



## Team Description Paper 2024

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### 1 Team Information

Team Name: rUNSWift  
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### 2 Code Usage

Most of the rUNSWift codebase has been incrementally developed over the years. We would like to thank the Nao Devils team for the use of their camera driver first used in 2018, with some modifications.

The basic structure of the 2022 vision system remains the same as that of 2017-19 [2], [3], [1].

Localisation and state estimation remain largely the same as 2018 [3] and 2019 [1].

rUNSWift’s motion is primarily based off the Hengst’s walk generator [4] developed in house and used since the 2014 RoboCup competition.

The basic structure of the 2022 tooling remains the same as that of 2019 [1]. With the recent addition of web-based toolset (Webnao).

### 3 Own Contribution

While rUNSWift had made significant contributions previously, during the period from 2019 to present, the ongoing research hasn’t resulted in publishable articles yet.

We are working on the several major improvements that should result in significant contributions to the state-of-the-art in the near future including tooling, architecture and the vision system.

#### 3.1 Tools

We recently developed a web-based toolset Webnao with the aim of calibrating the vision, localisation and kinematics better and quicker. This was a result of updating a vision tool that was accessible cross-platform rather than the previous vision tool Offnao that was only compatible with Ubuntu 18 which has reached an EOL.

#### 3.2 Vision

Historically, the team have been using multi-stage vision pipeline with a mixture of ML-based and algorithm-based approaches. We are developing experimental approach that would allow us to train the vision pipeline using single ML model instead. This significant undertaking requires us to build tools for capturing auto-labeled data during the game and under special situations on the field. In 2022-2023 period we have been working on a set of tools to enable the data capture and auto-labeling for future training. We also identified situations where the robots had blind spots and consequently improved the algorithm’s approach to find the ball while minimising motion blur in a way that was quicker and more reliable with dynamic pitch and yaw.

#### 3.3 Motion

rUNSWift’s reinforcement-learning base walk engine has been a significant breakthrough for its time that have been adopted by many teams around the world. We are using a motion engine based on the deep reinforcement learning. Due to the high uncertainty and random joint movements at the beginning of the training, using physical robots is not practical, therefore as a first step we have experimented with various simulation engines and have developed a simulator based on PyBullet. The initial use for this is to test different get-ups and walks in simulation so as to not cause wear/damage to real robots. This will allow us to better analyse what happens during the game by replaying the game logs in a simulation.

### 3.4 Architecture

The team has been working on implementing and testing ROS2 nodes running on the robot as we see great potential in support an ecosystem of well-maintained narrow-purpose open-source packages based on ROS2 as it would allow for easier innovation translation between RoboCup SPL and the industry at large.

### 3.5 Whistle Detection

The team is currently working on an improved whistle detection algorithm as well as more comprehensive whistle detection behaviours to allow the robots to respond more effectively to in game commands.

### 3.6 Robot Detection

The team is also currently working on detecting the colour of the jerseys of robots around them so that they can distinguish robots on our team and on the opposing team.

## 4 Past History

Team *rUNSWift* has been competing in the Standard Platform League (SPL) since 1999. Every year, we strive to improve the weakest aspects of our system and adapt it to new challenges presented by the SPL technical committee (TC) through rule changes.



**Fig. 1.** The rUNSWift 2023 team members at RoboCup 2023 in Bordeaux, France. *From left to right:* Neeraj Gopikrishnan, Nicholas Bell, Stefan Immaraj, Mary Pillay, Mikhail Asavkin, Maria Lizura

The competition took place from 6-9 July 2023, with a day and a half of setup and a closing research symposium. The seeding round consisted of a Swiss

tournament which seemed to accommodate the 9 competing teams better than the pools and play in rounds of prior years. A single-elimination tournament decided the winner, with a 3rd place playoff added. rUNSWift achieved 3rd place in the competition through a nail-biting penalty shootout at the Exhibition Center of Bordeaux, equaling the team’s performance in Thailand 2022 and Sydney 2019. This was one of the first penalty shootouts ever in SPL and it was fascinating to see the robots in a penalty situation that was only partially prepared for because of how rare the situation was - with robots not listening for penalty whistles and goalies not being prepared to dive for the penalty.

rUNSWift feels fortunate to have placed 3rd overall this year, winning 2 games out of 5 in the seeding rounds, a quarter final and 3rd place game.<sup>1</sup>

For the upcoming year, we plan to focus on rebuilding the team’s capability, passing the metaphorical baton to a new generation of RoboCuppers. We unfortunately won’t participate in GORE2024 as it is logistically challenging to move the robots and team overseas. Over the next couple of years we will continue to focus on improving our vision system, as well as transitioning our code-base to ROS2 which is used more industrially meaning it will have a more comprehensive support system and better in-built tools.

## 5 Impact

### 5.1 On SPL

The Hengst walk engine [4] won 2014 and 2015 and reached the final of 2016 as part of the UT Austin Villa system. Further it was integrated into B-Human 2017 code release.<sup>2</sup> . A labelled dataset for field segmentation consisting of 20 videos was published in 2021 [5].

