

**NRC ROBOCUP SINGAPORE COSPACE
CODING CHALLENGE**
Primary, Secondary
AUTONOMOUS DRIVING



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RoboCup Singapore CoSpace Coding Challenge Rules 2023

(Autonomous Driving Category)

These are the official rules for RoboCup Singapore CoSpace coding challenge (autonomous driving category) 2023. This rule book is released by the RoboCup Singapore CoSpace Technical Committee. English rules have priority over any translations.

PREFACE

The theme for NRC RoboCup Singapore CoSpace coding challenge (autonomous driving category) 2023 is **SMART TRANSPORTATION**.

In RoboCup Singapore CoSpace coding challenge – autonomous driving category, teams are required to program a virtual robot to complete 5 individual tasks commonly used in smart transportation, such as

- Navigation challenge
- Smart sensing challenge
- Path planning Challenge

The 5 tasks are designed to lead students on:-

- How to use different type of sensors
- How to solve common problems in smart transportation, such as navigation and smart sensing.

There are two age groups.

- The primary age group is for students with little experience with robotics and coding. Novice teams are also welcome.
- Secondary age group is for students with foundation of robotics and coding, such as application using different sensors.

With the foundations built-up, students are able to complete the RCAP CoSpace autonomous driving challenge missions.

Contact us:

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CHAPTER 1: GENERAL RULES

1 CoSpace Coding Challenge (Autonomous Driving Category) Description

In RoboCup Singapore CoSpace coding challenge – autonomous driving category, teams are required to program a virtual robot to complete 5 individual tasks commonly used in smart transportation, such as

- Navigation challenge
- Smart sensing challenge
- Path planning Challenge

2 Team

2.1. Age Division

2.1.1 Primary age group:

Teams with all student members aged 8 to 12 year old can participate in primary age group. If one team member is 13 or above, the team can only take part in secondary age group.

2.1.2 Secondary age group:

Teams with all student members aged 13 to 16 year old can participate in secondary age group.

2.2 Team Members

2.2.1 A CoSpace coding team should consist 1 to 2 members. Each participant can only register for one team.

2.2.2 Each team must have a captain. The captain is responsible for communication with referees during the game.

2.2.3 Every team member including team captain needs to carry out a technical role for the team (strategy planning, programming, etc.), which should be identified at registration. Each member will need to explain his/her technical role and should be prepared to answer questions regarding the technical aspects of their involvement during preparation for the CoSpace coding challenge.

2.3 Responsibility

2.3.1 The team members are responsible for

- verifying the latest version of the rules prior to the competition. If any rule clarification is needed, please contact the CoSpace Technical/ Organizing Committee.
- checking updated information (schedules, meetings, announcements, etc.) during the event.
- communication with CoSpace Technical/ Organizing Committee for all CoSpace coding challenge related matters.

3 Referees

- 3.1.1 A referee is an official who manages the CoSpace coding challenge and makes sure that the challenge rules are followed.
- 3.1.2 The referee receives and uploads the teams' virtual programs, as well as running the game.

4 Interruption of a Game

- 4.1.1 In principle, a game will not be stopped during the challenge unless the referee needs to discuss an issue/problem with the CoSpace Technical/ Organizing Committee.

5 Conflict Resolution

5.1 Referee

- 5.1.1 During the CoSpace coding challenge, the referee's decisions are final.
- 5.1.2 At the conclusion of a game, the referee will ask the captain to sign the CoSpace coding challenge result sheet. Captains are given a maximum of 1 minute to review the result and sign. By signing it, the captain accepts the final result on behalf of the entire team. In case of further clarification, the team captain should write their comments on the result sheet and sign it.
- 5.1.3 A violation of the rules may result in disqualification from the tournament or the round at the discretion of the referee, officials, organizing committee and general chairs.
- 5.1.4 In case the team refuses to sign the scoresheet after the game, they should be advised to file a complaint following the procedure in section 5.4. This should not interrupt the following games. The referee should follow the instruction given by the chief judge.

