

RCAP CoSpace Autonomous Driving Challenge Rules 2026

U19

These are the official rules for CoSpace Autonomous Driving Challenge 2026.

PREFACE

The RCAP CoSpace Autonomous Driving Challenge focuses on path planning in a smart city. For this challenge, teams are required to program autonomous vehicles to navigate through a smart city in both real and virtual environments (CoSpace).

The CoSpace Autonomous Driving Simulator is the only official platform for the CoSpace Autonomous Driving Challenge. This simulator allows programs to be developed using a graphical programming interface (GUI), Python or C language. The same program for the virtual robot in the virtual environment can be downloaded on to a real robot in the real environment. Participating teams can contact support@cospacrobot.org for CoSpace Auto-Driving Simulator download, help and assistance.

In the CoSpace Autonomous Driving, U19 category, students will compete in both REAL_WORLD and VIRTUAL_WORLD.



Figure.1 CoSpace Auto-driving Challenge



OVERVIEW

Technical Interview (Optional):

Judges will evaluate students' understanding of robotics AI and programming. Every team member must be prepared to address the technical aspects of their specific contributions to the CoSpace Autonomous Driving Challenge. Interviews typically last 10–15 minutes.

Judges may request a second interview if necessary. All submitted AI architectures and codebases must demonstrate complete authenticity and originality.

Individual Team challenge (Compulsory):

All registered teams are required to participate in the Individual Team Challenge.

SuperTeam Challenge (Compulsory for RCAP Finals):

At the RoboCup Asia-Pacific (RCAP) Finals, participants will also compete in the SuperTeam Challenge.

- **Composition:** Each SuperTeam consists of two or more paired teams.
- **Objective:** Teams are allotted limited onsite preparation time to pool their strengths, foster cross-team collaboration, and develop a new AI strategy to solve an unannounced challenge.
- **Scope:** The SuperTeam Challenge is exclusive to the RCAP Finals and is optional for regional qualifying tournaments.

Awards

Awards, including trophies and certificates, will be presented based on the total number of participating teams. The Organizing Committee reserves the right to determine or adjust the award distribution and categories as required.



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CHAPTER 1: GENERAL RULES

1 Challenge Description

The RCAP CoSpace Autonomous Driving Challenge focuses on smart-city path planning. Teams must construct an autonomous physical vehicle, program both physical and virtual robots, and compete across integrated CoSpace (dual-domain) environments (REAL_WORLD and VIRTUAL_WORLD).

1.1 Robot Construction

- 1.1.1 Teams must assemble a physical robot using the standard Robot Maker Kit.

1.2 Programming Requirements

- 1.2.1 Teams must program both the REAL_ROBOT and the VIRTUAL_ROBOT to execute autonomous driving missions.

1.3 Competition Structure

- 1.3.1 The challenge features two environments: **Virtual Map** and **Real Map**. Participation in both environments is mandatory

2 Team

2.1 Team Members

- 2.1.1 Teams must comprise **2 to 4 members**. Dual registration is strictly prohibited.
- 2.1.2 Each team must designate a **Captain** as the sole liaison to referees during matches.
- 2.1.3 **U19 Category:** All team members must be aged 13 to 19 on **July 1** of the competition year.
- 2.1.4 Every member (including the captain) must hold an assigned technical role (e.g., strategy, algorithm design, coding) declared during registration. Each participant must be prepared to articulate and defend their specific technical contributions during inspections and interviews.

2.2 Responsibility

- 2.2.1 Teams must track official rule updates, announcements, and schedules throughout the tournament.
- 2.2.2 Teams are responsible for programming and deploying verified code to both the REAL_ROBOT and VIRTUAL_ROBOT.
- 2.2.3 Technical and administrative inquiries must be directed exclusively through the Technical Committee (TC) and Organizing Committee (OC).

2.3 Field Safety & Operation

- 2.3.1 To ensure safety and prevent robot damage, **only the Team Captain** may handle and operate the physical robot, strictly following referee instructions.

