RCAP CoSpace Rescue Rules 2022

RCAP CoSpace Rescue Challenge, University (Advanced)

These are the official rules for the RoboCup Asia Pacific (RCAP) 2022 CoSpace Rescue Challenge, University (Advanced). They are released by the RoboCup Asia Pacific CoSpace Rescue Technical Committee. The English rules have priority over any translations.

In the RCAP CoSpace Rescue Challenge University category, the following 2 challenges will be organized in 2022.

- Preliminary Challenge: CoSpace Rescue U19 simulator and competition rules will be adopted.
- Advanced Challenge: CoSpace Rescue (Vision) simulator and this competition rules will be adopted.

PREFACE

In RCAP CoSpace Rescue Challenge, teams have to develop and program appropriate strategies for both real and virtual autonomous robots to navigate through the real and virtual worlds to collect objects while competing with another team's robot that is searching and collecting objects in the same real and virtual worlds.

In the RCAP CoSpace Rescue Challenge, students need to make their own robot, code the robot, and finally take part in the CoSpace Rescue Challenge.

The RCAP CoSpace Rescue 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 Rescue Simulator download, help and assistance.

Figure 1.1: RCAP CoSpace Rescue Challenge, University (Advanced), World 2

Contents

1 Team

1.1. Team Members

1.1.1 A CoSpace Rescue team should consist of 1 to 4 members. Each participant can only register for one team. Each participant can only register for one team.

1.1.2 RCAP CoSpace Rescue University group challenge is exclusive to currently enrolled college and university students at the graduate and undergraduate levels.

1.1.3 Every team member need 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 Rescue Challenge.

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

1.2. Team Captain

1.2.1 The team leader is solely responsible for

- verifying the latest version of the rules prior to the competition. If any rule clarification is needed, please contact the RCAP CoSpace Technical Committee.
- coding for the virtual robot in the virtual world.
- uploading the correct code to the CoSpace Challenge server.
- communication with RCAP CoSpace Technical Committee and Organising Committee for all RCAP CoSpace Rescue Challenge related matters.

2 CoSpace Rescue Challenge (Online Version) Description

In the RCAP CoSpace Rescue Challenge University category, the following 2 challenges will be organized in 2022.

- Preliminary Challenge: CoSpace Rescue U19 simulator and competition rules will be adopted.
- Advanced Challenge: CoSpace Rescue (Vision) simulator and competition rules will be adopted.

2.1 Game process (Online Challenges)

2.1.1 For RCAP CoSpace Rescue Challenge University category (Online Version), students are only required code a virtual robot, and finally take part in the CoSpace Rescue Challenge. The game will last for 6 minutes and it will only take place in virtual world 2. It will be a singles game or counteract game.

2.2 VIRTUAL_WORLD

2.2.1 In VIRTUAL_WORLD, VIRTUAL_ROBOT searches for 5 types of objects, RED, CYAN, BLACK, SUPER and SUPER+ objects. VIRTUAL_ROBOT has to collect the objects and deposit them in the collection box to receive points. It cannot collect more than 6 objects at any one time without depositing them in the collection box.

2.2.2 SUPER or SUPER+ objects will be created upon every set of RED, CYAN and BLACK objects collected and deposited successfully in one single trip to the collection box (refer to section 5.2.1).

2.3 Competition Setup

2.3.1 A Team must be able to program VIRTUAL_ROBOT.

2.3.2 Virtual robots must be controlled autonomously.

2.3.3 The use of a remote control to manually control robots is not allowed.

3 Arena

3.1 Dimensions

3.1.1 The dimensions of WORLD_1 are 180cm x 240cm. The dimensions of WORLD_2 are 270cm x 360cm. The game will last for 6 minutes. Teams are only required to program the virtual robot in virtual world 2.

3.2 Floor

3.2.1 VIRTUAL_WORLD

- The VIRTUAL_WORLD is a 3D simulated environment. The floor is not restricted to white or light colour. However, the colour objects, collection box, special zones, etc., can still be distinguished.

3.3 Boundary

3.3.1 VIRTUAL_WORLD

- There will be no boundary for VIRTUAL_WORLD. Teams are required to keep the robot within the virtual arena based on the dimensions given. There will be an indication of the boundary for audience.

Appendix A shows the sample layout of REAL_WORLD and VIRTUAL_WORLD.

4 REAL_WORLD and VIRTUAL_WORLD Layout

Both WORLD_1 and WORLD_2 contains various elements as follows:

4.1 Markers

4.1.1 There may be some markers in the virtual worlds. The makers can be used to help the virtual robot for its localization, guidance, etc. The minimum size of the marker is 2cm x 2cm. The colour and shape of the marker is not fixed.

4.2 Special zones

4.2.1 Certain areas in the virtual world are designated as special zones. RED, CYAN and BLACK objects collected in these areas are worth double points. The special zone is blue in colour as shown in figure 3. The special zones have a minimum size of 30cm x 30cm. The shape of the special zone is not fixed.

