# RoboCupJunior CoSpace Rescue Rules 2015

RoboCupJunior CoSpace Technical Committee 2015:

Martin Bader (Germany), martin_bader@gmx.de
Lisette Castro (Mexico), ettesil77@hotmail.com
Tristan Hughes (UK), tristanjph@gmail.com
Jiayao Shen (Singapore), jyshen@sp.edu.sg (Chair)


RoboCupJunior CoSpace Technical Consultant:

Tianwu Yang (Singapore), yangtw@sp.edu.sg

**This document contains the official rules for RoboCupJunior CoSpace Rescue 2015, and is released by the RoboCupJunior CoSpace Technical Committee. The rules contained in this document have priority over any translations.** Differences between the RoboCupJunior CoSpace Rescue 2014 rules and the RoboCupJunior CoSpace Rescue 2015 rules are highlighted in red.


## PREFACE

In CoSpace Rescue, 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.

The CoSpace Rescue Simulator can be downloaded at http://www.cospacerobot.org.


## GENERAL RULES

### 1.    GAME DESCRIPTION

### 1.1    Game Process

1.1.1    A game lasts 8 minutes, with two teams competing in one game. A game consists of WORLD_1 and WORLD_2. A team has one robot in each WORLD as shown in figure 1.

- ROBOT_1 can spend between 3-5 minutes in WORLD_1
- ROBOT_2 will spend the remaining time in WORLD_2.

1.1.2    A team must program their ROBOT_1 and ROBOT_2 to navigate and collect objects in WORLD_1 and WORLD_2. A team must end the ROBOT_1 and activate the ROBOT_2 when transferring from WORLD_1 to WORLD_2 (refer section 1.3).

1.1.3    Only one robot can move at any one time. When ROBOT_1 moves in WORLD_1, ROBOT_2 must be in standby mode. When the ROBOT_2 is activated, ROBOT_1 stops until the end of the game.

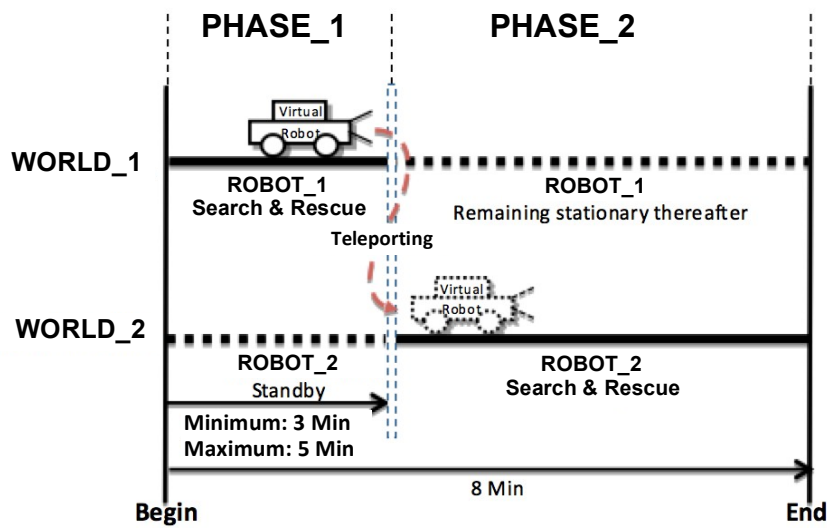Figure 1: CoSpace Rescue Game Process

## 1.2 PHASE_1

1.2.1 A game begins with ROBOT_1 navigating in WORLD_1.

1.2.2 In the WORLD_1, ROBOT_1 searches for 3 types of objects, RED, GREEN, and BLACK objects. ROBOT_1 has to collect the objects and then 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.

1.2.3 Bonus points will be awarded for every set of RED, GREEN and BLACK objects collected and deposited in one single trip to the collection box (refer to section 4.7.4).

## 1.3 Teleportation

Teleportation means ending ROBOT_1's movement in WORLD_1 and activating the team's ROBOT_2 in WORLD_2.

1.3.1 A team needs to teleport their ROBOT_1 at any time after 3 minutes but before the first 5 minutes passed whilst ending the ROBOT_1's movement.

1.3.2 Teleportation within the first 3 minutes is invalid.

1.3.3 If a team fails to teleport by the end of the first 5 minutes, ROBOT_2 will be activated by the CoSpace server automatically (refer to section 4.7.5).

## 1.4 PHASE_2

1.4.1 In WORLD_2, ROBOT_2 searches for 5 types of objects, RED, GREEN, BLACK, SUPER and SUPER$^+$ objects. ROBOT_2 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.

1.4.2 SUPER or SUPER$^+$ objects will be created upon every set of RED, GREEN and BLACK objects collected and deposited in one single trip to the deposition area (refer to section 2.12).

