RCAP CoSpace Autonomous Delivery Rules 2023
RCAP CoSpace Autonomous Delivery Challenge, Open

These are the official rules for the RoboCup Asia Pacific (RCAP) 2023 CoSpace Autonomous Delivery Challenge, Open. They are released by the RoboCup Asia Pacific CoSpace Autonomous Delivery Technical Committee. The English rules have priority over any translations.

PREFACE

The RCAP CoSpace Autonomous Delivery (ADL) Challenge is blending mobile robots and supply chain management. Vehicle-road coordination system provided by CoSpace Autonomous Delivery platform allows participants from Secondary, Tertiary and University to better study AI problems such as path planning and dynamic planning.

In RCAP CoSpace Autonomous Delivery Challenge, teams need to develop and program appropriate strategies for robots based on the Intelligent transportation system (ITS) provided by CoSpace platform. In the last mile delivery and smart city scenarios build by CoSpace, robots need to deliver parcels from Distribution Centre to Collection Station with maximum efficiency.

The RCAP CoSpace ADL Simulator is the only official platform for the sub-league. This simulator allows programs to be developed using a graphical programming interface or C language. Participation teams can contact support@cospacerobot.org for RCAP CoSpace ADL Simulator download, help and assistance.

Figure 1: RCAP CoSpace ADL Challenge

Contents

CHAPTER 1: GENERAL RULES

1 Team

1.1. Team Members

1.1.1 A CoSpace Autonomous Delivery team should consist of 2 to 4 members. Each participant can only register for one team. Each participant can only register for one team.

1.1.2 Every team member needs to carry out a technical role for the team (strategy planning, programming, etc.), which should be identified at the registration. Each member will need to explain his/her technical role and should be prepared to answer questions on the technical aspects of their involvement in preparing the CoSpace Autonomous Delivery Challenge.

1.1.3 Teams should be responsible for checking updated information (schedules, meetings, announcements, etc.) during the event.

1.2. Responsibility

1.2.1 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 Committee.

- checking updated information (schedules, meetings, announcements, etc.) during the event.

- coding for both real and virtual robots in both real and virtual worlds.

- uploading the correct code to both REAL_ROBOT and VIRTUAL_ROBOT.

- communication with CoSpace Technical Committee and Organising Committee for all CoSpace Autonomous Delivery Challenge related matters.

1.2.2 As the space around the competition fields is limited (and crowds can often result in accidents that damage the robots), only the team captain is allowed to operate the real robot, based on the stated rules and as directed by the referee. Other team members (and any spectators) within the vicinity of the real world are to stand at least 150 cm away from the real world while their real robot is active, unless otherwise directed by the referee.

2 Referees

2.1 Official

2.1.1 A referee is an official who manages the CoSpace Autonomous Delivery games and makes sure that the CoSpace Autonomous Delivery rules are followed.

2.1.2 The referee receives and uploads the teams' virtual programs, as well as running the game.

3 Interruption of a Game

3.1.1 In principle, a game will not be stopped during the challenge unless the referee needs to discuss an issue/problem with the OC/TC.

4 Conflict Resolution

4.1 Referee

4.1.1 During a gameplay, the referee's decisions are final.

4.1.2 At conclusion of game play, the referee will ask the captain to sign the score sheet. Captain should be given maximum 1 minute to review the score sheet and sign it. By signing it, the captain accepts the final score on behalf of the entire team; in case of further clarification, the team captain should write their comments in the score sheet and sign it.

4.1.3 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 4.4. This should not interrupt the following games. The referee should follow the instruction given by the chief judge.

4.2 Rule Clarification

4.2.1 It is team's responsibility to verify at the RoboCup Asia Pacific Official website on the latest version of the rules prior to the competition. If any rule clarification is needed, please contact the RCAP CoSpace Autonomous Delivery Technical Committee.

4.2.2 If necessary, even during a tournament, a rule clarification may be made by members of the RCAP CoSpace Autonomous Delivery Technical Committee and Organizing Committee.