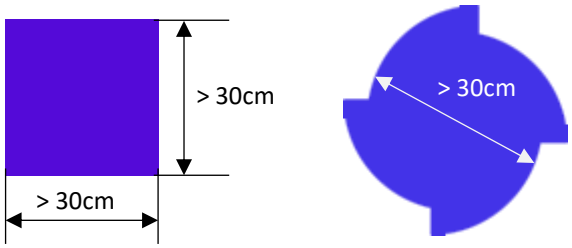


Figure 4.1: Sample of Special Zones

4.3 Obstacles

4.3.1 Obstacles found in virtual worlds can be of any size, any shape with the minimum dimensions of 10cm x10cm.

4.4 Traps

4.4.1 Traps in WORLD_1 are surrounded by a yellow boundary as shown in figure 4.1. The minimum size of the trap is 10cm x 10cm. The traps can be any colour. The shape of traps is not fixed. If a robot goes over a trap it will lose any objects it is currently carrying.

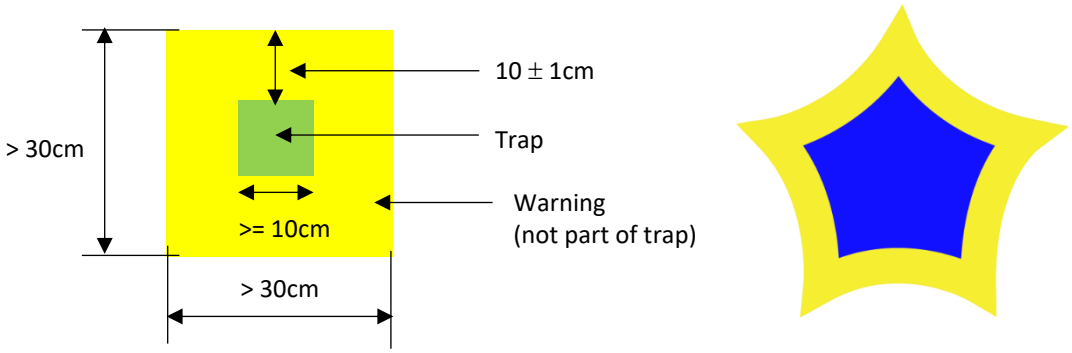


Figure 4.2: Sample of Traps in WORLD_1

4.4.2 Traps in WORLD_2 are surrounded by a yellow boundary as shown in figure 4.2. The minimum size of the trap is 10cm x 10cm. There is an AprilTags inside the trap.

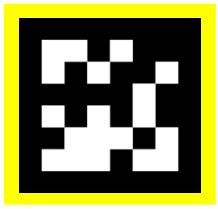


Figure 4.3 : Sample of Traps in WORLD_2

4.5 Object Collection Boxes

4.5.1 Figure 5.1 shows the object collection box in WORLD_1. The collection box is ORANGE in colour. The dimensions can be (30 ± 3) cm x (30 ± 3) cm. The collection box can be any shape.

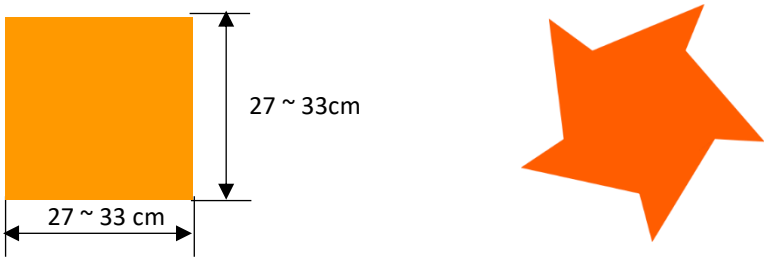


Figure 4.4: Sample of object collection boxes in WORLD_1

4.5.2 Figure 5.2 shows the object collection box in WORLD_2. Each collection box is pasted with an AprilTag, and the AprilTag is pasted on the side of the 3D object in the field. The robot can identify the AprilTag's attributes through its camera and confirm whether the collection box belongs to itself.

