

# Team Description of the INVIC Team for RoboCup 2026

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**Abstract.** The INVIC team is a multidisciplinary group with extensive competition experience, consisting of students from various schools at Wuhan University. The team has been continuously participating in the RoboCup China Open Standard Platform League (SPL) since 2018 and has won numerous honors. This paper outlines the lessons learned from past competitions, analyzes the core technical challenges faced, and proposes targeted improvement plans. Dedicated to the research of key technologies, the team plans to open-source the datasets and other materials generated during development. This initiative aims to provide the league with a referenceable and reproducible technical case, lower the technical barrier to entry, and promote collaborative progress within the competition community.

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

## 1 Introduction

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 [5]; 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

Based on our extensive competition experience and technical analysis, we have identified several critical challenges that must be addressed to advance our performance.

### 3.1 Visual Perception in Dynamic Environments

The robot relies solely on its dual head-mounted cameras for environmental perception, which is constrained by a limited field of view and inherent image distortion. It must balance between rapidly scanning the environment by moving its head and maintaining stable visual tracking of the ball. Furthermore, rapidly changing lighting conditions on the field pose significant challenges, demanding high and real-time adaptability from the vision system [4].

### 3.2 Bipedal Locomotion Stability in High-Speed Contests

The robot needs to achieve fast and agile omnidirectional locomotion while maintaining dynamic balance amidst physical collisions or pushes. Additionally, it must be capable of executing complex actions such as shooting while in motion.

### 3.3 Precise Control for Shooting, Passing, and Contending

Hardware limitations in joint freedom and torque restrict the simultaneous optimization of shot power and angle. Dynamic gameplay also complicates accurate passing and necessitates quick, balanced clearing kicks to resolve contention scenarios effectively.

### 3.4 Development Plan

**Plan 1** By optimizing the existing code and system integration within the B-Human framework, we aim to enhance the robustness, success rate, and localization accuracy of target detection under variable lighting and complex backgrounds, while strengthening the coordination between rapid environmental scanning and stable ball tracking.

**Plan 2** Gait Optimization and Motion Engine Tuning: Optimize core parameters for gait control in simulation environments. The goals are to improve walking speed, agility in omnidirectional movement, and balance recovery against disturbances. A key focus will be enhancing adaptability to different surface frictions and refining strategies for quick standing up from various fall poses to minimize downtime.[6].

**Plan 3** Precise Control and Extension of Kicking Actions: Improve the directional consistency and force control accuracy for shooting and passing through dynamics modeling and online optimization. For ball-contention scenarios, develop specialized rapid-clearing actions (such as optimizing front-kick speed or introducing a side-kick mechanism) to reduce reaction time and prevent the ball from becoming trapped [1].

## 4 Implementation Progress

Based on the outlined development plan, our team has made tangible progress in several key areas. First, we have optimized the core parameters for gait control and are currently conducting field tests, with initial results confirming the effectiveness of the improvements in stability and agility. Second, we have completed a preliminary optimization of the visual perception system, enhancing its baseline performance in target detection and tracking.

## 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



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

mechanism developed for the NAO 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

The team seeks to enhance the NAO 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 The Team’s Contributions and Summary

Our team is dedicated to the research and development of key technologies, such as gait optimization and dynamic visual perception. Throughout this process, we have systematically organized and annotated training and debugging data, and plan to open-source the resulting datasets, optimized model parameters, and core code modules to the league.

We believe that fully disclosing the complete pipeline—from problem definition and simulation training to physical robot debugging—along with the corresponding code and data, will provide the league with a referenceable and reproducible technical case. This will help lower the entry barrier in related technical areas and foster collaborative progress across the entire competition community.

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!

## References

1. Böckmann, A., Laue, T.: Kick motions for the NAO robot using dynamic movement primitives. In: Behnke, S., Sheh, R., Sarel, S., Lee, D.D. (eds.) RoboCup 2016: Robot World Cup XX. Lecture Notes in Artificial Intelligence, vol. 9776, pp. 33–44. Springer (2017)
2. Reichenberg, P., Röfer, T.: Step adjustment for a robust humanoid walk. In: Alami, R., Biswas, J., Cakmak, M., Obst, O. (eds.) RoboCup 2021: Robot World Cup XXIV. Lecture Notes in Artificial Intelligence, vol. 13132, pp. 28–39. Springer (2022)
3. Reichenberg, P., Röfer, T.: Dynamic joint control for a humanoid walk. In: Buche, C., Rossi, A., Simões, M., Visser, U. (eds.) RoboCup 2023: Robot World Cup XXVI. Lecture Notes in Artificial Intelligence, vol. 14140, pp. 215–227. Springer (2024)
4. Röfer, T., Laue, T., Felsch, G., Hasselbring, A., Haß, T., Oppermann, J., Reichenberg, P., Schrader, N.: B-Human 2019 – complex team play under natural lighting conditions. In: Chalup, S., Niemueller, T., Suthakorn, J., Williams, M.A. (eds.) RoboCup 2019: Robot World Cup XXIII. Lecture Notes in Artificial Intelligence, vol. 11531, pp. 646–657. Springer (2019)
5. Röfer, T., Laue, T., Reichenberg, P., Gittner, L., Schiefelbein, L.: B-Human 2024 – enhanced vision and faster ball handling. In: Barros, E., Hanna, J.P., Okada, H., Torta, E. (eds.) RoboCup 2024: Robot World Cup XXVII. Lecture Notes in Artificial Intelligence, vol. 15570, pp. 483–494. Springer (2025)
6. Thomas Münder, T.R.: Model-based fall detection and fall prevention for the NAO robot. In: Akiyama, H., Obst, O., Sammut, C., Tonidandel, F. (eds.) RoboCup 2017: Robot World Cup XXI. Lecture Notes in Artificial Intelligence, vol. 11175, pp. 312–324. Springer (2018)