- 2.3.2 All other team members and spectators must maintain a minimum distance of **150 cm** from the arena boundary during active runs, unless otherwise directed by a referee.

3 Referees & Officiating

- 3.1.1 Referees are accredited officials responsible for enforcing rules, managing match progression, and loading team virtual programs into the simulation environment.

4 Human Interference

- 4.1.1 **Restrictions:** Unprompted human interference during an active run is strictly forbidden.
- 4.1.2 **Robot Resets:** Manual resets of the REAL_ROBOT are permissible only with explicit referee authorization.
- 4.1.3 **Communication:** Only the Team Captain is permitted to communicate with match officials during play.

5 Game Interruption

- 5.1.1 In principle, a matches proceed without interruption. A referee may pause an active match only when consulting the TC or OC on technical or procedural matters.

6 Conflict Resolution

6.1 Authority of Referees:

- 6.1.1 The referee's decisions on the field are final.
- 6.1.2 Post-match, the Team Captain has **one (1) minute** to review and sign the score sheet. Signature denotes formal team acceptance of the recorded result. Any concerns or reservations must be noted directly on the score sheet prior to signing.
- 6.1.3 Refusal to sign does not suspend the competition schedule; unresolved disputes must immediately proceed through formal complaint channels (Section 6.4).
- 6.1.4 Severe infractions may lead to round forfeits or total disqualification at the discretion of the Referees, TC, OC, and General Chairs.

6.2. Rule Clarification

- 6.2.1 Clarifications issued by the TC and OC—including those made during an ongoing tournament—are considered binding amendments.

6.3. Extraordinary Circumstances

- 6.3.1 If unforeseen technical failures, field anomalies, or emergency disruptions occur, the OC Chair—in consultation with available TC members—may modify rules onsite. Non-attendance at emergency captain meetings constitutes implicit acceptance of all resulting decisions.

6.4. Formal Protest Procedure



- 6.4.1 In-match disputes cannot interrupt an ongoing run.
- 6.4.2 A formal protest must be lodged by the Team Leader (to a Technical Committee) within **10 minutes** of run completion (or immediately upon emergency referee termination).
- 6.4.3 The TC will convene an ad-hoc tribunal comprising match referees, the Technical Committee(TC), and the Organising Committee(OC). The dispute shall be resolved by OC vote or unanimous agreement, and the Chief Judge will convey the binding ruling to the referee.
- 6.4.4 Consistent with the cooperative ethos of RoboCup, all protests must be conducted professionally and in good faith.

7 Documentation

7.1 Team description Paper

- 7.1.1 Teams are required to submit the Team description Paper (TDP) prior to the event.

8 Code of Conduct and Penalties

8.1 Fair Play and Integrity

- 8.1.1 The competition is grounded in mutual respect, sportsmanship, and fair play.
- 8.1.2 Mentors, coaches, educators, translators, and parents are strictly barred from the student pit area and may neither code nor configure student robots during the event.

8.2 Disciplinary Actions (Yellow & Red Cards)

- 8.2.1 **Compliance & Accountability:** Prior to the challenge, team leaders and mentors must sign an acknowledgment confirming that they have read, understood, and agreed to adhere to the official rules and Code of Conduct. All participants are fully accountable for their actions.
- 8.2.2 **Authority & Progression:** Participants must strictly follow referee directives during matches. Failure to comply will result in a **Warning (Yellow Card)**. A subsequent infraction leads to an automatic **Disqualification (Red Card)** for that round. Disqualifications resulting from deliberate disruptions are final and non-appealable. All cards issued are formally tracked throughout the tournament.
- 8.2.3 Yellow Card (Warning) Procedure
- A Yellow Card is issued at the discretion of the Lead Referee, provided no objections are raised during mandatory consultation with the Assistant Referee.
 - A WARNING will be issued for the following disruptive behaviours and activities including but not limited to:
 - (a) Disobeying referee instructions.
 - (b) Obstructing participants, tournament staff, or referees.
 - (c) Shouting, shouting-adjacent behavior, profanity, or offensive vocalizations.
 - (d) Damaging or sabotaging another team's equipment or personal property.