4.3 Special Circumstances

4.3.1 In special circumstances, such as the occurrence of unforeseen problems or malfunction of a robot, rules may be modified by the RCAP CoSpace Autonomous Delivery Organizing Committee Chair in conjunction with available Technical Committee and Organizing Committee members, even during a tournament if necessary.

4.3.2 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 at 4.3.1, it will be considered as an endorsement.

4.4 Complaint Procedure

4.4.1 Rule issues are not to be discussed during the run. Referee decisions are binding for the CoSpace Autonomous Delivery 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 (e.g. field damage, lighting failures, burning robots).

4.4.2 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.

4.4.3 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.

5 Documentation

5.1 Poster

5.1.1 Teams may be required to display their poster in the public space during the event. The Technical Committee will inform team prior to the event.

5.1.2 The size of the poster should be no larger than A1 (60 x 84 cm). The aim of the poster is to explain the technology used in the robots. It should include:
- Team name;
- Team members' names and (perhaps) a picture of the team members;
- Team's country and city or town;
- Team's track record;
- The innovative method used in programming the Autonomous Delivery robot;
- What the team hopes to achieve in robotics.

5.2 Team Description Paper (TDP) and Technical Demonstration Video

5.2.1 Each team is required to submit a TDP and Technical Demonstration Video before the deadline given by the organizing committee. Please refer to Appendix A & B for the detailed guidelines.

5.2.2 The RCAP organising committee will announce the awards.

6 Code of Conduct

6.1 Fair Play

6.1.1 CoSpace Autonomous Delivery 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 robots or 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) Teams that cause a deliberate interference with real robots or damage to the real-world setup.
  - (c) 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 Autonomous Delivery Simulator, and direct or indirect control of the behaviours of the RCAP CoSpace Autonomous Delivery 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 6.3.1 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 or CoSpaceRobot.org after the event.

6.4.3 RCAP CoSpace Autonomous Delivery sharing furthers the mission of RoboCup Asia Pacific as an educational initiative.

6.5 Spirit

6.5.1 It is expected that all participants (students and mentors alike) will respect the RoboCup Asia Pacific 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 AND ROBOTS

In RCAP CoSpace Autonomous Delivery Challenge, teams need to develop and program appropriate strategies for robots based on the Intelligent transportation system (ITS) provided by CoSpace platform. In the last mile delivery and smart city scenarios build by CoSpace, robots need to deliver parcels from Distribution Centre to Collection Station with maximum efficiency.

7   Virtual Field

7.1   VIRTUAL_WORLD Layout

7.1.1   The VIRTUAL_WORLD is a 3D simulated environment. The dimensions of field will be less than 2000 cm x 2000 cm.

7.1.2   Surface colors that do not interfere with the robot's detection or movement are permitted.

7.1.3   Turn on delivery system view from the top menu: Display→Delivery System.

Figure 2: RCAP CoSpace ADL, delivery system view

7.1.4   The VIRTUAL_WORLD may consist any of Distribution Centre (C1, C2…), Collection Station (S1, S2, S3…), Navigation Points (P1, P2…), obstacles, detour markers, and mysterious tasks.

7.1.5   The data information shown on the panel on the right side of Figure 3 is as follows:

Figure 3: RCAP CoSpace ADL, smart traffic system

- Front Ultrasonic Sensor feedback: 222 cm.
- Left Ultrasonic Sensor feedback: 31 cm.
- Right Ultrasonic Sensor feedback: 56 cm.
- Next Navigation Point ID is 17, and the distance to the robot's current position is 109 cm.
- The nearest Distribution Centre ID is 1, and the distance to the robot's current position is 25 cm, as the robot is now parked on C1.
- Next Collection Station ID is S3, and the distance to the robot's current position is 50 cm.
- The current position of the robot is PositionX=941, PositionY=799.
- Angle (DeltaAngle), the current angle between the robot and the road centreline is 0 degrees. Refer to Figure 6.
- Offset (DeltaDist), the distance from the centre of the robot to the intersection of the vertical line of the robot's central axis and the centreline of the road, which equals to the distance from the centre of the robot to the centreline of the road divided by cos(DeltaAngle). Refer to Figure 6.
- The direction of the robot is 89 degrees.

