RedBackBots Qualification Document RoboCup Soccer SPL, 2023

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http://www.rmit.edu.au/ailab

1 RedBackBots Team Information

RedBackBots is applying to qualify for the RoboCup Soocer SPL in 2023. We have previously competed remotely in RoboCup Soccer SPL in 2022 for the technical challenges. We also previously qualified for RoboCup 2020/2021. However, due to COVID-19 Pandemic lockdowns in Melbourne during June/July of 2021 we were unable to gain access to our laboratory and therefore unable to compete in the 2021 competition. The RedBackBots academic team leaders have both previously participated in multiple RoboCup events and been active members in the RoboCup communities.

Team Name: RedBackBots
Team Leader: Dr. Timothy Wiley
Academic Supervisors: Prof. John Thangarajah
Affiliation: School of Computing Technologies, STEM College, RMIT University, Melbourne, Australia
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Qualification Video: TODO - UPDATE https://youtu.be/-1_yLYdWx_w

Robots: We have a collection to 10 V6 Nao robots. The funding of the robots was partially provided for qualification and participation in the Soccer SPL. These are also currently used for undergrad student projects, and in our Master's of AI program. The robot Jersey's have been designed and created by our colleagues at the School of Design, using materials the School has been developing for human sporting activities.

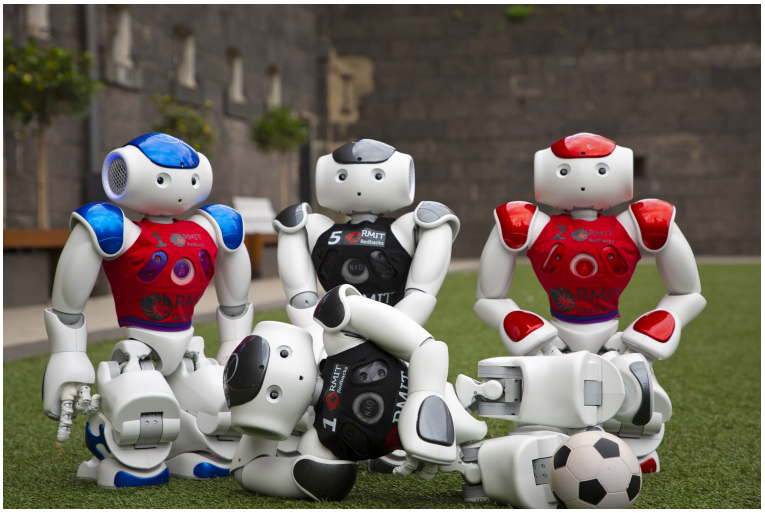


Figure 1: RedBackBots V6 & V5 Nao Robots with home/away Jerseys

2 Code Use

We acknowledge the following code-use as part of our current development of our RedBackBots software:

- Primarily the rUNSWift 2020 code release, for the software architecture, locomotion, vision, communication, etc.
- B-Human (and Nao Devils) 2022 code release, for the structure and creation of a bootable Nao V6 Ubuntu 20.04 image, along with general build configuration scripts, and general robot configuration management scripts.
- B-Human 2022 code release for the Nao V6 camera driver compatible with the Nao V6 Ubuntu 20.04 image.

We understand and fully support the need for each team providing contributions to the league.

At the time of this application, we intend to use the following additional code as part of our 2023 developments:

- We intend to review the rUNSWift 2022 code release, for updated machine learnt models.

We will notify the TC or RoboCup mailing lists of further code-use if this arises.

3 Own Contribution(s)

We declare to make the following novel contributions:

- As mentioned, we have ported our existing codebase to the buildable Nao V6 Ubuntu 20.04 image developed by teams including B-Human and Nao Devils. As our codebase is based on the rUNSWift 2020 code release, this enables another independent codebase to be deployed as an independent image following the same structure as other teams. This therefore increases the diversity of different codebases available in the SPL. This is why we believe this work to be a contribution to the development of the Soccer SPL.
- Implementation of Whistle Detection with novel approaches with machine learning models.
- If possible, implementation of vision algorithms, especially robot detection. This contribution is subject to the time commitments our the team members who are primarily undergraduate students.