- (e) Unauthorized entry into the competition field while matches are active.
- (f) Unauthorized entry into another team's designated pit area.
- (g) Disorderly conduct, running, rough play, or physical altercations.
- (h) Harassing or arguing with referees.
- (i) Direct mentor interference with robots, students, or referee decisions.

8.2.4 Red Card (Disqualification) Procedure

- A Red Card may be issued by the Lead Referee after consulting the Assistant Referee. An immediate Red Card requires joint agreement between the Lead and Assistant Referees.
- A Red Card will be issued for the following cases:
 - (a) Accumulating two (2) Yellow Cards across the competition period (spanning the event opening through closing ceremonies).
 - (b) Deliberately interfering with physical robots or damaging arena infrastructure.
 - (c) Code plagiarism or unauthorized code sharing—both the donor and recipient teams will be disqualified.

8.2.5 Escalation of Red Card Penalties:

- A first Red Card immediately disqualifies the team from their current run.
- A second Red Card results in complete expulsion from the tournament.

8.2.6 Formal Review & Extended Sanctions:

All immediate disqualifications are subject to review by the Chief Judge and the Organizing Committee. Severe infractions will be evaluated for further disciplinary measures, including formal bans from future RCAP events.

8.3 Software Integrity & System Penalties

8.3.1 The following system-level manipulations are strictly prohibited:

- (a) Deploying background tools, third-party hooks, or custom code to extract unauthorized telemetry or memory data from the simulation.
- (b) Interfering with the RCAP CoSpace Simulator environment (e.g., resizing or scaling windows, manipulating thread execution, or tampering with rendering).

8.3.2 Sanctions:

- First Offense: Forfeit/disqualification from the current match (issued by Chief Judge / TC).
- Repeat Offense: Immediate expulsion from the competition.

8.4 Knowledge Sharing

8.4.1 Post-tournament sharing of strategies, source code, and algorithms is strongly encouraged.

8.4.2 Selected solutions and technical frameworks may be archived and published via RCAP Academy and CoSpaceRobot.org to advance collaborative robotics research.

- 8.4.3 Above all, participants and mentors are expected to uphold the educational spirit of RoboCup: *the depth of knowledge acquired holds greater value than winning or losing.*

CHAPTER 2: FIELDS

9 REAL_WORLD (real arena)

9.1 REAL_WORLD Dimension

- 9.1.1 The dimensions of the REAL_WORLD are 180cm x 240cm.
- 9.1.2 The floor may be either smooth or textured and may have steps and/or gaps of up to 3 mm. It can also be printed on a canvas.
- 9.1.3 The REAL_WORLD will be placed so that the floor is level.

9.2 REAL_WORLD Layout

- 9.2.1 The arena may incorporate path guidelines, static/dynamic obstacles, and unannounced mystery tasks.
- 9.2.2 Guidelines
- Paths consist of high-contrast lines (black, white, or distinct colors).
 - Lines are 1.8–2.0 cm wide, applied using standard electrical tape or printed directly onto the mat.
 - Guidelines designate the intended navigation paths for the REAL_ROBOT.
 - Straight track segments may feature line discontinuities (gaps) up to 20 cm in length. Each gap will be preceded by a continuous straight section of at least 5 cm.



Figure 2: Sample of black

- 9.2.3 **Obstacles:** Obstacles may be cylindrical or cubic, with variable dimensions, colors, and surface finishes.
- 9.2.4 **Mystery Tasks:** Unannounced challenge elements may be introduced on the day of the competition.
- 9.2.5 **Waypoints:** The REAL_ROBOT is required to navigate through and clear all designated waypoints on the arena floor.