Intelligent transportation system (ITS) of CoSpace Autonomous Delivery provides information as follows:

7.2 Distribution Centres

7.2.1 There are Distribution Centres in the virtual field. The robot car collects items from Distribution Centre and delivers them to the Collection Station.
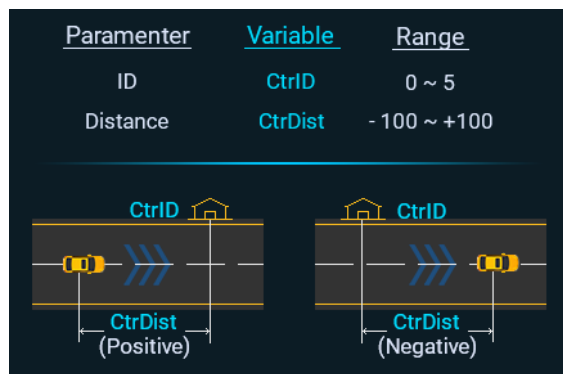

Figure 4: RCAP CoSpace ADL, Distribution Centre

7.3 Collection Stations (Collection Points)

7.3.1 There are Collection Stations in the virtual field. The robot car collects items from Distribution Centre and delivers them to the Collection Station.
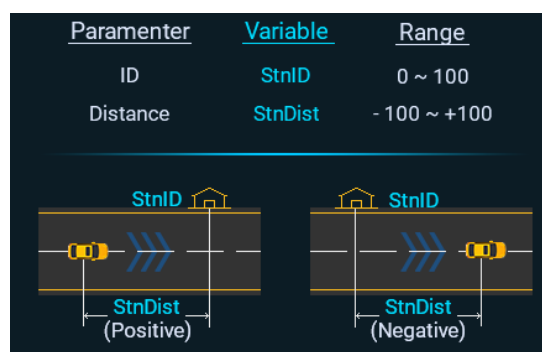

Figure 5: RCAP CoSpace ADL, Collection Stations

7.4 Navigation Points

7.4.1 Navigation Points are set on the virtual field. Each Navigation Point has an ID. The distance between the robot car and the next Navigation Point is set as NavPtDist.
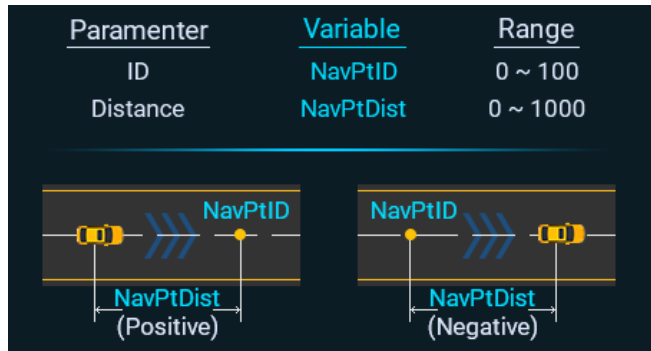

Figure 6: RCAP CoSpace ADL, Navigation Points

7.5 Coordinate System

7.5.1 For the CoSpace ADL Open, the CoSpace Server will send the robot its own coordinates while the robot is delivering in the VIRTUAL_WORLD.

7.5.2 The server will provide the coordinates for the entire map.

7.6 On-Car (Robot Information)

7.6.1 For the CoSpace ADL Open, the CoSpace Server will send the robot its own coordinates and information about its relationship to the road centreline while the robot is delivering in the VIRTUAL_WORLD.

