RedbackBots - Team Description Paper RoboCup Soccer HSL, 2026

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Abstract. RedbackBots is applying to qualify for the RoboCup Soccer Humanoid Soccer League (HSL) in 2026. Redback- Bots is an established former SPL team that was founded at RMIT University in 2019. We participated in the former SPL across 2022–2025. Our academic team lead, Dr. Timothy Wiley, has been an active member in RoboCup since 2010 and our team currently one of the HSL Executive members. Additionally, we strongly believe in supporting the RoboCup community though our SPL league contributions and active committee memberships.

Keywords: RoboCup · Soccer · HSL.

1 RedbackBots Team Information

Team Name: RedbackBots
Team Leader and Academic Supervisors: Dr. Timothy Wiley, Prof. John Thangarajah
Student Leads: Sam Griffiths, Mark Field
Team Members: Aiden Brundell, Stephanie Byars, Benjamin Chandler, Tom Ellis, Mark Field, Sam Griffiths, Peter Hong, Yashal Hookmani, Ronit Israni, Shahira Jasmine Binti Yahaya, Thamadi Kulathunga, Karen Laurentia, Gianluca Monsone, Luke Mullan, Kim Nguyen, Murray Owens, Eric Pham, Devika Sheeja, James Thomson, Rishi Verma and Kurniawan Zhong Zhen
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Qualification Video: https://youtu.be/OYDhPLzrRlU
Robots: In 2026 we will transition to the Middle-Sized HSL league. We will compete with the Booster K1 robot as an *standard platform*. We currently have 2 K1 robots and intend to use the robot pool from Booster.
Combined Team: We note that we're in discussions with two other Australian teams rUNSWift (UNSW Sydney) and Nubots (Newcastle University) to form a combined team in 2026 depending on available robots.

2 RedbackBots Development, Progress, and Team Status

2.1 Challenges being addressed in 2026

As a former SPL team, we are transitioning to the Booster K1 under the HSL *standard platform* rules with an unmodified robot. Thus, in 2026 we address the following software challenges, that are focused around:

- Migrate our existing codebase for Nao V6 to Booster K1. Except for the Booster K1 walk engine.
- Redevelop the architecture our non-ROS based codebase into a ROS2 architecture.
- Primarily use and continue development of our vision, localisation, and behaviour algorithms.
- Development of our AR tool GameSight for Human-Robot Interaction with RoboCup robots, and continue our user studies of AR and explainability for HRI.
- Training of new motions for kicking via Deep Reinforcement Learning.

2.2 Active Development and Plans for 2026

We have commenced on moving our software infrastructure and algorithms to the Booster K1 robot platform, commencing this is simulation in the 4th quarter of 2025. We received 2 K1 robots in December 2025, and as of submission, have commenced working with the hardware platform in-conjunction with simulation.

We are currently working on the following features of our code base:

- We have ported our software codebase to the Booster simulation environment in Isaac Sim, including integraton of camera images into our vision stack, and abstracting our behaviour motion commands to K1 ROS2 messages. Integration with physical K1 robot hardware is underway, however delayed by hardware faults.
- We are revising our vision processing for use with the K1, with respect to the significantly improved compute performance over the Nao V6, and retraining our ML models to work with the different elements of HSL games (such as the ball and opposing robots). This includes adapting our multimodal Kalman filter for localisation and continuing our incorporation and extensive modifications the B-Human vision library into our codebase, the next phase targeting robot detection.
- We are continuing development of our robot behaviours for playing 5v5 soccer based on our previous competition learnings. Re-focusing our behaviour development with a test-driven methodology to refine our fundamental soccer skills with standardised testing framework. All behaviours are being reassesed with the change to the new platform and league.
- We intend to update GameSight based on a preliminary user study on the impact of AR for HRI conducted in November 2025, these results are under review in a conference paper. We intend to commence a broader end-user study in mid 2026, potentially at RoboCup 2026.

By the 2026 competition, we anticipate to have completed the following:

- Fully functional implementation of our software in both simulation and on the K1.
- Use our own implementations for our vision, behaviour, and localisation modules during competition.
- Develop new soccer behaviours with a focus on reliability and accuracy, developed through a test-driven methodology.
- Conduct end-user testing with GameSight during the RoboCup 2026 competition.

