RoboCup Standard Platform League (NAO) Technical Challenges

RoboCup Technical Committee

(~~2024~~2025 technical challenges, as of 2025-03-01)

Questions or comments on the technical challenge rules should be submitted via
`https://github.com/RoboCup-SPL/Rules/issues`, to the `#rule-book` channel
on the SPL Discord server, or by mail to `rc-spl-tc@lists.robocup.org`.

Contents

1 Introduction

At RoboCup ~~2024~~2025, the Standard Platform League will hold one technical challenge, which is described in this document. RoboCup ~~2024~~2025 awards a trophy for winning this challenge and the option for pre-qualification if a team is not pre-qualified by other means.

Technical challenges are used in the SPL to develop technical capabilities which will be used in upcoming RoboCups in the main competition. The purpose is to give teams time to develop solutions and exchange ideas before they will be introduced into the main competition. Challenges are designed to move the league in a direction of further improvement of soccer skills and towards the overall goal of 2050. Each team is strongly encouraged to participate in these challenges to contribute to the league's advancement.

1.1 Code Publication

Every team participating in a challenge must publish the corresponding code used in that competition according to Appendix A.7 of the SPL rule book, unless a specific challenge states otherwise.
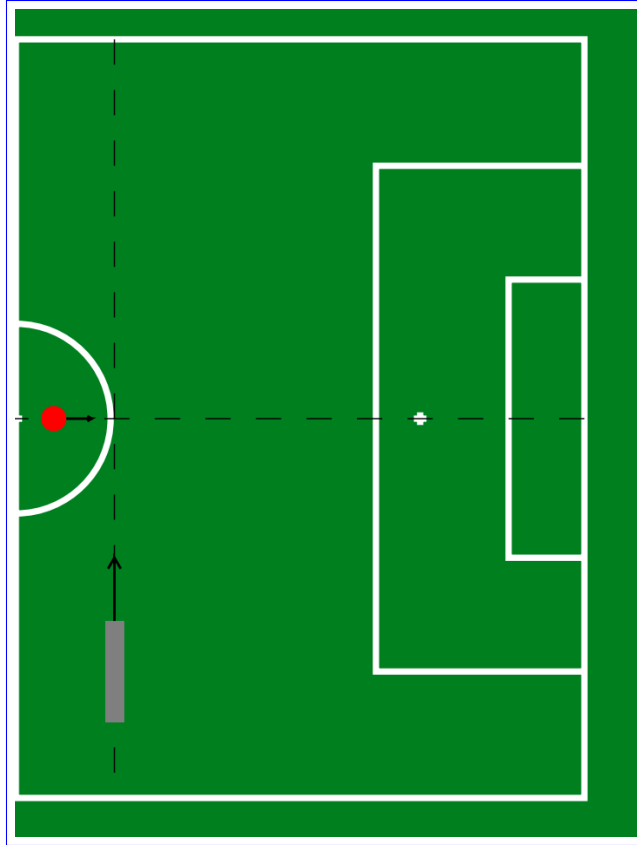
Figure 1: Illustration of robot and ramp placement for the challenge: The robot is depicted as a red dot, while the ramp is shown as a grey rectangle.

2 ~~Shared Autonomy~~ KICKin' & Rollin' Challenge

~~This technical challenge will challenge participants to develop a mixed team that consists of one human-operated Nao robot and one fully autonomous Nao. This challenge will consist of matches of two vs two robots on the~~ The objective of this challenge is for a robot to successfully kick a rolling ball from a ramp into a designated goal area. Each participating team will record three sessions, with a significant time between them. A more specific schedule will be communicated closer to the competition. A session consist of three kicks.

2.1 Field Setup

The challenge will take place on a standard SPL field with its official marking. The ramp will be positioned on the virtual vertical line as show in Figure 1. The general idea is to position the Nao facing the goal, with the ball moving from its left to its right, or vice versa. The ramp can be positioned at varying distances from the robots to modify the difficulty, as determined by the TC. ~~The exact number of matches will be subject to the number of available fields and the~~

~~main competition schedule, however, teams should expect to participate in at least three matches.~~ However, a minimum distance of 30 cm between the ramp and the virtual horizontal line (Figure 1) must be maintained to ensure the ball rolls directly onto the field. The participating robot can be positioned at the team's discretion along the virtual horizontal line. The robot must have one foot on each side of this virtual line. The ball may not roll in a straight line due to field imperfections. Teams need to adapt to the field conditions.