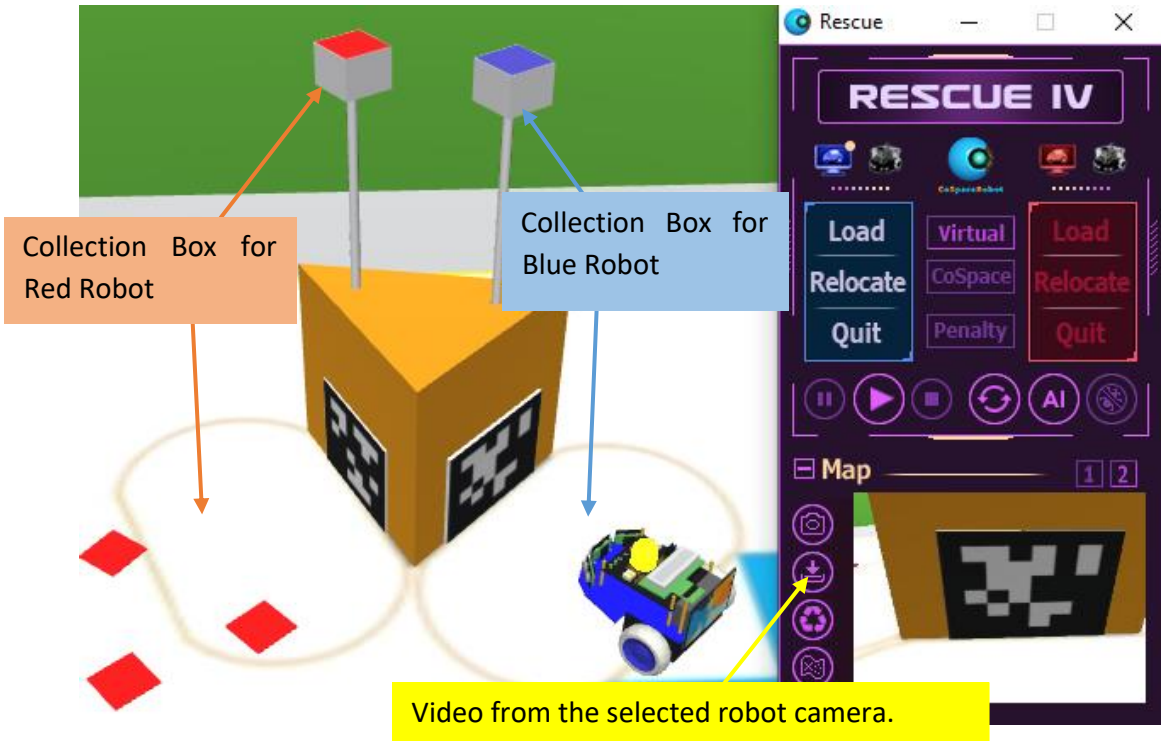


Figure 4.5: Sample of object collection boxes in WORLD_2

4.6 Robot Coordinates

4.6.1 Robot coordinates are not available in the CoSpace Rescue University Category Advanced challenge

4.7 Swamplands (University Group –WORLD_2 Only)

4.7.1 Certain areas in the WORLD_2 are designated as swamplands. The swampland is grey color as shown in figure 4.5. The swampland can be any size bigger than 30cm x 30cm. The shape of the swamplands is not fixed

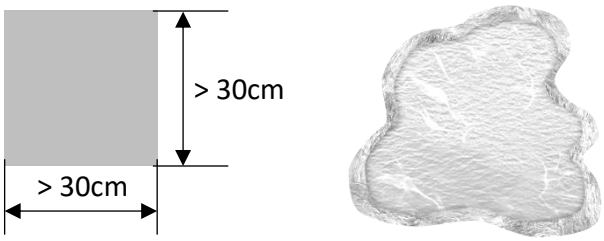


Figure 4.5: Sample of Swamplands

5 Objects

5.1 Basic Objects

5.1.1 There are THREE types of objects, RED, CYAN, and BLACK located randomly throughout the course. The thickness of each object is less than 2mm. Each type of objects worth different value (refer to section 7.4.2).

5.1.2 Colour, size and shape of the objects

Colour, size and shape of the objects will be different for FirstSteps, U12, U19 & University groups. Appendix B shows the details.

5.2 SUPER and SUPER+ Objects (University Group –WORLD_2 Only)

5.2.1 Creation of SUPER and SUPER+ objects

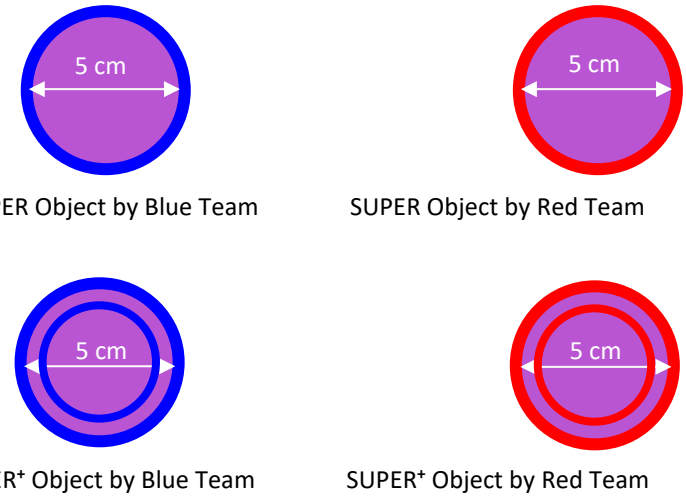
(a) ONE SUPER Object will be generated for every ONE set of RED, CYAN and BLACK objects collected and deposited successfully (refer to section 7.4.3) in the VIRTUAL_WORLD.

(b) ONE SUPER+ Object will be generated for every TWO sets of RED, CYAN and BLACK objects collected and deposited successfully (refer to section 7.4.3) in the VIRTUAL_WORLD.

(c) The SUPER or SUPER+ objects generated by BLUE team can only be collected by the BLUE team itself. The SUPER or SUPER+ objects generated by RED team can only be collected by the RED team itself.

5.2.2 Size, colour and shape of SUPER and SUPER+ objects

The SUPER and SUPER+ objects are about 5cm in diameter. They are circular in shape and purple in colour.



SUPER Object by Blue Team

SUPER Object by Red Team

SUPER+ Object by Blue Team

SUPER+ Object by Red Team

Figure 5.1: SUPER and SUPER+ objects

5.2.3 Placement of SUPER and SUPER+ objects

The CoSpace server will send the coordinates (X, Y) of the SUPER or SUPER+ objects to the respective team upon SUPER or SUPER+ objects' creation.