## 1.5    Competition Setup

1.5.1    Primary Category

In the primary category, the ROBOT_1 and ROBOT_2 are virtual robots. Both WORLD_1 and WORLD_2 are virtual environments.

1.5.2    Secondary Category

In the secondary category, the ROBOT_1 is real and ROBOT_2 is virtual. WORLD_1 is a real arena and WORLD_2 is a virtual environment.

A team must program both real and virtual robots and establish communication between them in order to teleport from WORLD_1 (real) to WORLD_2 (virtual).


# 2.    ARENA

## 2.1    Layout

2.1.1    Primary Category:

Both WORLD_1 and WORLD_2 contain objects, obstacles, traps, markers, object collection boxes and special zones.

Appendix A shows the sample layout of WORLD_1 and WORLD_2 for the primary category.

2.1.2    Secondary Category:

Both WORLD_1 (real) and WORLD_2 (virtual) contain objects, obstacles, traps, markers, object collection boxes and special zones. The WORLD_2 also contains swamplands and signal block zones.

Appendix B shows the sample layout of WORLD_1 and WORLD_2 for the secondary category.

## 2.2    Dimensions

2.2.1    The dimensions of WORLD_1 are 180cm x 240cm. The dimensions of WORLD_2 are 270cm x 360cm.

## 2.3    Floor

2.3.1    Primary Category

The floor of both WORLD_1 and WORLD_2 is generally white.

2.3.2    Secondary Category

(a)  WORLD_1 (Real World):

- The floor of WORLD_1 is generally white. The floor may be either smooth or textured.
- The real world will be placed so that the floor is level.

(b)  WORLD_2 (Virtual World):

- The virtual world is a 3D simulated environment (Refer to appendix B). The floor is light colour, such as white, light green, light blue, etc.

## 2.4    Boundary

2.4.1    Primary Category

WORLD_1 and WORLD_2 will be enclosed by a wall of height 20cm.

2.4.2    Secondary Category

- ▪ The outer edge of the WORLD_1 is covered by a 10cm wide yellow boundary (refer to Appendix B). The yellow boundary serves as warning area and it is used to prevent the real robot from moving out of the real arena.

- ▪ There will be no boundary for WORLD_2. Teams are required to use the coordinates of this area to keep the robot within the virtual arena. There will be an indication of the boundary for audience.

## 2.5    Markers

2.5.1    There may be some markers in the virtual/real worlds. The makers can be used to help the virtual/real 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.

## 2.6    Obstacles

2.6.1    Obstacles found in real and virtual worlds can be of any size, any shape with the minimum dimensions of 10cm x 10cm x 10cm.

## 2.7    Special Zones

2.7.1    Certain areas in the virtual/real world are designated as special zones.  RED, GREEN and BLACK objects collected in these areas are worth double points.  The special zone is blue in colour as shown in figure 2. The special zones have a minimum size of 30cm x 30cm. The shape of the special zone is not fixed.
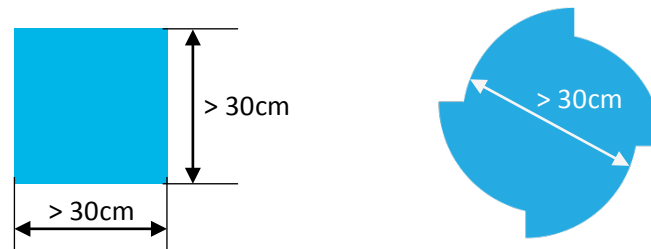
Figure 2: Sample of Special Zones

## 2.8    Traps

2.8.1    Traps are surrounded by a yellow boundary as shown in figure 3. 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.
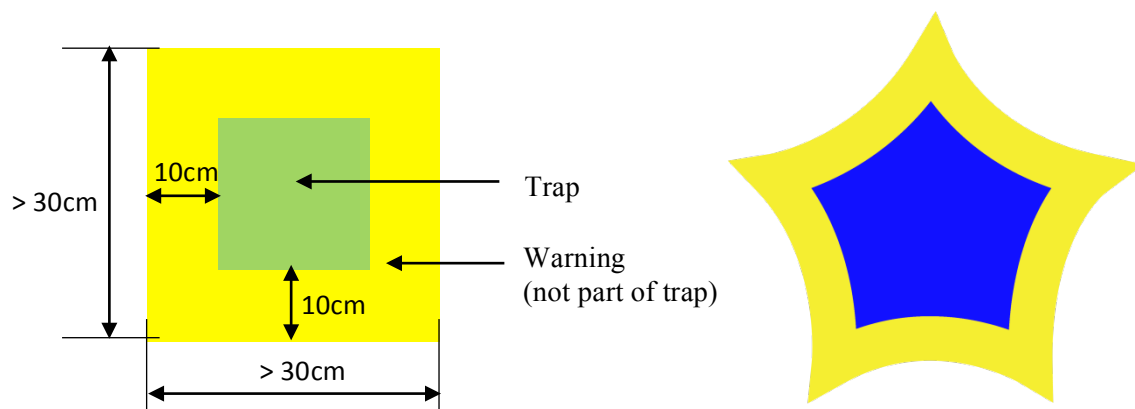
Figure 3: Sample of Traps