2.2   ~~Challenge Goal~~

2.1.1   Ramp

The selected ramp design will be made available on the SPL website. It may feature an adjustable angle to allow for modifications in difficulty.

~~This challenge takes a step towards the goal of enabling robots to play on the same field as agents with human level intelligence. To level the playing field in terms of physical embodiment, all players will be Nao robots~~Teams are encouraged to propose their own ramp designs. For more information, visit the `https://spl.robocup.org/kickin-rollin-challenge-ramp/.` ~~However, each teamwill have one of their robots be remotely operated by a human to provide human-level intelligence for robot control. The other robot will be fully autonomous in accordance with the main SPL competition rules.~~

2.2   ~~Challenge Rules~~

2.2   Challenge Procedure

~~This section details the complete rules to determine play and the winner of each match within the shared autonomy challenge. If not otherwise stated,~~ At the scheduled time, all participating teams must assemble on the designated field. The ramp will be set up by the ~~Champions Cup rules will be in effect.~~ technical committee and will remain the same for all kicks executed this session. Each team will perform their three kicks successively. Teams are responsible for positioning their robots in accordance with Section 2.1. The ready signal must be triggered manually using a sequence of sensors or buttons, at the team's discretion. This manual input may also be used to indicate the position of the ramp to the robot. Network communication is strictly prohibited. The robot is free to move after the manual input until the kick has been executed or the ball has stopped moving. After the kick, whether successful or not, the team must pick up the robot and reset it for any remaining kicks in the session. Teams may bring as many robots as needed, but they will not be allowed to deploy code between kicks.

2.2.1   ~~Team Composition~~

~~Each participating team will set up one fully autonomous robot and provide one other robot that is programmed so that it can be operated by a human operator with restricted direct observation of the field, and one team member as the human operator.~~

2.3   Scoring

2.3.1   ~~Limitations for Human Operation~~

Each kick will receive a score based on the location of the ball. These points are non-cumulative:

- ~~Each participating team will select the operator for their human-operated NAO from their registered team members.~~

- ~~Participating teams will design the appropriate interface for receiving field information from and sending controls to their human-operated robot.~~ 0 points for a missed kick or an undetected ball.

- ~~The human operator will sit with their back to the field but close enough to hear referee whistles. The intention is that the operator cannot directly perceive the field but must do so through the controlled robot's sensors.~~

- ~~The human-operated robot will be penalized if the operator turns and looks at the field.~~

- ~~The human operator may not receive other forms of game perception beyond what the operated robot can stream to it. This limitation includes~~ 1 ~~) the human operator watching the challenge live feed on YouTube and~~ point for a deflected ball. A ball is considered deflected if it changes direction due to contact with the robot's feet.

- 2 ~~) other team members with a view of the field communicating game information. However, due to the difficulty of prevention, teams will notbe penalized if third-party spectators are overheard remarking on the game and then the human operator bases decisions on those remarks.~~

- ~~Teams are free to determine the operator interface subject to (1) the operator may not look at the field, (2) no teammate is allowed to communicate game information to the operator. The intention is that the operator may only have game information streamed from the human-operated robot and game controller. The referee has the discretion to bar unanticipated modes of communication that go against the spirit of this intention.~~ points for kicking the ball. A ball is considered kicked if it makes contact with the front sensor of the robot's feet.

- ~~The human-operated robot is not permitted to score goals directly on offense and may not take the goalkeeper role on defense.~~ 3 points for the ball entering the penalty area during the kick. If the ball leaves the area before coming to a complete stop, without qualifying for subsequent points, this still counts.

- 5 points for the ball entering the goal.

- 100 points for the ball going over the goal between the virtual planes of the two goalposts.

2.3.1 ~~Limitations for Autonomy in the Human-Operated Robot~~

A ball can only be considered kicked or deflected if it result from a direct action by the robot. Contact resulting from a stationary feet or a backward step will result in 0 points.

~~For the human-operated robot, teams are encouraged to automate parts of control that would be difficult for human control. For example, the human operator may provide walk velocity commands that the robot then implements with a walk engine, or the operator may request a kick, and a kick engine generates the kick on the robot. The human operator may also set higher-level controls, such as the desired location to walk to. However, in the spirit of a mixed human-robot team, the human-operated robot must implement some form of a command from the human operator. That is, it is not permissible to participate in the challenge with two fully autonomous robots or to *only* have the human operator augmenting the robot's perception and localization.~~

2.4 Ranking

Each team will be ranked based on the average of their best kick from each session.