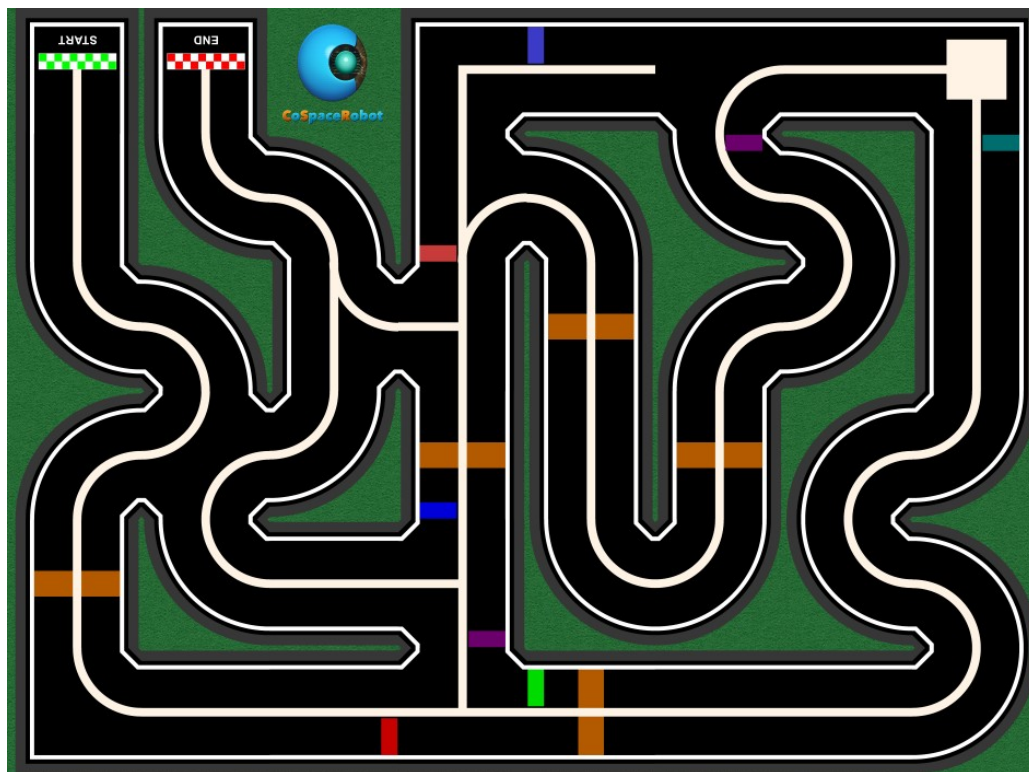


Figure.3 REAL_WORLD layout

9.3 Environmental Conditions & Robot Calibration

- 9.3.1 **Venue Variance:** Ambient conditions at the tournament will differ from training environments. Teams must calibrate their vehicles on-site to adapt to local conditions.
- 9.3.2 **Ambient Variations:** Ambient lighting levels and local magnetic fields across the arena floor may fluctuate.
- 9.3.3 **Optical Interference:** Arenas may experience intermittent optical interference, such as camera flashes or stray reflections. While organizers will make reasonable efforts to maintain stable conditions, teams are expected to design robust sensing solutions resilient to sudden lighting changes.

10 VIRTUAL_WORLD

10.1 VIRTUAL_WORLD Layout

- 10.1.1 The VIRTUAL_WORLD may incorporate black/white guidelines, static obstacles, gantries, waypoints, detour markers, termination markers, and unannounced mystery tasks. Ground texture colors are chosen to prevent false-positive sensor readings or unintended vehicle interference.
- 10.1.2 Black/White Guidelines
- Black/white guidelines feature high contrast: dark lines on light terrain or light lines on dark terrain.
 - Guidelines define the designated driving path for the VIRTUAL_ROBOT.

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10.1.4 **Gantries:** Gantries are elevated structures spanning the roadway displaying signs, warnings, or signals. Gantries provide adequate clearance and will not physically impede robot navigation. Visual designs and colour schemes may vary.



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Figure.10 VIRTUAL_WORLD Layout

CHAPTER 3: ROBOT

11 REAL_ROBOT

Teams must supply their own Standard Robot Platform for the challenge.

11.1 REAL_ROBOT Construction and Specifications

11.1.1 Mechanical & Electrical Integration: The standard base vehicle comprises a chassis, battery holder, drive motors, control electronics, and sensor arrays. Teams must follow the official assembly manual to complete all mechanical mountings and electrical connections. Detailed specifications match the baseline configuration.