The details, such as SUPER and SUPER+ objects notification and the coordinates, are described in the CoSpace Rescue Simulator user guide.

6 Robot

6.1 VIRTUAL_ROBOT Configuration

6.1.1. The ROBOT has the following configuration:

- 3 ultrasonic sensors
- 1 gyro sensor
- 2 RGB sensors
- 2 DC motors
- 1 LED for status indication
- 1 Camera

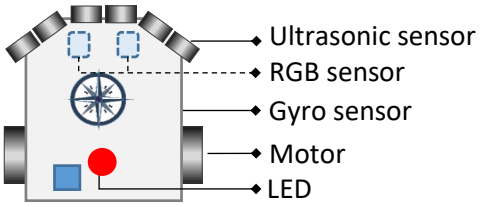


Figure 6.1: ROBOT configuration

6.2 Camera Configuration

6.2.1 The virtual robot in the CoSpace Rescue (Vision) simulator adds a front simulated camera to the above configuration.

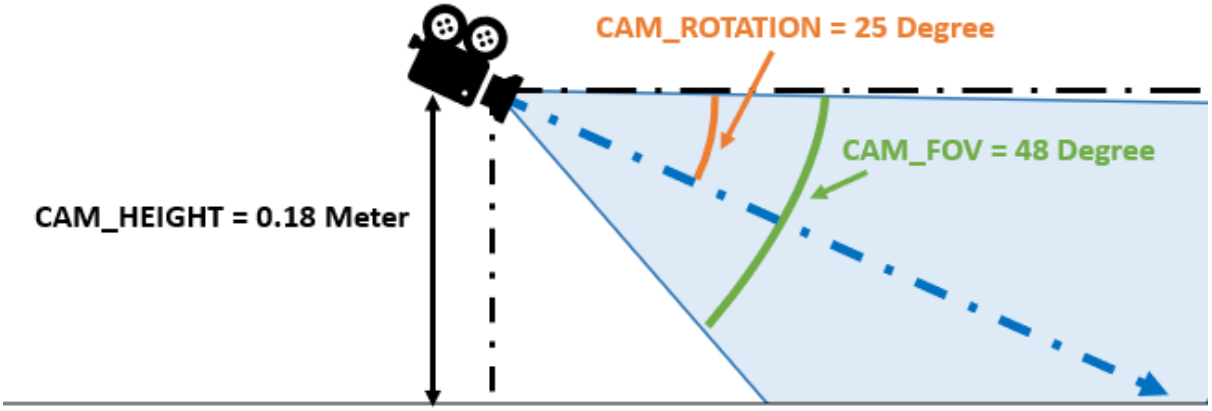


Figure 6.2: Camera configuration

6.2.2 Simulated camera parameters.

```
//Simulated Camera Parameters
#define CAM_HEIGHT   0.18      // Camera hight, in meters.
#define CAM_FOV      48        // Camera view angle in vertical axis, in degrees.
#define CAM_ROTATION   25    // Camera rotation in vertical axis, in degrees.

//Image Dimension
#define IMG_WIDTH   320
#define IMG_HEIGHT  240
```

6.3 ROBOT Control

6.3.1 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.

6.3.2 Any pre-mapped type of dead reckoning strategy (movements predefined based on known locations or placement of features in the field) is prohibited.

6.4 Lighting

6.4.1 The lighting condition for the virtual worlds could be varied. Teams must be able to perform calibration in order to complete the mission.

7 Gameplay

7.1 Pre-setup

7.1.1 The layout of the VIRTUAL_WORLD will be released to teams prior to the tournament. The organiser will announce the details.

7.2 Game Procedure

7.2.1 Teams are only required to program the virtual robot in virtual world 2. Teams must submit code to the CoSpace online server at the end of coding session. Multiple submission is allowed but only the last submission will be used in the game.

7.2.2 Start of Play

- It is the participant's responsibility to ensure that the correct program is uploaded.
- The official will download the program submitted, upload the programs onto the VIRTUAL_ROBOT, place it in the initial position in the starting point in the virtual world and start the virtual game.

7.3 Scoring

7.3.1 A team will be given 100 points at the beginning of each game.

7.3.2 Collecting objects

A team will gain points by collecting the objects.

To indicate that a robot has collected an object, it must stop and flash the LED for 3 seconds when any one of the color sensor has detected the object.

Object Type	Points in Real World		Points in Virtual World	
	Regular Zone	Special Zone	Regular Zone	Special Zone
RED	20	40	10	20
CYAN	30	60	15	30
BLACK	40	80	20	40
SUPER	NA	NA	90	90
SUPER+	NA	NA	180	180

(a) A robot cannot collect more than 6 objects at any one time without unloading or depository them in the collection box.

(b) Objects in the virtual world will disappear after they are collected.

(c) In RCAP CoSpace Rescue Challenges, the robot is considered to pick up an object successfully if

i. The robot detects an object using any one of the colours sensors

ii. The robot stops for 3 seconds with LED flashing

iii. The robot must move away from its stopping position autonomously at the end of 3 seconds.

7.3.3 Depositing objects

When a robot deposits objects successfully, the points of the objects deposited will be doubled.