We will also notify the Technical Committee of any intention in changes to these contributions.

We have the capacity for these contributions as our academic supervisors have research and experience in the fields of machine learning and computer vision. These contributions would be in conjunction with the team having to develop our own robot behaviours. We think, given the size of our team, that this would be a significant amount of work for our team to get through in time for the competition.

3.1 Current Development Progress

Across our development in 2022 and 2023 we are working on the following features of our codebase:

- Developing robot behaviours for playing 5v5 soccer. As we are a new team that has yet to complete (due to travel constraints) we are still in the development of our initial soccer playing capabilities. We currently have simple behaviours for 1v1 soccer, and are in development towards supporting a larger number of robots.
- Porting our RedBackBots codebase, based on the rUNSWift 2020 code release, to be compatible with the Nao V6 Ubuntu 20.04 image developed by teams including B-human and Nao Devils. This work has been completed as of this application.
- Development of vision methods for the 2022 Technical Challenges, including publishable work for the 2022 Visual Referee Challenge.
- Build of Python 3 for the original SoftBank RoboCup Nao V6 image, including build of Pip and some pip packages.

We observe that as a new team, we are in progress of creating our initial soccer behaviours. While we endeavour to also make a novel contribution to the league, as per the requirements of the qualification. However, we also note that the initial development of competitive behaviours is intensive for new teams.

3.2 Qualification Video of our current Progress

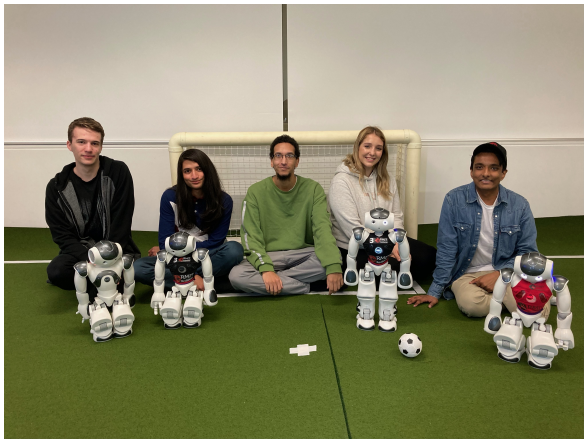
TODO - UPDATE VIDEO Our video demonstrates show:

- Individual robot scoring from kick-off play controlled via Game Controller.
- Current development of 1 vs 1 soccer behaviours.
- Current development of Goal Keeper behaviours.
- Our 2022 RoboCup participation.
- Minor Thesis work of Lohani 2022.

4 Team History

RMIT University established the RedBackBots team in 2019. The RedBackBots team is a small but keen team of combined undergraduate and postgraduate students who are studying at RMIT University.

(a) 2022 RedBackBots Team



(b) 2023 RedBackBots Team

The below table summarises RedBackBots participation in RoboCup Soccer SPL.

Year	Participation	Results
2022	Technical Challenges	8th place Technical Challenges overall. 3rd Place Visual Referee Challenge.
2021	Qualified	Withdrew due to COVID-19 travel restrictions.
2020	Qualified	RoboCup 2020 cancelled due to COVID-19 pandemic.

Our academic team leaders have previously been involved in RoboCup, as listed below.

- Dr. Timothy Wiley has acted in multiple roles: RoboCup LOC (2019), Soccer SPL TC (2018 - 2022); Team Lead, rUNSWift, Soccer SPL (2017 - 2018); Team lead, UNSW@Home, RoboCup@Home DSPL (2017 - 2018); Team member, CASualty, RoboCup Rescue Real-Robots (2010 - 2013).
- Professor John Thangarajah led RMIT's team in RoboCup Soccer 4-legged league in the early 2000s.