2.3 RedbackBots Impact and Contributions to the HSL (and formerly SPL)

Since 2023, we have made the following contributions to the SPL:

- Developed and published GameSight, an open-source Augmented Reality (AR) visualiser for Robot Soccer[10,8].
- Visual referee challenge participation and subsequent publication. [2,7].
- We support student Master's Minor Thesis and Honours projects [18,6,1].
- Designed a ball ramp for the 2025 SPL leader-board challenges.
- Software contributions including alternate implementation of B-human vision systems .

For 2026, we declare the following novel contributions:

- Continued development of GameSight with further HRI research.
- Migrate our vision, localisation and behaviour modules to the Booster K1.
- Attempt Deep RL training of a K1 kick (simulation-to-real training).

2.4 Code Releases

Our published releases for our 2025 SPL soccer code release and team paper[1], Gamesight[2] and our 3D printable ball ramp[3] developed for the "KICKin-Rollin Challenge" are all available on GitHub.

2.5 Code re-use from other HSL (formerly SPL) teams

We acknowledge the following code-use as part of our RedbackBots software:

- rUNSWift 2020 code release as a base, with major components significantly modified or replaced,
- B-Human (and Nao Devils) 2022 code release - build / configuration scripts.
- B-Human 2024 code release - vision system with extensive modifications.
- Nao Devils 2024 code release for whistle detection.

[1] https://github.com/rmit-computing-technologies/redbackbots-coderelease/releases/tag/coderelease2025
[2] https://github.com/rmit-computing-technologies/redbackbots-gamesight/releases/tag/coderelease2024
[3] https://github.com/rmit-computing-technologies/redbackbots-spl-ballramp

2.6 Lessons learned from previous RoboCup Participation

As a team primarily consisting of under-graduate students, we are continuously learning (and re-learning) how to develop reliable and real-time robotics systems with a focus on autonomous software. Our key learnings from 2025 moving into the merged HSL with a new robot are:

- Discussion with many former SPL and HL teams for integrating into a new merged league, and how to transition to the K1 hardware.
- A prioritisation on reliable execution of fundamental robot skills.
- Using a test-based methodology for testing robot behaviours.
- A focus on challenging assumptions when programming for dynamic and real-world systems.

3 Team History

The RedbackBots team is a small but keen team of combined undergraduate and postgraduate students who are studying at RMIT University. Our website[4] summarises our participation in RoboCup Soccer, including our active presence in RoboCup Leadership roles (LOC, OC, TC and Exec).

4 Additional Information

4.1 Publication History

RedbackBots has built a track record of publications and thesis work. Additionally, our academic team leaders have an established track record of publications in both the RoboCup domain, and the wider field of AI. We have published several pieces directly related to RoboCup [16,9,8,7,2,14,15,3] and student thesis work from within the team adds to our body of work [18,6,1,13]. Additionally, recent related work from our team and collaborators further complement our research [10,11,5,4,12,17]. Our team members received a Best Paper Award at the Annual IEEE/ACM International Conference on Human-Robot Interaction (HRI 2025) [9].

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Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