3   Open Research Challenge

The idea of this challenge is to create a platform within the Standard Platform League for teams to showcase innovations that contribute to the growth, development, and improvement of the league, beyond the core competition objectives. These innovations aim to enrich the league's ecosystem by fostering collaboration, technological advancement, and accessibility.

3.0.1   ~~Number and duration of attempts~~

~~Each match will give each team one attempt to play offense while the other team defends. An attempt will last 90 seconds or until the attacking team scores.The defending team is not permitted to score goals. If the defending team shoots the ball and it crosses the opponent's goal line (so that in normal games, a goal would be scored), then a goal kick will be awarded to the attacking team. Effectively, we will treat the entire end line of the attacking team's side of the field as an out-of-bounds line. It is illegal to score directly off of kick off. Matches end in wins, losses, or draws depending on points scored, as described next.~~ This challenge incentivizes teams to focus on league-wide growth areas such as software, hardware, and community alignment. It provides an opportunity for teams to make impactful contributions in areas like fostering innovation through creative solutions, strengthening collaboration within the SPL community, enhancing accessibility for new and existing teams, boosting engagement with spectators and sponsors, and supporting the long-term growth and sustainability of the league.

3.0.1   ~~Scoring matches~~

~~Points will be awarded during matches on the basis of scoring goals and team coordination. To emphasize scoring on attempts, the attacking team receives two points for each successful goal scored. Teams may also receive additional points for passing where a qualifying pass consists of one robot on a team kicking the ball a distance of more than one (1)meter and then the teammate of the kicking robot making contact with the ball before a robot on the other team kicks or dribbles the ball. Here, a kick (or dribble) is taken to be any contact between a robot's foot while lifted off the ground with the ball. The intention is that incidental contact from the opponent does not disqualify a pass but that intentional contact does. For each qualifying pass, a team receives an additional point. The defending team may also score points via passes. Matches will be decided based on points and not on goals scored.~~

3.1   Submission Requirements

Teams must submit a brief description of their planned contribution by **July 1, 2025** to the Technical Committee (`rc-spl-tc@lists.robocup.org`). Multiple contributions per team are allowed. The description should include:

- **Objective**: The purpose and scope of the innovation.

- **Expected Impact**: How it benefits SPL or improves existing systems.

- **Implementation Feasibility**: Resources and time needed to accomplish/execute the contribution.

3.1.1 ~~Attempt Set-up~~

~~All robots will be manually placed in their *set* location by their team in order to speed up the time between attempts. Attacking robots will be placed on one side of the field and the defending robots will be on the other side. The attacking team will try to score on the side where the defense starts. For defense, one robot will be designated as the goalkeeper and one as a field player. The goalkeeper must be~~

3.2   Presentation Format

Contributions will be presented through a **10-minute presentation** during the SPL competition. Presentations must include:

- Clear explanation of the contribution and its impact.

- A **live demonstration**, if feasible, or a **video demonstration** otherwise. If neither a live nor video demonstration is possible, the team must request an exception by notifying the Technical Committee and explaining the issue.

Presentations in the ~~autonomous robot. The human-operated field player must be within the penalty area line to start~~PDF format must be submitted to the Technical Committee on the day of the presentation and will also be uploaded to the **SPL website** for public review and reference.

3.3   Full Code Release Requirement

A **full code release** is mandatory for participating in this challenge. The code must be publicly available no later than the **main code release deadline** from the SPL rule book and must be announced over the `robocup-nao@lists.robocup.org` mailing list.

3.3.1 ~~GameController and Penalties~~

~~All robots have to communicate with the GameController. All rules from normal gameplay in the Champions Cup (including penalties) still apply unless explicitly changed here. The game controller operator will communicate the attempt time verbally at 30-second intervals to human operators.~~ Ideally, the code should be released before the competition to allow interested teams and individuals to review and provide feedback!

3.3.1 ~~Network Conditions~~

~~No guarantees are made about the conditions of the wireless network at the competition venue. No limits are placed on communication between the robot and the operator, however, attempts to jam the other teamshould not be taken.~~

3.4 Evaluation Process

Contributions will be evaluated during the competition using the **Borda count method**[1], to ensure a fair and democratic assessment. Each team leader of the participating teams ranks all the presented contributions except their own. The rankings are aggregated to determine the overall score for each team. Equal overall scores are allowed. In such cases, tied contributions will share the same position in the overall ranking.
If a team submits multiple distinct contributions, each will be evaluated and ranked separately, potentially resulting in multiple individual rankings for that team.