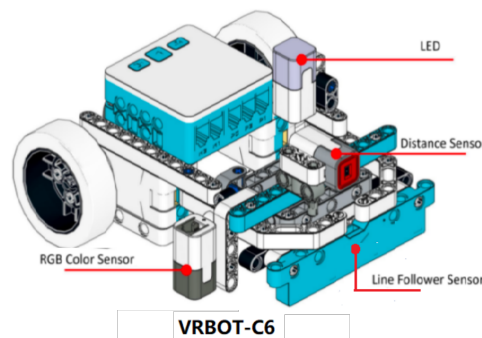


Figure.11 REAL_ROBOT Configuration

11.1.2 Operational Readiness: Teams are solely responsible for robot maintenance and system health. Robots must be fully charged, tested, and structurally sound prior to match calls.

11.1.3 Power Supply: Teams must bring sufficient rechargeable batteries. The Organizing Committee will not supply spare batteries.

11.1.4 Hardware Constraints: Custom modifications to the baseline kit are strictly prohibited. Teams may not alter motors, microcontrollers, sensor layouts, or overall chassis geometry.

11.1.5 Team Identification: Vehicles are encouraged to display a small flag or label showing their official Team Name and Team ID.

11.2 REAL_ROBOT Control

- 11.2.1 **Full Autonomy:** Vehicles must operate fully autonomously. Remote-control overrides, manual intervention, tethered communication, or wireless data telemetry during active runs are strictly forbidden.
- 11.2.2 **Match Start:** The REAL_ROBOT must be initiated manually by the Team Captain upon referee instruction.

12 VIRTUAL_ROBOT

12.1 VIRTUAL_ROBOT Configuration

- 12.1.1 The VIRTUAL_ROBOT configuration is as follows:

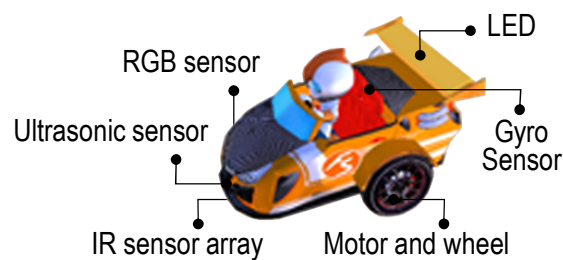


Figure.12 Virtual robot

13 Robot Coding

13.1 Coding the REAL_ROBOT

- 13.1.1 **Supported Languages:** Teams may program the REAL_ROBOT using the graphical user interface (GUI) or standard C to execute tasks within the REAL_WORLD.
- 13.1.2 **Sensor Calibration:** Teams must calibrate the onboard optical sensors to ambient arena illumination to maintain detection reliability and performance.

13.2 Coding the VIRTUAL_ROBOT

- 13.2.1 **Supported Languages:** Teams may develop software for the VIRTUAL_ROBOT using GUI-based tools, Python, or standard C to navigate and complete tasks within the VIRTUAL_WORLD.

CHAPTER 4: GAMEPLAY, JUDGING AND AWARD

14 Gameplay Procedure

14.1 Task Announcement

- 14.1.1 The Organizing Committee will announce the official tasks for both the real and virtual challenges in the main competition arena.

14.2 First AI Submission (AI_1)

14.2.1 **Deadline:** The Chief Judge will announce the strict submission deadline for the first program (AI_1) in the competition hall.

14.2.2 **Mandate:** Every team must submit the AI_1 code developed during the official coding session directly to the Chief Judge.

14.3 Match Initialization & Progression

14.3.1 **Check-in:** Team Captains must report to the referee at their assigned station **five (5) minutes** prior to their scheduled run.

14.3.2 **Round 1 Execution:** Run 1 must execute using AI_1. Re-submissions or modifications to AI_1 are not permitted.

14.3.3 **Iterative AI Re-submission:** From Run 2 onward, teams may submit a revised AI version to the referee no later than **five (5) minutes** before the scheduled start time.