In addition, rUNSWift has had several members become members of the SPL TC in the past, with Tarandeep currently in the TC and also members in the SPL OC with Claude Sammut a past president of RoboCup.

### 5.2 On UNSW & local community

During Open Day at UNSW held on 2 September 2023, rUNSWift set up a robotics demo stall including Naos playing on a small field, to inspire prospective students to consider Computer Science/STEM in general as a career, also entertaining small children to create positive associations with robots.

rUNSWift also organizes demo games on the full SPL standard field in the Kensington lab periodically as a platform for recruitment, refereeing, training, and to inform students about RoboCup and SPL.

With regard to coursework, students are given the option to work on a project related to RoboCup as a part of a Robotics Software Architecture course offered

<sup>1</sup> <https://spl.robocup.org/results-2022/>

<sup>2</sup> See Section 8.3: Walking <https://b-human.de/downloads/publications/2017/coderelease2017.pdf>

Competition	Level	Opponent	Score	Res
RoboCup 2023	Third-place	HULKs	<b>1:1</b> [0:2]	win
RoboCup 2023	Semi-finals	B-Human	<b>10-0</b>	loss
RoboCup 2023	Quarter-finals	Nao Devils	<b>0-3</b>	win
RoboCup 2023	Round 5	Bembelbots	<b>2-0</b>	win
RoboCup 2023	Round 4	SPQR Team	<b>0-0</b>	draw
RoboCup 2023	Round 3	Berlin United	<b>2-0</b>	win
RoboCup 2023	Round 2	HULKs	<b>3-0</b>	loss
RoboCup 2023	Round 1	HTWK Robots	<b>3-0</b>	loss
RoboCup 2022	Third-place	Nao Devils	<b>1-0</b>	win
RoboCup 2022	Semi-finals	B-Human	<b>6-0</b>	loss
RoboCup 2022	Quarter-finals	UT Austin Villa	<b>1-3</b>	win
RoboCup 2022	Round 4	SPQR Team	<b>0-5</b>	win
RoboCup 2022	Round 3	UPennalizers	<b>5-0</b>	win
RoboCup 2022	Round 2	UT Austin Villa	<b>0-0</b>	draw
RoboCup 2022	Round 1	HTWK Robots	<b>3-0</b>	loss
GORE 2022	Quarter-finals	RoboEireann	<b>0-1</b>	loss
GORE 2022	Round 6	SPQR Team	<b>0-0</b>	draw
GORE 2022	Round 5	R-ZWEI KICKERS	<b>5-0</b>	win
GORE 2022	Round 3	B-Human	<b>0-7</b>	loss
GORE 2022	Round 2	Bembelbots	<b>1-0</b>	win
GORE 2022	Round 1	HULKs	<b>6-0</b>	win
RoboCup 2019	Third-place	Nao Devils	<b>11-2</b>	win
RoboCup 2019	Semi-finals	B-Human	<b>3-0</b>	loss
RoboCup 2019	Quarter-finals	TJArk	<b>5-0</b>	win
RoboCup 2019	2nd Round Robin	Bembelbots	<b>7-0</b>	win
RoboCup 2019	2nd Round Robin	HULKs	<b>5-0</b>	win
RoboCup 2019	1st Round Robin	Camellia Dragons	<b>4-0</b>	win
RoboCup 2019	1st Round Robin	UT Austin Villa	<b>4-0</b>	win
GO 2019	Third-place	HULKs	<b>1-2</b>	loss
GO 2019	Semi-finals	B-Human	<b>5-0</b>	loss
GO 2019	Play-in	Berlin United	<b>10-0</b>	win
GO 2019	Round Robin	HTWK	<b>1-4</b>	loss
GO 2019	Round Robin	HULKs	<b>2-1</b>	win
GO 2019	Round Robin	NomadZ	<b>8-0</b>	win

**Table 1.** Results of competitive games from 2019-2022

at UNSW, offering them a chance to expand their knowledge by working on a real project.

rUNSWift often visits schools to inspire and engage with students about the future of robotics. We have historically had an association with Kensington Primary School<sup>3</sup>, taking Nao robots on site to inspire questions, inform and entertain K-6 students.

rUNSWift also did a demo for the RoboCup junior event in Sydney this year, inspiring the next generation of RoboCuppers to continue their interest in the future of robotics.

rUNSWift looks forward to a potential future including competition taking place on the recently redeveloped village green synthetic football field built to FIFA accreditation standard.<sup>4</sup>

## 6 Other

### Acknowledgements

The 2023 team wish to acknowledge the legacy left by previous rUNSWift teams and deeply thank the School of Computer Science and Engineering, University of New South Wales for their continued administrative, financial and laboratory support to our team. We'd also like to warmly thank additional sponsors and contributors, including though not limited to ANT61, the Chief Scientist of NSW and CR8. We also wish to pay tribute to all RoboCup teams, in particular RoboCup SPL teams that inspire and drive our innovations in the spirit of friendly competition.

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<sup>3</sup> <https://kensington-p.schools.nsw.gov.au/>

<sup>4</sup> <https://www.estate.unsw.edu.au/village-green-redevelopment-0>