7.6.2 Angle (DeltaAngle), the current angle between the robot and the road centreline is 0 degrees.

7.6.3 Offset (DeltaDist), the distance from the centre of the robot to the intersection of the vertical line of the robot's central axis and the centreline of the road, which equals to the distance from the centre of the robot to the centreline of the road divided by cos(DeltaAngle).
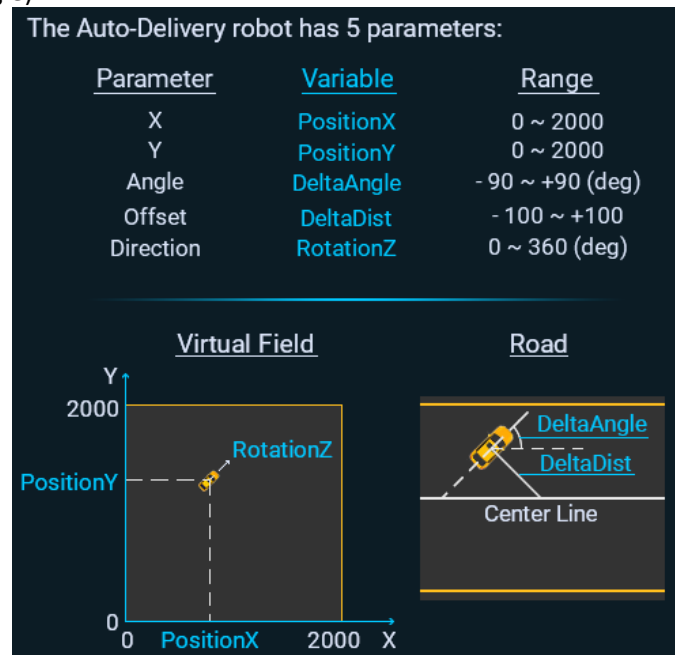

Figure 8: RCAP CoSpace ADL, Robot information

CHAPTER 3: ROBOT

8 Robot

8.1 VIRTUAL_ROBOT Configuration

8.1.1 The RCAP CoSpace ADL Challenge uses a Standard Platform. The basic design of the VIRTUAL_ROBOT consists of two differential wheels, three ultrasonic sensors and gyro sensor. VIRTUAL_ROBOT has the following configuration:

- 3 ultrasonic sensors
- 1 Gyro sensor
- 1 GPS sensor
- 2 DC motors
- 1 LED for status indication
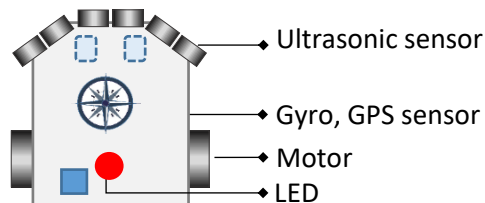
8.2 Coding for VIRTUAL_ROBOT

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

CHAPTER 4: GAMEPLAY AND JUDGING

9 Gameplay

9.1 Release of Task

9.1.1 The Organising Committee will announce the tasks for both real and virtual challenges in the competition hall.

9.2 Submission of 1st AI

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

9.2.2 At the end of the programming period, each team must submit their first AI (AI_V1) to the respective Game Station.

9.2.3 The first AI will be used for the first game. Once submitted, the program cannot be changed for the first game. However, after your team's first game, you can change the AI once before your next game and submit the revised version to the referee. Modified AI programs MUST be submitted 5 minutes before your next game.

9.3 Start of Each Round of Game

9.3.1 5 minutes before each run
- Team captains must report to the referee at their respective game stations with their real robots.
- Teams are allowed to submit a revised version of their AI to the referee if they wish to make a change to their earlier AI. No modification of AI is allowed once the run begins. The referee will continue to use AI_1 if there is no submission of revised AI.

9.4 Virtual Game

9.4.1 The referee will upload the programs onto the CoSpace server and place the VIRTUAL_ROBOT in the initial station in the VIRTUAL_WORLD.

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

9.4.3   Team captains must be present during the virtual run.

9.5   Delivery Task 1

9.5.1   The robot has already loaded all packages/items at the distribution center to start the game. Its task is to deliver the items to each collection station, requiring it to plan the quickest path and visit each station.

9.5.2   To deliver the package successfully, the LED must be blinking, and the robot must stay still for at least 2 seconds. And leave the Collection Stations automatically after it.

9.5.3   20 points for each completed delivery of an item.

9.5.4   The robot needs to delivery items to each collection station on the map once.

9.5.5   The game will end after all items are delivered or the play time exceeds 6 Minutes.

9.6   Delivery Task 2

9.6.1   The robot has a maximum carrying capacity of 6 packages/items and needs to return to the Distribution Centre to restock.