[4] https://redbackbots.com/

References

1. Lohani, P.: Visual Referee Challenge For RoboCup Soccer. Master's minor thesis, School of Computing Technologies, RMIT University, Melbourne, Australia (2022)
2. Lohani, P., Wiley, T.: Hybrid Methods for Real-time Video Sequence Identification of Human Soccer Referee Signals. In: Proceedings of the RoboCup Symposium. pp. 1–12 (2023)
3. Milstein, A., McGill, M., Wiley, T., Salleh, R., Sammut, C.: A Method for Fast Encoder-Free Mapping in Unstructured Environments. Journal of Fields Robotics, Special Issue on Safety, Security, and Rescue Robotics **28**(6), 817–831 (Nov 2011)
4. Ord, S., Marino, M., Wiley, T.: Modernising Delivery: A Low-Energy Tethered Package System Using Fixed-Wing Drones. In: 2024 IEEE/RSJ International Conference on Intelligent Robots and Systems. pp. 2271–2277 (2024). https://doi.org/10.1109/iros58592.2024.10802785
5. Ord, S., Marino, M., Wiley, T.: Fixed-Wing UAV System for Aerial Tethered Delivery of Small to Medium Packages. In: 21st Australian International Aerospace Congress. pp. 262–267. Engineers Australia; Royal Aeronautical Society (2025)
6. Owens, M.: Visual Referee Signals for RoboCup Standard Platform League. Master's minor thesis, School of Computing Technologies, RMIT University, Melbourne, Australia (2023)
7. Owens, M., Wiley, T.: Lightweight Real-Time Gesture Recognition for Dynamic Soccer Referee Signals. In: Proceedings of the RoboCup Symposium (2024)
8. Rodriguez, A.I.S., Ellis, T., Killeen, B., Owens, M., Griffiths, S., Wiley, T.: GameSight: Augmented Reality Visualisation for the RoboCup Soccer SPL. In: Lecture Notes in Computer Science (in press), pp. 1–12 (2025)
9. Sanfilippo, F., Wiley, T., Rousi, R.: RoboCup Soccer Autonomy Uprising: How Crowds, Referees, and Humanoid Robots are Redefining the Future of Human-Robot Interaction. In: 2025 20th ACM/IEEE International Conference on Human-Robot Interaction (HRI). pp. 1131–1139 (2025). https://doi.org/10.1109/hri61500.2025.10974154
10. Sanfilippo, F., Zafar, M.H., Wiley, T., Zambetta, F.: From caged robots to high-fives in robotics: Exploring the paradigm shift from human–robot interaction to human–robot teaming in human–machine interfaces. Journal of Manufacturing Systems **78**, 1–25 (2025). https://doi.org/10.1016/j.jmsy.2024.10.015
11. Stiemer, L., Groves-Raines, M.M., Wood, L., Mohamed, A., Wiley, T.: Online Deep Reinforcement Learning of Servo Control for a Small-Scale Bio-Inspired Wing. In: Gong, M., Song, Y., Koh, Y.S., Xiang, W., Wang, D. (eds.) AI 2024: Advances in Artificial Intelligence, vol. 15443, pp. 65–76. Springer Nature Singapore (2025). https://doi.org/10.1007/978-981-96-0351-0_6
12. Tennakoon, R.B., Hoseinnezhad, R., Tran, H., Bab-Hadiashar, A.: Visual inspection of storm-water pipe systems using deep convolutional neural networks. In: ICINCO (1). pp. 145–150 (2018)
13. Wiley, T.: Autonomous Victim Identification. Honours thesis, The University of New South Wales, Sydney, Australia (2010), school of Computer Science and Engineering
14. Wiley, T., Bratko, I., Sammut, C.: A Machine Learning System for Controlling a Rescue Robot. In: RoboCup Symposium. pp. 1–12. Nagoya, Japan (Aug 2017)
15. Wiley, T., McGill, M., Milstein, A., Salleh, R., Sammut, C.: Spatial Correlation of Multi-sensor Features for Autonomous Victim Identification. In: Röfer, T., Mayer, N.M., Savage, J., Saranli, U. (eds.) RoboCup 2011: Robot Soccer World Cup XV, pp. 538–549. Springer-Verlag Berlin Heidelberg (Jul 2012)

16. Wiley, T., Sammut, C.: Data efficient online learning of robot behaviours via qualitative planning and reinforcement learning. Robotics and Autonomous Systems **194**, 105122 (2025). https://doi.org/10.1016/j.robot.2025.105122
17. Wiley, T., Sammut, C., Hengst, B., Bratko, I.: A Planning and Learning Hierarchy using Qualitative Reasoning for the On-Line Acquisition of Robotic Behaviors. Advances in Cognitive Systems **4**, 93–112 (2016)
18. Zhen, K.Z.: Learning Soccer Strategies Against Different Opponents in A Simulated Robot Soccer Environment. Master's minor thesis, School of Computing Technologies, RMIT University, Melbourne, Australia (2025)