We believe that our team leads have had active participation in previous RoboCup events for both the Soccer leagues and the wider RoboCup community and would continue to serve as active participants in the community for the benefit, development, and promotion of the RoboCup Soccer SPL.

5 Impact

In 2022 we completed remotely in the Technical Challenges for the RoboCup Soccer SPL. We primarily focused on the Visual Referee Challenge, placing 3rd overall for this challenge. This work included publishable novel contributions as part of a student's Master's work (Lohani 2022), and we intend to submit this work for publication in the RoboCup Symposium. In 2023, our first contribution to the league is porting our existing codebase to the buildable Nao V6 Ubuntu 20.04 image developed by teams including B-Human and Nao Devils. We have also restructured and revised this codebase to share a similar structure to these teams.

5.1 RMIT University

RMIT University has made a significant investment in Artificial Intelligence and Robotics. The Artificial Innovation Intelligence Lab was launched in late 2019, and the RoboCup team is a key element ot he lab strategic direction. RMIT University also launched the Centre for Industrial Artificial Intelligence and Research Innovation (CIAIRI) in late 2021 with a focus on AI applications for industry.

RMIT University was also an education partnership with Amazon Web Services (AWS), in particular as one of 25 universities world-wide to partner with AWS in launching the RoboMaker platform.

The RedBackBots team is a major part of this strategic drive of RMIT, and the School of Computing Technologies. Students in the Master's of AI along with senior undergraduate students, will be required to completing our established course in Autonomous Robotics. The Robot Soccer project is a fundamental part of this coursework, and one of the core projects.

5.2 Publication History

While our RedBackBots team may be relatively new to the Soccer SPL, our academic team leaders have an established track record of novel publications in both the fields of autonomous robotics, multi-agent systems, planning, machine learning and artificial intelligence. In particular Dr. Timothy Wiley has a history of novel research within the RoboCup domain. We believe this history provides strong evidence of our independent work, and provides the basis of our intention to continue our research interests within the Soccer SPL.

RoboCup Publications

- Wiley, T., Bratko, I., & Sammut, C. (Aug. 2017). A Machine Learning System for Controlling a Rescue Robot. *RoboCup Symposium*. Nagoya, Japan, pp. 1–12.
- Wiley, T., McGill, M., Milstein, A., Salleh, R., & Sammut, C. (July 2012). Spatial Correlation of Multi-sensor Features for Autonomous Victim Identification. *RoboCup 2011: Robot Soccer World Cup XV*. ed. by Röfer, T., Mayer, N. M., Savage, J., & Saranli, U. Springer-Verlag Berlin Heidelberg, pp. 538–549.
- Milstein, A., McGill, M., Wiley, T., Salleh, R., & Sammut, C. (Nov. 2011a). A Method for Fast Encoder-Free Mapping in Unstructured Environments. *Journal of Fields Robotics, Special Issue on Safety, Security, and Rescue Robotics*. 28 (6), pp. 817–831.
- Wiley, T. (2010). Autonomous Victim Identification. School of Computer Science and Engineering, The University of New South Wales Australia.

Student Thesis Works

- Lohani, P. (2022). Visual Referee Challenge For RoboCup Soccer. Master's Minor Thesis. Melbourne, Australia: School of Computing Technologies, RMIT University.

Recent Related Works

- Tennakoon, R. B., Hoseinnezhad, R., Tran, H., & Bab-Hadiashar, A. (2018). Visual Inspection of Storm-Water Pipe Systems using Deep Convolutional Neural Networks. *ICINCO (1)*, pp. 145–150
- Wiley, T. (June 2017). A Planning and Learning Hierarchy for the Online Acquisition of Robot Behaviours. PhD Thesis. School of Computer Science and Engineering, The University of New South Wales.
- Wiley, T., Sammut, C., Hengst, B., & Bratko, I. (2016). A Planning and Learning Hierarchy using Qualitative Reasoning for the On-Line Acquisition of Robotic Behaviors. *Advances in Cognitive Systems*. 4, pp. 93–112.