5.2 Rule Clarification

- 5.2.1 It is the team's responsibility to verify on the official website the latest version of the rules prior to the competition. If any rule clarification is needed, please contact the CoSpace Technical/ Organizing Committee.
- 5.2.2 If necessary, a rule clarification may be made by members of the CoSpace Technical/ Organizing Committee, even during a tournament.

5.3 Special Circumstances

- 5.3.1 Under special circumstances, such as the occurrence of unforeseen problems or malfunctions of the robot, rules may be modified by the Organizing Committee Chair in conjunction with available Technical Committee and Organizing Committee members, if necessary even during a tournament.
- 5.3.2 If any of the team captains/members/mentors do not show up to the team meetings to discuss the problems and the resulting rule modifications described in 5.3.1, it will be considered as an endorsement.

5.4 Complaint Procedure

- 5.4.1 Rule issues are not to be discussed during the run. Referee decisions are binding for the CoSpace coding challenge. A team may protest by executing the following complaint procedure. The procedure is automatically invoked if a referee decides to abort the run for any reason.
- 5.4.2 To initiate the complaint procedure, the team leader of the challenging team has to contact a member of the Technical Committee within 10 minutes of the end of the run. The member of the Technical Committee will then invoke a team leader conference in consultation with the Organizing Committee. The following parties will participate in this conference: the referees of the run, Organising Committee members, and the Technical Committee (counselling). The situation shall be resolved by unanimous consent or by vote of the Organising Committee members. The chief charge should inform the referee concern about the final decisions.
- 5.4.3 All teams are reminded that while this is a competition, the league is also about cooperative research and evaluation, as such, complaints should be handled in a fair and forthcoming way.

6 Code of Conduct

6.1 Fair Play

- 6.1.1 CoSpace coding challenge is built upon the foundation of fairness, respect, and friendship. Team members should be mindful of other people and their robots when moving around the tournament venue.
- 6.1.2 Mentors (teachers, parents, chaperones, translators, and other adult team members) are not allowed in the student work area. They are not allowed to be involved in the programming of students' robots.

6.2 Behaviour

- 6.2.1 Prior to the Challenge, team leaders and mentors are required to sign and acknowledge that they fully understand and are aware of the rules as well as Code of Conducts for the Challenge. All participants are responsible for their own actions.
- 6.2.2 During challenge, participants are to follow the directions of the referee. Failure to do so will result in a WARNING (Yellow Card). Subsequent infractions will result in an automatic DISQUALIFICATION (Red Card) of the round. Disqualification as a result of deliberately distract the competition is FINAL and appeals will not be entertained in any form. The status of Yellow/Red Cards will be recorded.
- 6.2.3 WARNING (Yellow Card) procedure
- A WARNING can be issued at the sole discretion of the lead referee; however, assistant referee will be consulted. If no objection is raised, WARNING will be issued.
 - A WARNING will be issued for the following disruptive behaviours and activities including but not limited to:
 - (a) Not following referee's instructions
 - (b) Disturbing other participants and/or competition staffs (including referees).

- (c) Speaking loudly, shouting, using any kind of profanities or making sound that resembles profanity.
- (d) Sabotaging other teams belongings or equipment
- (e) Entering competition area when other teams are competing.
- (f) Entering other teams' area without explicit permission.
- (g) Engaging in disorderly conducts such as fighting, physical scuffles, running around competition and/or team area.
- (h) Harassing referee
- (i) Mentor interference with referee decisions.

6.2.4 DISQUALIFICATION (Red Card) procedure

- A DISQUALIFICATION can be issued at the sole discretion of the lead referee; however, assistant referee will be consulted. If no objection is raised, DISQUALIFICATION will be issued.
- An immediate DISQUALIFICATION can only be issued jointly by the lead and assistant referee. A DISQUALIFICATION will be issued for the following cases:
 - (a) Teams have collected two consecutive WARNINGS during competition period. A competition period is defined as the start to end of duration of competition.
 - (b) If one team copies a program from another team, both teams will be disqualified.

6.2.5 Once the RED CARD is issued, the team will be disqualified from the current run. If team receives 2 RED CARDS, it will be disqualified from the whole entire competition.