14.3.4 **Default Codebase:** If no revised program is submitted at the 5-minute mark, the referee will deploy the most recently active version. The referee must confirm the active version with the Team Captain before starting the match.

14.3.5 **Lockout:** No program adjustments or uploads are permitted once a match begins.

14.4 REAL_WORLD Run Procedures

14.4.1 **Deployment:** The Team Captain uploads the program to the REAL_ROBOT and places the vehicle at the designated initial station under referee guidance.

14.4.2 **Verification:** The Team Captain is solely responsible for uploading the correct, functional codebase.

14.4.3 **Presence:** The Team Captain must remain trackside for the entire duration of the run.

14.4.4 **Field Calibration:** Teams are allotted **two (2) minutes** on the competition track for final sensor calibration and operational checks prior to the run.

14.4.5 **Start Position:** The Team Captain must position the vehicle within the designated START zone as directed by the referee (*Figure 3*).

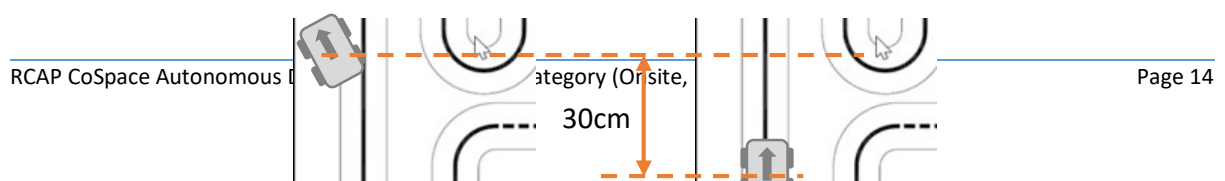
14.4.6 **Navigation & Mystery Tasks:** The REAL_ROBOT must traverse all waypoints (in any order) and complete any active mystery tasks between the START and END zones.

14.4.7 **Waypoint Rules:** The robot must stop at each waypoint and flash its LED for 2 seconds before proceeding to the next waypoint. Teams are encouraged to leverage path markers for trajectory planning unless a fixed path is mandated by officials.

14.4.8 **Lack of Progress (LoP):** An LoP will be called when:

- a) The Team Captain formally declares an LoP.
- b) The robot leaves the guidance line and fails to reacquire the path.
- c) The robot drives against the designated direction of travel.
- d) The robot fails to complete a required mystery task.

14.4.9 **LoP Reset Procedure:** Upon an LoP declaration, the referee will instruct the Captain to relocate the vehicle **30 cm behind** the point of failure along the guideline.



- 14.4.10 **Authorization to Resume:** The vehicle must remain stationary until the referee confirms positioning and authorizes the restart.
- 14.4.11 **Restart Restrictions:** During an LoP recovery, the Captain may cycle power (turn the unit off and on) and restart the program. Modifying code, calibrating sensors, providing external path inputs, or performing mechanical repairs during this sequence is strictly prohibited.
- 14.4.12 **Restart Limit:** A maximum of **three (3) restarts** is permitted per run. Restarts do not carry point penalties.

14.5 VIRTUAL_WORLD Run Procedures

- 14.5.1 **Deployment:** The referee uploads the verified virtual program to the CoSpace platform and initializes the VIRTUAL_ROBOT in the starting area.
- 14.5.2 **Verification:** The Team Captain must ensure the referee deploys the correct program file.
- 14.5.3 **Presence:** The Team Captain must remain at the station throughout the virtual run.
- 14.5.4 **Waypoints & Gantries:** The VIRTUAL_ROBOT must stop at each waypoint and flash its LED for 2 seconds before proceeding to the next waypoint. The VIRTUAL_ROBOT must traverse all waypoints and clear all overhead gantries in any order.
- 14.5.5 **Obstacle Avoidance:** Collision-free navigation around all virtual obstacles is mandatory.
- 14.5.6 **Detour Markers:** Teams are encouraged to detect detour markers at intersections for optimal path selection.
- 14.5.7 **Match Termination:** The virtual run terminates immediately when the VIRTUAL_ROBOT crosses the designated FINISH line.