3.4.1 ~~Overall Challenge Scoring~~

~~All participating teams will complete at least three matches and additional matches may be held as the main competition schedule allows. For purposes of deciding an overall challenge winner, the ranking will be based on the following in this order:~~

Judging Criteria:

- ~~Overall matches won.~~**Relevance**: Alignment with SPL's goals of growth and improvement.

- ~~Highest score.~~ **Feasibility**: Practicality of implementation within league resources.

- ~~Total successful passes.~~ **Impact**: Potential benefit to the league or teams.

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[1] https://en.wikipedia.org/wiki/Borda_count

- ~~Goals scored.~~

  ~~If a tie remains after all of these metrics are considered, then the winner will be determined by additional matches between the teams tied for top rank. The TC will determine a method for selecting opponents such that teams are appropriately matched in terms of strength.~~

3.4.1 ~~Code Release and Research Dissemination~~

~~To foster the sharing of novel research and enable future development, all participating teams must:~~ **Innovation**: Originality and creativity of the idea.

- ~~Prior to the first day of the challenge, submit up to two (2) .pdf slides presenting the team's approach to the competition. At a minimum, the slides should describe 1) the interface for the human operator, 2) the type of command the operator provides to the robot, and 3) the strategy for coordinating the human-operated and autonomous robot. To protect innovation during the competition, these slides will not be shared until after the first day of the challenge~~**Usability**: Ease of use, integration, and adaptability of the contribution.

- **Live Demonstration**: Preference should be given to contributions that include a live demonstration.

- ~~Release the code they develop for the human-operated robot (both robot code and interface code).~~ **Code Release**: Consideration of whether the code was made available beforehand for review and that it is well documented.

3.5 ~~Miscellaneous Notes~~

Depending on the number of contributions, it may be necessary to conduct multiple Borda count evaluations. Each evaluation can focus on different sets of judging criteria, allowing every contribution to be assessed under the most appropriate context and ensuring a more nuanced and fair comparison.

3.5 Scope of Contributions

Projects should focus on innovations beneficial to the league but not necessarily related to winning matches. Examples include:

- ~~Teams are given wide flexibility in interface implementation with the goal of inspiring innovation in how the challenge is addressed. For instance, a team could stream images from the human-operated robot but may face low bandwidth at the venue (Note, the rules do not specify that any special effort will be made to provide stronger bandwidth for the challenge). Due to bandwidth constraints, teams may prefer to process images on board~~

robot and send high level state info back to operator. However, this forces the operator to work with the robots imprecise state estimation. The choice is left as a research challenge for teams.

- Similarly, no specification is given on what control interface can be presented to the human operator. Teams may choose to directly command walk directions and kicks or to use a mixed autonomy mode where the operator gives high level directives that the human-operated robot implements. The only limitation is that the input from the operator must be some sort of command, i.e., it is not sufficient to only augment the robot 's perception or localization**Common Simulator**: A platform to test robot software binaries in a shared virtual environment.

- Finally, the hardware of the interface (e.g., keyboard, joystick, virtual reality headset) is left up to the discretion of teams **Universal Log File Format**: Standardizing data recording formats for easier analysis and collaboration.

- **Interoperable Code Standards**: Aligning software frameworks across teams and leagues for better portability and sharing.

- The defending team is not permitted to score because doing so may be too easy to counterattack with long kicks due to the field size and the limited size of teams**Shared Software Architecture**: Creating modular interfaces to simplify the exchange of robot components between teams.

- **Semi-Automatic Refereeing**: Utilizing field-side cameras and AI for referee assistance. As a corollary, the attacking team cannot score own goals.

- If the attacking team exceeds its message budget, then its score is set to zero and the best result it can obtain is a draw as in the main **Real-Time Game Statistics**: Broadcasting match data through automated systems and providing teams with these statistics.

3.6   Contributions Archive

All contributions will be showcased on the **SPL website**, including:

- The presentations from the competition.

- Total expected time per match: 5 minutes (3 minutes playing and 2 minutes set up)Full code releases for each contribution.

This ensures that every innovation is documented, celebrated, and accessible for future reference and use by the SPL community.