## 2.9    Swamplands (Secondary Category – WORLD_2 Only)

2.9.1    Certain areas in the WORLD_2 are designated as swamplands. The swampland is grey colour as shown in figure 4. The swampland can be any size bigger than 30cm x 30cm. The shape of the swamplands is not fixed.
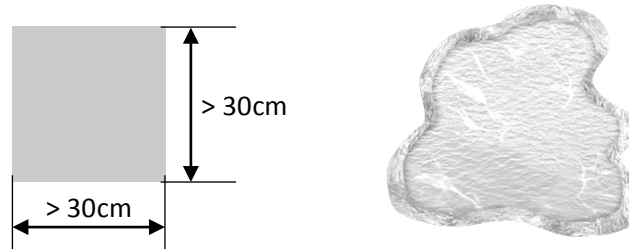


Figure 4: Sample of Swamplands

## 2.10    Signal Block Zone (Secondary Category – WORLD_2 Only)

2.10.1    While the robot is searching in the WORLD_2, the CoSpace Server will send the robot its own coordinates. When the robot enters a signal block zone, its coordinates information will be blocked, meaning teams will have ZERO coordinate information in this zone.

## 2.11    Objects

2.11.1    There are THREE Objects, RED, GREEN, and BLACK objects, located in random location throughout the course. The thickness of each object is less than 2mm. Each type of objects worth different value (refer to section 4.7.2).

2.11.2    Colour, size and shape of the objects

(a)  Primary Category:

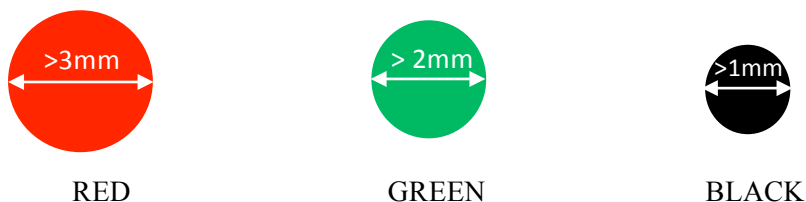The colours and size of objects are fixed. Figure 5 shows the sample of the objects.
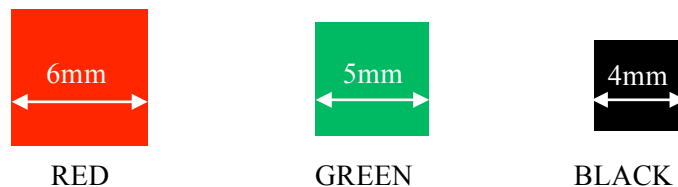


Figure 5: Sample of objects for primary category

(b)  Secondary Category

The objects can be any shape. The minimum dimensions of each object are shown in Figure 6.



Figure 6: Sample of objects for secondary category

## 2.12 SUPER and SUPER$^+$ Objects (WORLD_2 Only)

2.12.1 Creation of SUPER and SUPER$^+$ objects

- ONE SUPER Object will be generated for every ONE set of RED, GREEN and BLACK objects collected and deposited (in one single trip to the Collection Box, refer to section 2.13) in the WORLD_2. ONE SUPER$^+$ Object will be generated for every TWO sets of RED, GREEN and BLACK objects collected and deposited (in one single trip to the Collection Box) in the WORLD_2.

- 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.

2.12.2 Size, colour and shape

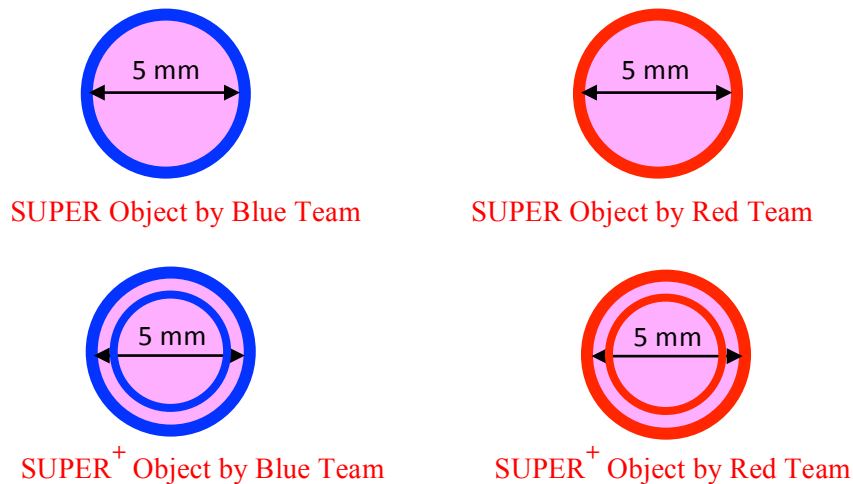The SUPER and SUPER$^+$ objects are about 5mm in diameter. They are circular in shape and purple in colour.