CHAPTER 5: RANKING RULES AND AWARDS

15 Ranking Rules

15.1 Competition Maps & Rounds

- 15.1.1 **Structure:** The tournament encompasses multiple distinct maps across both the REAL_WORLD and VIRTUAL_WORLD domains. Multiple competitive rounds may be held on each individual map.

15.2 Round Ranking Protocol

15.2.1 **Criteria:** Teams will be evaluated and ranked per round (Real or Virtual) according to the following hierarchy:

	Situation	Rank
Tier 1	The robot (REAL_ROBOT or VIRTUAL_ROBOT) successfully clears all waypoints and crosses the Finish Line.	The team's rank is determined strictly by the elapsed race time recorded at the Finish Line (fastest time ranks highest).
Tier 2	The robot (REAL_ROBOT or VIRTUAL_ROBOT) fails to clear all waypoints (regardless of whether the Finish Line is reached).	<u>VIRTUAL MAP:</u> - The elapsed race time is logged when the VIRTUAL_ROBOT clears its final successful waypoint. - Rankings are determined primarily by the total number of waypoints cleared, with ties broken by the recorded elapsed time. <u>REAL MAP:</u> - Intermediate waypoint timestamps are not recorded for the REAL_ROBOT. - Rankings are determined strictly by the total number of waypoints cleared.

15.3 Map Ranking

15.3.1 **Scoring & Ranking:** A team's score for an individual map is determined solely by their single best round performance on that layout. Teams are then ranked based on these top single-round scores.

15.3.2 **Tie-Breaker:** In the event of a tie in best-round scores, the teams' second-best round scores on that map will serve as the tie-breaker.

15.4 Overall Competition Ranking

15.4.1 **Final Standings:** A team's cumulative tournament score is calculated as the sum of their final rank placements across all completed maps. The team with the lowest cumulative score wins the overall competition.

15.4.2 **Final Tie-Breaker:** If two or more teams finish with identical total scores, overall placement will be determined by their relative rank on the final competition map.



16 Awards

- 16.1.1 **Distribution & Formats:** Awards (including trophies and certificates) will be presented based on total team enrollment. The Organizing Committee reserves the authority to adjust award categories and formats as necessary.

RCAP CoSpace Technical Committee

Contact us:

Rule clarification: cospace@robocupap.org

Technical support: support@CoSpaceRobot.org



Appendix A: Technical Interview Preparation

During the Technical Interview, judges evaluate each student's practical competence, algorithmic reasoning, and overall learning journey. Teams should prepare to address the following prompts clearly and logically:

1. **Strategic & Algorithmic Design:** Explain the core logic and algorithmic strategy developed to solve a designated challenge (specified by the judges during the interview). What alternative approaches did the team evaluate, and what were the decisive advantages of the chosen implementation?
2. **Practical Programming Proficiency:** Demonstrate the technical ability to program and configure an autonomous agent to execute specific operational tasks on demand.
3. **Reflective Learning & Problem-Solving:** Articulate the key technical, collaborative, and problem-solving insights gained throughout the CoSpace Autonomous Driving Challenge.
4. **Communication Standard:** Technical justifications must be delivered with clarity, precision, and logical coherence. Every team member must actively articulate their individual technical contributions.

APPENDIX B: Real Arena Suggested Building Instructions

The inner dimensions of the real arena are 180cm x 240cm which is about the same as the RCJ soccer field. The following is the suggested instruction for building the real arena. These instructions are applicable only for the World Championship organizers.

1. Cut a piece of 243 cm x 183 cm plywood or fiberboard (about 1.5cm thickness is adequate). The surface of the board may be either smooth or textured. You may also join a few small ones together. Please make sure the joint is smooth. It should not affect the real robot movement.
2. Lay the board on the floor. The floor should be level.
3. Paint the surface to white colour.
4. A simple frame should be added at the edge to prevent the robot from falling if the arena is not placed on floor.

