RO:BIT Team Description Paper for Humanoid SmallSize League of RoboCup 2026

Doyeon Koo, Geunhyeong Kim, Eungang No, Wonjun Lee, Geonhu Park, Yeonu Song, Seyeong Choi, Changseok Hyun

Robot sports game team of Humanoid Robot
School of Robotics, Kwangwoon University, Republic of Korea

dykoo05@naver.com

Abstract. This paper describes RO:BIT's development plan for RoboCup 2026 (Humanoid Small Size). Based on lessons learned from previous competitions, we focus on improving walking stability, reducing motion execution latency, and strengthening perception and localization under match conditions.

Keywords: Walking Control, Motion Control, Vision, Localization, Capture Point

1 Introduction

This paper summarizes RO:BIT's technical direction for RoboCup 2026, building on our experiences from RoboCup 2023 and 2024. In prior matches, we repeatedly observed instability during walking (sway and drift) and balance loss during kick-related motions. These issues became more visible under disturbances and during transitions from walking to actions. In addition, robot recognition in match scenes was not consistently reliable, which sometimes affected localization and decision making. For RoboCup 2026, our goal is to improve robustness in locomotion and motion execution while maintaining real-time performance in perception and localization.

2 Walking Control and Motion Control

In In RoboCup 2024, we explored a mechanical linkage ("bridge") design intended to stabilize walking. While it improved short-term stability, the additional weight increased load on the leg actuators and occasionally led to overload and drivetrain stress. For RoboCup 2026, we shift the emphasis toward control-side compensation using actuator feedback to reduce foot–ground impact and improve stability without excessive structural burden

Our motion generation has also relied on manual parameter tuning, where joint targets are adjusted at fixed time intervals. This approach can be time-consuming, and when a motion becomes unstable, the tuning cycle must be repeated. Moreover, action execution sometimes experienced delays due to the separation between locomotion control and higher-level action code.

To address these issues, we plan to redesign the inverse kinematics and motion layer so that walking and motion share a consistent execution pipeline. This is expected to reduce transition latency and improve motion stability under sensor feedback. We are also developing a planning-and-control approach that combines MPC-style trajectory adjustment with Capture Point–based stabilization. Although real-time step generation remains challenging, we will continue to improve responsiveness, and we will investigate reinforcement learning as a supporting method for real-time step adaptation under constraints[2].

3 Vision and Localization

In the past, we labeled all field landmarks inside the stadium as a single class and detected them using YOLO, and then performed MCL-based localization based on the detection results. However, because the landmark types were not distinguished, the observations lacked specificity, which made the measurement update in MCL unstable and prevented us from achieving sufficiently accurate pose estimation. To address this issue, we plan to refine the labeling by subdividing landmarks into corner points, cross points, and T points, train YOLO to detect each type separately, and incorporate these type-aware detections into the MCL-based localization pipeline to improve localization accuracy [1].

References

1. Sebastian Thrun, Dieter Fox, Wolfram Burgard, “PROBABILISTIC ROBOTICS”, pp. 195-200, 1999-2000.

2. Johannes Englsberger, Christian Ott, Maximo A. Roa, Alin Albu-Sch¨affer, and Gerhard Hirzinger, “Bipedal walking control based on Capture Point dynamics”, pp. 4422-4423, Sep 2011.