6.2.6 All immediate DISQUALIFICATION will be reviewed by the Chief Judge and the Organising Committee. Infractions that resulted in immediate DISQUALIFICATION will be reviewed and additional sanctions such as bans from future competitions will be considered.

6.3 Penalty

6.3.1 The following are strictly prohibited.

- (a) During the game, using third-party software, self-written code, or any other tools to retrieve additional system information is strictly prohibited.
- (b) Any other behaviours that affect the normal operation of the RCAP CoSpace Auto-Driving Simulator, and direct or indirect control of the behaviours of the RCAP CoSpace Auto-Driving Simulator, such as the scaling of the simulation window is strictly prohibited.

6.3.2 A DISQUALIFICATION from the current match can be issued at the sole discretion of the CoSpace Chief Judge and CoSpace Technical Committee if teams offend the rules 8.3.1 for the first time.

6.3.3 A DISQUALIFICATION from the entire competition can be issued at the sole discretion of the CoSpace Chief Judge and CoSpace Technical Committee for repeat offenders.

6.4 Sharing

- 6.4.1 Teams are encouraged to share their codes and strategies with members after the competition.
- 6.4.2 Any developments may be published on the RCAP Academy Channel (<https://www.youtube.com/RCAPAcademy/>) or CoSpaceRobot.org after the event.
- 6.4.3 CoSpace coding challenge sharing and presentation furthers the mission of RoboCup as an educational initiative.

6.5 Spirit

- 6.5.1 It is expected that all participants (students and mentors alike) will respect the RoboCup mission.
- 6.5.2 The referees and officials will act within the spirit of the event.
- 6.5.3 It is not whether you win or lose, but how much you learn that counts!

CHAPTER 2: FIELDS

7 VIRTUAL_WORLD Layout

- 7.1.1 The VIRTUAL_WORLD may consist any of black/white guidelines, obstacles, gantries, waypoints, detour markers, and mysterious tasks.
- 7.1.2 Black/White Guidelines
 - There will be black line on light road or white guideline on dark road.
 - The black/white guideline forms a path to guide the virtual robot.
 - Straight sections of the black/white guideline may have gaps with at least 5 cm of straight line before each gap. The length of a gap will be no more than 20 cm.



Figure 1: Black / white guideline

7.1.3 Obstacles

The virtual obstacles can be walls, buildings, cylinders, or cubes. The size, design and colour of obstacles can be varied.

7.1.4 Detour Markers

There are some colour markers in virtual VIRTUAL_WORLD to help robots to make decision at junctions. The marker can be of any colour.



Figure 2: Sample of detour markers

7.1.5 Termination Markers

This is the terminal point of the Black/White guideline.



Figure 3: Termination marker

7.1.6 Typical VIRTUAL_WORLD layout:



Figure 4: VIRTUAL_WORLD Layout

CHAPTER 3: ROBOT

8 VIRTUAL_ROBOT

8.1 VIRTUAL_ROBOT Configuration

8.1.1 The VIRTUAL_ROBOT configuration is as follows:

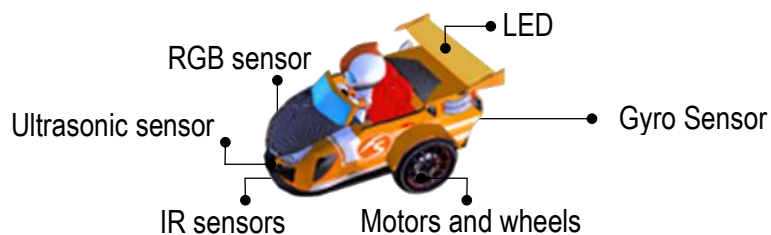


Figure 5: Virtual robot

8.2 Robot Control

8.2.1 Teams can use GUI, Python or C to program the VIRTUAL_ROBOT to complete the task in VIRTUAL_WORLD.

8.2.2 ROBOT must be controlled autonomously. The use of a remote control, manual control, or passing information (by sensors, cables, wirelessly, etc.) to the robot is not allowed.

CHAPTER 4: CHALLENGE TASKS

9 Challenge Tasks

All teams are required to complete 5 individual tasks.