"Robot deposits objects successful" means:

- A robot must stop inside the collection box with the LED steady ON for 3 seconds to indicate the depositing process;

  A robot is only considered to be in the collection box when the colour sensor detects the collection box (the colour sensor is in the collection box).

- The robot will exit the collection box autonomously after deposition (the colour sensor is out of the collection box).

7.3.4 Falling into a Trap

If a robot falls into a trap (refer to section 4.4), all objects that have been collected but not yet placed in the object collection box (refer to section 4.5) will disappear. Therefore, the points awarded for those objects collected will be deducted.

A robot is considered to be in the trap if any one of the robot's color sensor has detected the trap.

7.3.5 Falling into a Swampland (University Group – VIRTUAL_WORLD Only)

If a robot falls into a swampland (refer to section 4.7), the robot's speed will be reduced by 80% by the CoSpace server.

A virtual/real robot is considered to be in a swampland if any one of the color sensor has detected the swampland.

7.3.6 Falling into a Signal Block Zone (University Group – VIRTUAL_WORLD Only)

If a robot falls into a signal block zone, no points will be deducted. However, the robot's position info (refer to 4.8) will be lost.

A virtual robot is considered to be in a signal block zone if the centre of the robot is within the zone. The centre coordinates is provided to teams by the CoSpace server.

7.3.7 Out of Boundary (RCAP CoSpace Rescue Challenge, University – VIRTUAL_WORLD Only)

If a robot is out of the boundary, it will be placed inside VIRTUAL_WORLD by the CoSpace server automatically. No points will be deducted. However, it will be frozen for 10 seconds.

A virtual robot is considered out of boundary if the centre of the robot is outside the VIRTUAL_WORLD.

7.3.8 Game Points

After each match, following GAME POINTS will be given accordingly.

Game	GAME POINTS
Win	3
Tie	1
Loss	0

7.4 Human Interference

7.4.1 Except for a lack of progress, human interference (e.g. re-locate a robot to any reset point) during the game is not allowed unless permitted by the referee. A violation of the rules may be penalized by disqualification from the tournament, the round or may result in loss of points at the discretion of the referee, officials, organizing committee or general chairs.

7.5 Relocation

7.5.1 In virtual game, the team captain can request to relocate the VIRTUAL_ROBOT to a different location for the following case:

(a) VIRTUAL_ROBOT is looping

(b) VIRTUAL_ROBOT is not performing well.

Upon team's request, the referee will call "RELOCATE" and relocate the VIRTUAL_ROBOT to a different location but close to where it was with different orientation. However, the robot will be frozen for 10 seconds after relocation. Each team can only call relocation up to 3 times in VIRTUAL_WORLD in each game. The referee will keep track of the number of relocations requested.

7.5.2 In virtual game, when a virtual robot is stuck for 10 seconds, the robot will be relocated to a different location but close to where it was with different orientation by the CoSpace server automatically. After relocation, the VIRTUAL_ROBOT will not be frozen for another 10 seconds. The relocation by CoSpace server will not be recorded as in section 7.5.1.

7.5.3 A team may decide to stop a round early if the lack of progress cannot be resolved within the first 5 minutes. In this case, the team captain must indicate to the referee the team's desire to terminate the game. The team will be awarded all points achieved.

7.6 Penalty

7.6.1 The following are strictly prohibited. Offenders will be disqualified from the RCAP 2022.

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

7.6.2 In the challenge program, please do not use functions such as Print() that need to generate output in the console.

7.6.3 It is compulsory for teams to specify the team name in virtual games. Teams will be given a verbal warning if they failed to do so for the first time. The team will be disqualified for the current game if the team fails to add the team name for the second time in a virtual game.

7.6.4 If a robot is hit/attacked by another virtual/real robot, the attacking robot will be separated from the attacked robot and repositioned at the same location with different orientation (if there is collision), and be frozen for 10 seconds. There will be no point deduction.

7.6.5 If two robots bump into each other, both robots will be separated from each other and repositioned at the same location with different orientation (if there is collision). Both robots will be frozen for 10 seconds. There will be no point deduction.

7.7 Interruption of Game

7.7.1 In principle, a game will not be stopped during gameplay.

7.7.2 The referee can end a game when all objects have been collected by the robots.

7.7.3 The referee can pause a game when the game coordinator/referee needs to discuss an issue/problem with the OC/TC. The game will be called “time-out” in this case.

7.7.4 Teams are not allowed to quit a game 5 minutes after the game started.

8 Conflict Resolution

8.1 Referee

8.1.1 During a gameplay, the referee’s decisions are final.

8.2 Rule Clarification

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

8.3 Special Circumstances

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

8.3.2 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 8.3.1, it will be considered as an endorsement.

9 Documentation

9.1 Team Description Paper (TDP), PPT Presentation and Technical Demonstration Video

9.1.1 Each team is required to submit a TDP, PPT Presentation and Technical Demonstration Video prior to the challenge day (details should announced by the RCAP CoSpace Challenge Organizing Committee). Please refer to Appendix C & D for the detailed guidelines.

10 Judging

10.1.1 There will be 2 round of challenges – Preliminary round and the final.

10.1.2 Teams will be judged based on TDP, video presentation and the prelim result. Teams have passed the assessment criteria will enter the finals.

