where the primary focus is on hardware acquisition and system setup, the team continues to serve as a platform for student-driven development and technical mentoring.

Through continuous participation in RoboCup and active engagement with the public, NomadZ contributes to advancing humanoid robotics education while promoting RoboCup as a unique benchmark for integrated robotic systems. By combining competition-driven development with outreach and student mentoring, the team aims to strengthen both the Humanoid Soccer League and the broader robotics community.

5 Conclusion

In the past, we have had great experiences at the RoboCup tournaments in Hefei, Leipzig, Nagoya, Montreal, Sydney, remotely in 2021, Bangkok, Bordeaux and Eindhoven. We are looking forward to share again with the RoboCup community this exceptional event. Let’s continue the journey with the RoboCup 2026 in Incheon!

Thank you for your work and for keeping RoboCup the amazing competition it is. We know from our own experiences that RoboCup is able to fascinate many (prospective) students to work in robotics by showing how much fun it can be!

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