9.1 Primary Age Group

9.1.1 Task 1: Navigation Challenge I

In this task, teams are required to program an autonomous car to track lines using infrared (IR) sensors mounted on the car in a smart town.



Figure 6: Line tracking example

9.1.2 Task 2: Navigation Challenge II

In this task, teams are required to program an autonomous car to avoid obstacles using ultrasonic sensor mounted on the car in a smart town / maze.



Figure 7: Obstacle avoidance example

9.1.3 Task 3: Smart Sensing Challenge

In this task, teams are required to program an autonomous car to detect road markers and navigate in a smart town using RGB colour sensor and IR sensors mounted on the car.



Figure 8: Smart sensing example

9.1.4 Task 4 & 5: Open Challenges

In this task, teams are required to program an autonomous car to complete open challenges using IR sensors, ultrasonic sensor, and RGB sensors.

9.2 Secondary Age Group

9.2.1 Task 1: Navigation Challenge

In this task, teams are required to program an autonomous car to navigate in a smart town / maze using infrared (IR) sensors and ultrasonic sensor mounted on the car.

9.2.2 Task 2: Smart Sensing Challenge

In this task, teams are required to program an autonomous car to detect road markers and navigate in a smart town using RGB colour sensor, IR, and ultrasonic sensors mounted on the car.

9.2.3 Task 3: Path Planning Challenge

In this task, teams are required to program an autonomous car to plan the best path using gyro sensor when traveling in the smart town.



Figure 9: Path planning example

9.2.4 Task 4 & 5: Open Challenges

In this task, teams are required to program an autonomous car to complete open challenges using all sensors mounted on the car.



Figure 10: Open challenge example

9.3 SuperTeam Challenge

9.3.1 SuperTeam is the combination of 2 – 3 teams from different schools.

9.3.2 SuperTeam participants will use both virtual and real robots (CoSpace) for Smart Transportation challenge.

CHAPTER 5: GAMEPLAY, JUDGING AND SCORING

10 Gameplay

10.1 Release of Task

10.1.1 The Organising Committee will announce the tasks in the competition hall.

10.2 AI Submission

10.2.1 The chief judge will announce the time for submission of the AI in the competition hall.

10.2.2 Each team must submit 5 individual codes for 5 individual tasks which is created during the programming period to the chief judge.

The code file name format should follow the name convention given below:

Task1: TeamName_Task1

Task2: TeamName_Task2

...

10.3 Virtual Run

10.3.1 5 minutes before each run, team captains must report to the referee at their respective game stations.

10.3.2 The referee will upload the programs and place the VIRTUAL_ROBOT in the starting position of each task.

10.3.3 It is the team captain's responsibility to ensure that the correct program is uploaded.

10.3.4 Team captain must be present during the virtual run.

10.3.5 Referee will complete all 5 tasks. Team captain is required to acknowledge the result by signing on the scoresheet.

11 Judging and Scoring

11.1 Scoring

The weightage of each task is as follows

Primary Age Group

- Task 1: Navigation challenge I – 10%
- Task 2: Navigation challenge II – 15%
- Task 3: Smart sensing challenge – 15%
- Task 4: Open challenge I – 30%
- Task 5: Open challenge II – 30%

Secondary Age Group

- Task 1: Navigation challenge – 10%
- Task 2: Smart sensing challenge – 15%
- Task 3: Path planning challenge – 15%
- Task 4: Open challenge I – 30%
- Task 5: Open challenge II – 30%

The overall score of 5 tasks determines the rank of the CoSpace coding challenge.

12 Awards and Prizes

The awards will be given to top three teams of each age group.

Winners will be able to receive the following prizes:

1st Place: \$300, Trophy for each team and Medals for each participant

2nd Place: Medals for each participant

3rd Place: Medals for each participant

All participants will also receive certificates of participation.

The Organiser reserves the right to amend the prizes without prior notice.

RoboCup Singapore CoSpace Technical Committee

Contact us

Rule clarification: cospace@robocupap.org

Technical support: support@CoSpaceRobot.org