11 Awards

The RCAP organising committee will announce the awards.

12 Code of Conduct

12.1 Fair Play

12.1.1 CoSpace Rescue Challenge is built upon the foundation of fairness, respect and friendship.

12.1.2 Mentors (teachers, parents, chaperones, translators, and other adult members) are not allowed to be involved in the programming of students' robots or perform other assistance work.

12.2 Sharing

12.2.1 Teams are encouraged to share their programming and strategies with members after the competition.

12.2.2 Any developments may be published on the CoSpace Robot website after the event.

12.2.3 RCAP CoSpace Rescue sharing furthers the mission of RoboCup Asia Pacific as an educational initiative.

12.3 Spirit

12.3.1 It is expected that all participants (students and mentors alike) will respect the RoboCup Asia Pacific mission.

12.3.2 It is not whether you win or lose, but how much you learn that counts!

Rule clarification: cospace@robocupap.oeg

Technical support: support@CoSpaceRobot.org

13 APPENDIX A: Competition Setup

13.1 REAL_WORLD

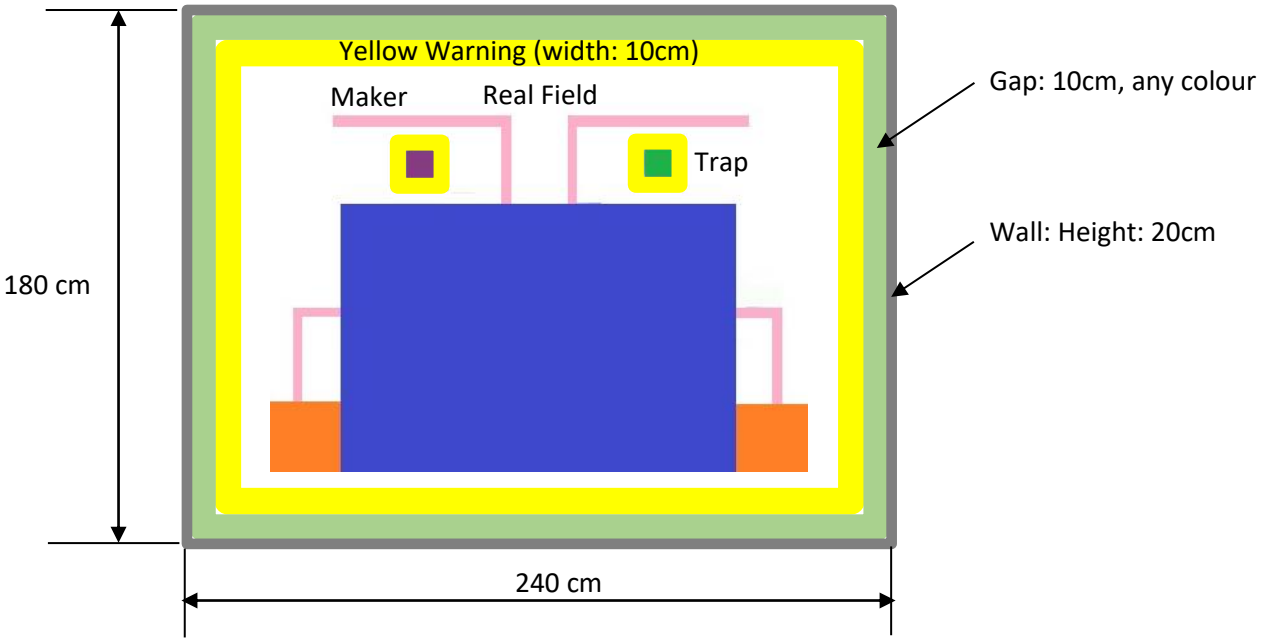


Figure 13.1: REAL_WORLD Setup

13.2 VIRTUAL_WORLD (U12 & FirstSteps Group):

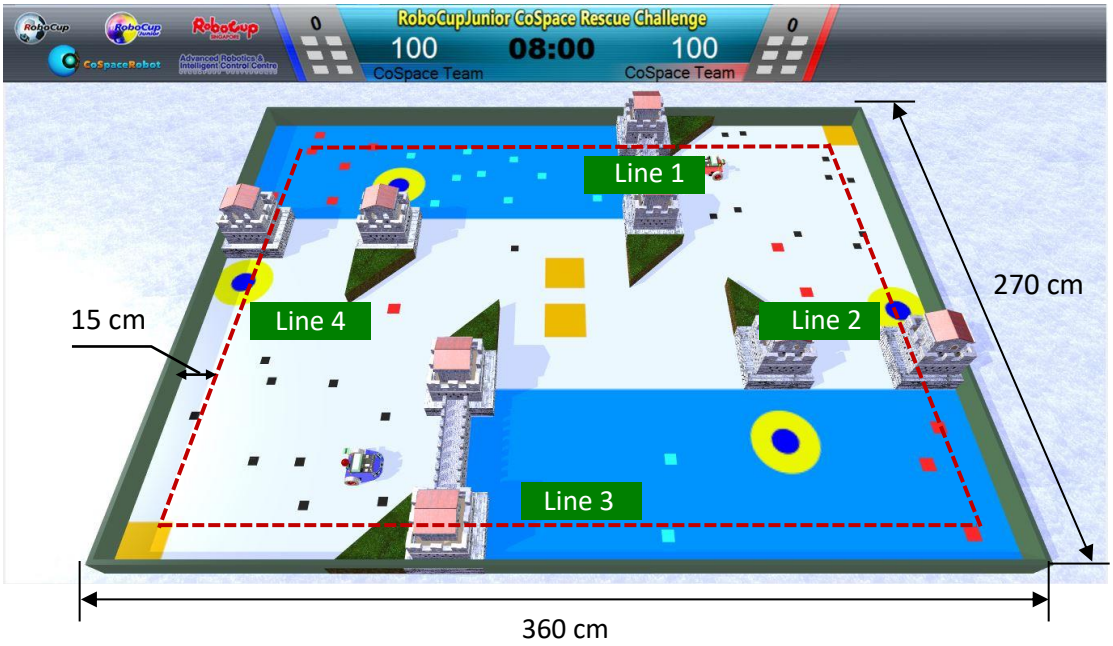


Figure 13.2: RCAP CoSpace Rescue Challenge, U12 & FirstSteps, VIRTUAL_World

- The SUPER and SUPER+ objects will be placed 15cm away from the wall (indicated by the dash-lines in the diagram; however, the dash-line will not be shown in the VIRTUAL_WORLD) upon generation.

13.3 VIRTUAL_WORLD (U19 & University(Preliminary))

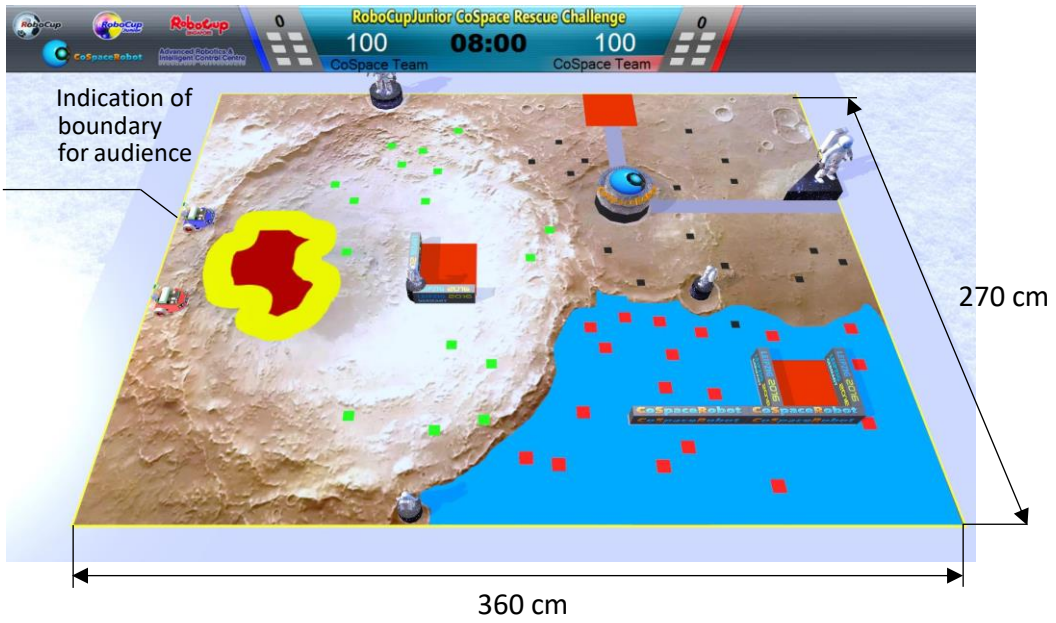


Figure 13.3: RCAP CoSpace Rescue Challenge, U19 & University (Preliminary), VIRTUAL_World

- The coordinates of virtual robots, special zones, collection boxes, traps, signal block zones will be provided to teams.
- The coordinates of SUPER and SUPER+ objects will be sent to team that generates the objects.