9.6.2   Each package now has a designated Collection Station for delivery, along with a deadline. Failure to meet the deadline will result in a reduction in score.

9.6.3   To load the package successfully, the LED must be blinking, and the robot must stay still for at least 2 seconds. And leave the Distribution Center automatically after it.

9.6.4   To deliver the package successfully, the LED must be blinking, and the robot must stay still for at least 2 seconds. And leave the Collection Stations automatically after it.

9.6.5   In Task 2, the packages now also have designated Collection Stations that they must be delivered to. The robot may only carry maximum 6 packages at any one time and will have to return to the Distribution Centre to get more. The packages have varying scores and deadlines for delivery. Failure to meet the deadline will result in a score reduction to a minimum of 10 points.

9.6.6   Package Urgency Level and deadline
- ItemID: The ID of the delivery item.
- StationID: The ID of the collection station where the item is to be delivered to.
- ItemScore: The score of the delivery item.
- Deadline: The deadline for the delivery item, which is timed from the start of the game. 999 means no deadline.
- There are four types of packages according to Urgency Level.
    - **1.Critical**: Score is 90 points, if exceed the deadline, every additional second will deduct 3 points until 10 points.
    - **2. Urgent**: Score is 60 points, if exceed the deadline, every additional second will deduct 2 points until 10 points.
    - **3. Normal:** Score is 30 points, if exceed the deadline, every additional second will deduct 1 point until 10 points.
    - **4. Free:** Score is 20 points, No delivery time restriction.

9.6.7   The robot needs to delivery as many items as possible.

9.6.8   The game will end after all items are delivered or the play time exceeds 6 Minutes.

9.7   Ranking

The teams are ranked as follows:

	Situation	Rank
Tier 1	Teams scored the same points by delivering.	Teams that consume less time will be ranked higher.
Tier 2	Teams have different scores at the end of the game.	Teams with higher scores will be ranked higher.

RCAP CoSpace Technical Committee

Contact us:

Rule clarification: cospace@robocupap.org

Technical support: support@CoSpaceRobot.org

RoboCup Asia-Pacific 2023

Team Description Paper

(Cover Page)

League Name:	
Age Group:	
Team Name:	
Team Website:	
Participants Name:	
Mentor Name:	
Institution:	
Region:	
Contact Person:	
Contact Email:	
Date:	

RoboCup Asia-Pacific 2023

Team Description Paper

League Name

Student 1, Student 2, …

Team Name, Institution, Country

1. Abstract

2. Introduction
    a. Team Background
    b. Team website (if you have one)
    c. Team photo (optional)
    d. Provide any video link (URL) related to your team and challenge if any (optional)
    e. Previous RoboCup or other robotics experience

3. Strategy
    a. Description of your AI strategy.
    b. Include flowcharts, tools, or pseudo code if appropriate.
    c. Describe and highlight innovative algorithms in any.

4. Track Record
    a. RoboCup Achievement
    b. Other robotics competition achievement

5. Discussion and Conclusion
    a. Share your team's learning experience
    b. Highlight collaboration with other teams if any
    c. Description of future work

6. Acknowledgements

7. References

APPENDIX B

PPT Presentation and Technical Demonstration Video

Guideline for PPT preparation:

1. Title/Identification
    - Team name, country, sub-league.
    - Team photos
2. Abstract
    - A concise summary of the entire project. The abstract should state
        - the problem(s) you investigated
        - the methods and key result
        - the conclusion
3. Strategy
    - Description of different types of the algorithms can be used to solve the problem
    - Which AI algorithm to be selected and used? Include flowcharts or pseudo code if appropriate.
    - Innovative ideas involved
4. Discussion and Conclusion
    - Teams should include the result when the selected AI algorithm is adopted.
    - How the result is improved.
5. Photos/Images
    - Teams should include images and graphics of the team's robots. Images and graphics should be original or should be available for non-commercial reuse with modification as per the creative commons license (http://creativecommons.org/).
6. Sharing
    - Share your team's learning experience
7. Additional Information
    - You may like to include all achievement in RoboCup / RCAP or other robotics competition achievement

Video Guideline

Each team should submit 1 video. The video is focusing on presentation and sharing.