

# Lessons Learned and Development Plans by INVIC Team for RoboCup 2026

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**Abstract.** The INVIC team, affiliated with Wuhan University Student Engineering Training and Innovation Practice Center, has years of experience in the RoboCup Standard Platform League (SPL) China Open and has won multiple national-level awards. For the 2026 Humanoid Soccer League, the team plans to use the K1 platform, optimize its system targeting 3 core challenges, and propose development plans such as a multi-modal collaborative ball search framework. This achievement not only provides a technical reference case for the league but also facilitates talent cultivation in universities and science popularization in communities.

**Keywords:** Team Description · SPL Experience · K1 Development Plan.

## 1 Team Description

The INVIC team is a multidisciplinary team with extensive competition experience, comprising students from different schools at Wuhan University. Affiliated with the Wuhan University Student Engineering Training and Innovation Practice Center, INVIC is a youthful and dynamic team. Composed of students from multiple schools including the Electronic Information School, School of Electrical Engineering and Automation, School of Robotics, School of Geodesy and Geomatics, and School of Computer Science, the team fully leverages professional knowledge from various disciplines to spark collisions of ideas. Together, we strive to build a robot soccer team with rigorous logic, orderly actions, and tacit cooperation. During the preparation for competitions, countless collisions of ideas, sudden bursts of inspiration, and passionate discussions have not only made our soccer team more formidable but also deepened the friendship among team members.

Our team has been participating in the RoboCup China Open Standard Platform League (SPL) since 2018(see fig. 1). From 2018 to 2025, we have successively won numerous competition honors(see tab. 1).

**Table 1.** Team Awards in RoboCup China Open Standard Platform League .

Year	Competition	Award Level
2018	RoboCup China Open (SPL)	First Prize
2019	RoboCup China Open (SPL)	Third Prize
2020	RoboCup China Open (SPL)	First Prize
2021	RoboCup China Open (SPL)	First Prize
2022	RoboCup China Open (SPL)	Second Prize
2023	RoboCup China Open (SPL)	Third Prize
2024	RoboCup China Open (SPL)	Second Prize
2025	RoboCup China Open (SPL)	Second Prize

## 2 Lessons Learned from Previous RoboCup Competitions

From previous participation in RoboCup SPL, the team has gained valuable insights into robot soccer development, leveraging the B-Human framework for effective practices.

Key lessons include optimizing the core parameters of gait control, walking speed, and balance performance to carry out gait optimization adjustments and precise balance control, achieving superior performance on the field [2]; enhancing kicking accuracy through a torque-kicking effect mapping and parameter optimization; upgrading multimodal ball search with combined camera and sensor data for better field adaptation [4]; optimizing dynamic positioning with a linked decision model tailored to field dimensions; and advancing goalkeeper strategies by extending joint angle flexibility and refining trajectory prediction for superior defense coverage [3].

## 3 Major Challenges and Major Improvement Plans

The team is focused on addressing major challenges for the upcoming competition, which include improving bipedal locomotion stability in humanoid robots, ensuring low-latency coupling between vision and action, and achieving rapid target tracking in dynamic scenarios. Additionally, they are working on optimizing motion control algorithms for the K1 robot's 22-degree-of-freedom structure and adapting these to GameController's local area network communication [1]. Ensuring compliance with the competition's humanoid league requirements, such as robot size, sensor restrictions, and autonomous behavior, is also a priority.

To address the aforementioned challenges, the team has formulated major improvement plans, integrating the K1 platform's characteristics and competition rules to achieve technical migration and specialized optimization:

### **Plan 1: Design Multi-Modal Ball Search Logic for Visual Perception**

**Constraints** A "regional traversal and prediction" strategy is adopted: in ball-less states, the robot searches the central field first then expands to corners, predicting the ball's position via odometry data. It integrates the head's  $\pm 90^\circ$  pitch/yaw motion to extend visual coverage.

**Plan 2: Reconstruct Teammate Ball Possession Tracking Logic** The K1's camera identifies qualified team markers to build a dynamic teammate position map. A teammate is deemed to hold the ball if within 0.5m of it and facing it, triggering a following motion. Prejudgment for ball transfer is added—the robot adjusts gait in advance when a teammate's movements indicate a pass.

**Plan 3: Reconstruct Assist Module for Humanoid Collaboration** This plan addresses motion synchronization latency and dynamic role assignment in bipedal robot collaboration. Based on the K1's Soccer Agent mode, a dynamic role pool is designed to switch roles automatically per GameController state [5].

**Plan 4: Reconstruct Goalkeeper Decision-Making System** This plan resolves goalkeeper interception, compliant ball holding and penalty response issues. A high-stability, low-step-frequency close-range interception gait is designed based on the K1's 6-DoF leg model [1].

**Plan 5: Optimize Kicking Motion Library for Compliance and Efficiency** With the K1 SDK, various kicking motions are developed. Inspired by the reinforcement learning approach of the Tsinghua Hephaestus team [6], reinforcement learning can improve motion coherence. The dynamic ball-striking algorithm is optimized to enhance prediction and accuracy for the "Dynamic Kick from Moving Ball" challenge.



**Fig. 1.** The team participated in the 2025 RoboCup China Open Standard Platform League (SPL).

## 4 Implementation Progress of the Proposed Improvement Plans

Deployment and preliminary verification of basic visual detection models. Optimization of the ball search logic to achieve autonomous ball search functionality. Adaptation and message parsing of GameController communication.

## 5 Impact of the Team’s Participation in RoboCup and Related Research

### 5.1 Impact on the Humanoid Soccer League

The team aims to offer a reusable framework for adapting SPL technologies to the HSL, using the multi-modal ball search algorithm and visual collaboration mechanism developed for the K1 platform as a model to help other teams transition smoothly, reducing technical barriers and promoting technology adoption within the league.

### 5.2 Impact on the Affiliated University/Community

By partnering with Booster, the team seeks to enhance the K1 platform’s competition readiness and bridge the gap between humanoid robot education and industry-academia-research collaboration, providing students with a comprehensive practice platform.

## 6 Demonstration of the Team’s Contributions

Our team will optimize the ball search logic to provide reproducible technical case references for subsequent leagues. It cuts ball search time, resolves collaborative tracking latency without direct communication, and provides a reproducible technical reference for future leagues.

Looking ahead, the team hopes to drive its competitive performance through technological innovation, while providing a replicable technical framework to assist other teams in promoting the development and popularity of humanoid robot soccer. Heart directed, path committed!

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