13.4 VIRTUAL_WORLD (University (Advanced))

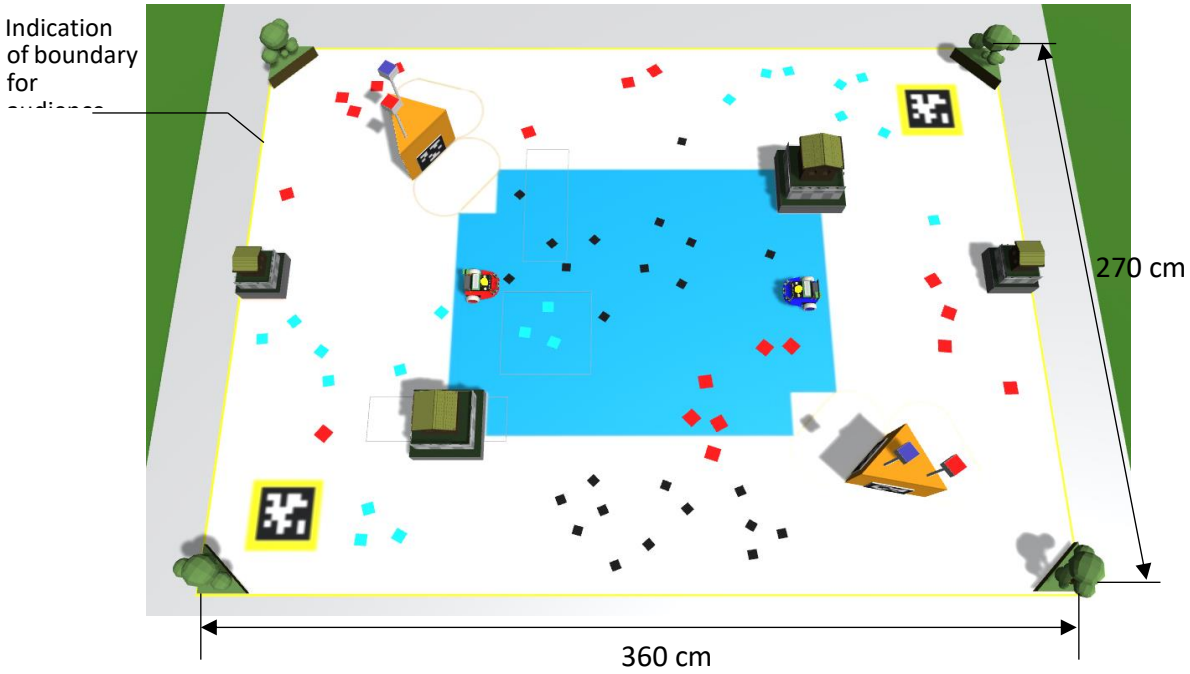


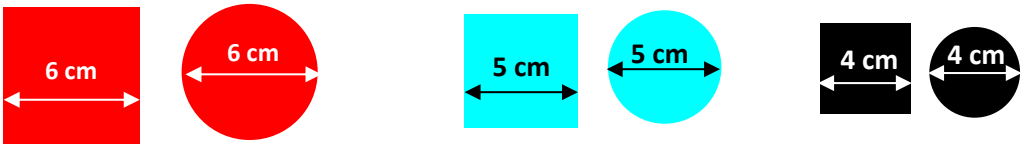
Figure 13.4: RCAP CoSpace Rescue Challenge, University (Advanced), VIRTUAL_World

- Robot coordinates are not available in the RCAP CoSpace Rescue Challenge, University (Advanced).

14 APPENDIX B: List of Objects

14.1 U12 & FirstSteps Group

The colour, shape, and size of objects is fixed. They are square or round shape in general.



RED CYAN BLACK

Figure 14.1: List of Objects, U12 & FirstSteps Group

14.2 U19 & University Group

- Shape: The shape of the objects will be any one of the following. There might be different shapes of objects in a map.

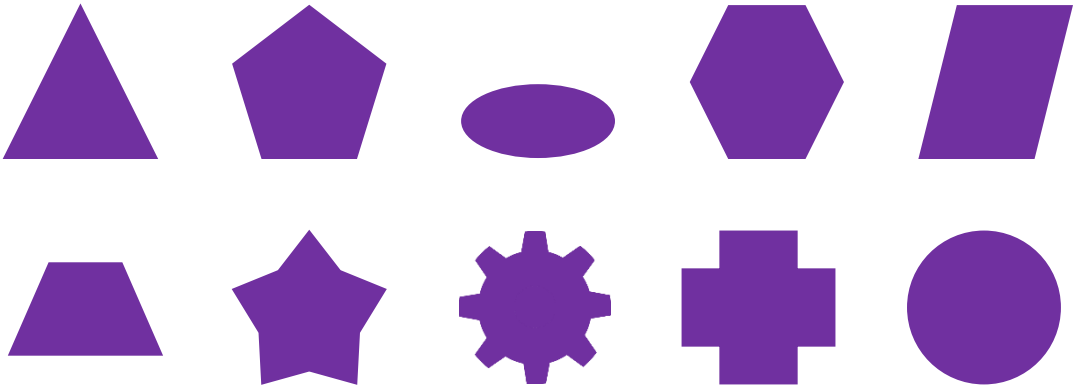
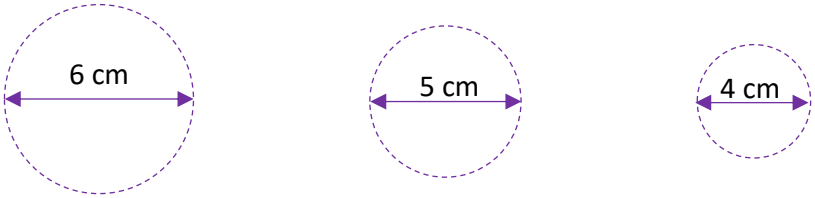


Figure 14.2: List of Objects, U19 & University Group

- Size: the inscribed circle for the 3 types object are:



- Colour: the colour of the objects will be in the RED/ CYAN categories or BLACK.

RED CYAN BLACK

15 APPENDIX C

Virtual RoboCup Asia-Pacific 2022

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.

16 APPENDIX D

Virtual RoboCup Asia-Pacific 2022

Team Description Paper

(Cover Page)

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

Virtual RoboCup Asia-Pacific 2022

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 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

Rule clarification: cospace@robocupap.org
Technical support: support@CoSpaceRobot.org