THMOS Extended Abstract for Humanoid Kid-size League of RoboCup 2026

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Abstract. This paper outlines the lessons learned from our participation in previous RoboCup Humanoid League competitions and presents the enhancements planned for RoboCup 2026. We focus on improving our robot's walking algorithms, vision systems, and decision-making processes. By integrating advanced control strategies and enhancing team training protocols, we aim to achieve greater stability, accuracy, and cooperative capabilities in the upcoming competition.

Keywords: RoboCup, Algorithms, Training protocols.

1 Lessons Learned and Problems

Our team has participated in the RoboCup Humanoid League (kid-size) for nearly a decade, achieving notable successes and steadily expanding with new members. However, the influx of inexperienced members has highlighted the need for more comprehensive pre-competition training. From last year's experience, we identified that increasing the number of simulated matches before the competition can help detect potential hardware issues such as motor failures and structural instabilities. Additionally, it allows for more effective debugging of the robot's gait. To address these challenges, we have implemented more rigorous simulation sessions and enhanced training programs to ensure seamless robot deployment, swift component replacement, and efficient maintenance during competitions.

2 Plans of the major changes

2.1 Walking

Building on our previous work, this year we have explored advanced gait algorithms, including Central Pattern Generators (CPG), Model Predictive Control (MPC), and Reinforcement Learning (RL). We conducted extensive real-world validations and plan to select the most effective algorithm after upcoming tests. we have implemented more rigorous simulation sessions and enhanced training programs to ensure seamless robot deployment, swift component replacement, and efficient maintenance during competitions.

2.2 Vision and Simulation

We have completed the development of a Line Segment Detector, which is crucial for recognizing various line features on the field. Combining this with our Particle Filtering Algorithm, we aim to achieve high-accuracy positioning. These developments are scheduled for comprehensive testing and refinement in the upcoming spring semester.

2.3 Decision making

This year, we have successfully developed multi-robot communication based on UDP, which allows our football robots to coordinate more effectively on the field. The goalkeeper has been designated as the ROS host due to its simpler decision-making requirements, primarily focusing on defensive actions based on ball position updates from teammates. The other robots act as listeners, actively searching for the ball and making strategic decisions such as chasing, passing, or kicking. These robots continuously communicate with the host to share field information and determine appropriate actions.
This communication framework enables the implementation of distinct offensive and defensive strategies, enhancing our team's tactical flexibility. Additionally, we have incorporated avoidance algorithms and optimized navigation algorithms to improve the robots' ability to maneuver around each other and navigate the field efficiently.

3 Conclusion

Our team is committed to leveraging past experiences to drive significant advancements in our humanoid robotic system. Through enhanced training protocols, advanced gait and vision algorithms, and robust decision-making frameworks, we aim to address previous challenges and achieve superior performance in RoboCup 2026. We look forward to showcasing our progress and contributing to the evolving landscape of humanoid robotics.