SUPER Object by Blue Team      SUPER Object by Red Team

SUPER$^+$ Object by Blue Team      SUPER$^+$ Object by Red Team

Figure 7: SUPER and SUPER$^+$ objects

2.12.3 Placement of SUPER and SUPER$^+$ objects

(a) Primary Category

The SUPER and SUPER$^+$ objects will be placed on the lines 15 cm away from the wall (Refer to Appendix A). The line reference number (Line 1, 2, 3, or 4) will be sent to the respective team upon the SUPER and SUPER$^+$ objects' creation.

(b) Secondary Category

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. (See Figure 8)
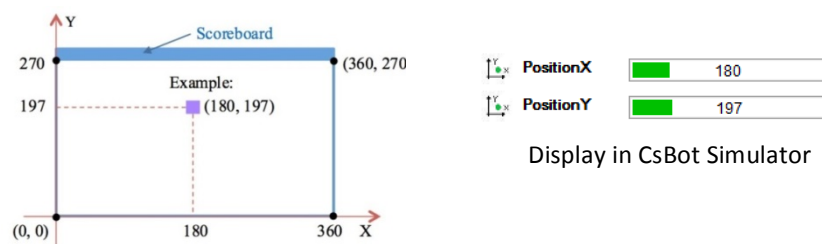


Figure 8: X & Y coordinate system for WORLD_2

## 2.13 Object Collection Boxes

2.13.1 Figure 9 shows the object collection box. The collection box is ORANGE in colour. The dimensions can be less than 30m x 30cm. The collection box can be any shape.
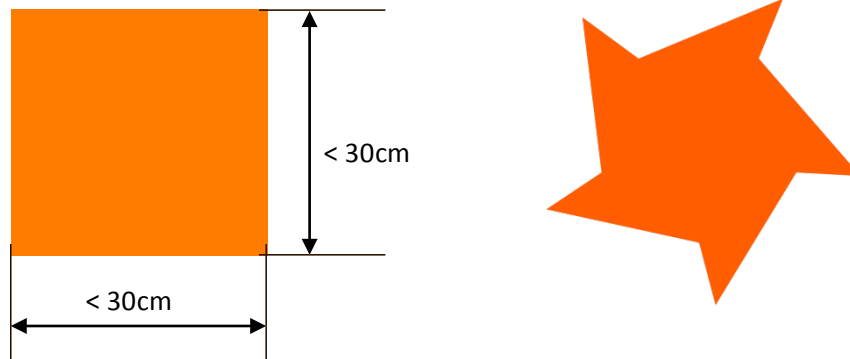


Figure 9: Sample of object collection boxes

## 2.14 Lighting

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

2.14.2 Picture taking by spectators might create IR and visible light into the real world setup and to the real robots. Whilst efforts will be made to limit this, it is very difficult for organisers to strictly control factors outside of the real world. Teams are strongly encouraged to program their real robots so that sudden changes (eg. camera flash) do not cause major problems.

2.14.3 Every effort will be made by the organizers to locate the real world away from sources of magnetic fields such as under-floor wiring and metallic objects, however, sometimes this cannot be avoided.

## 3. REAL ROBOTS (Secondary Category Only)

In RCJ2015, the organizer will provide the real robots (standard platform) for secondary teams during the competition. ZigBee communication protocol is used in the CoSpace robot platform for establishing the real/virtual robot communication. Self-built robots are not allowed.

## 3.1 Control

3.1.1 Virtual/real robots must be controlled autonomously.

3.1.2 The use of a remote control to manually control virtual/real robots is not allowed.

## 3.2 Communication

3.2.1 ROBOT_1 (real) must be fully autonomous. It navigates and collects objects in WORLD_1(real). The minimum duration of ROBOT_1 movement is 3 minutes and maximum duration is 5 minutes.

3.2.2 Teams need to setup the communication between ROBOT_1 and CoSpace server so that the team can teleport their robots from WORLD_1 to WORLD_2.

3.2.3 Teleportation within the first 3 minutes is invalid.

3.2.4 If a team fails to transport within the first 5 minutes, the CoSpace server will stop ROBOT_1 and activate ROBOT_2 automatically.

# 4.     GAMEPLAY

## 4.1     Pre-setup

4.1.1    The layout of both WORLD_1 and WORLD_2 will be released to teams prior to the tournament.

## 4.2     Pre-round Practice (Secondary Category Only)

4.2.1    Wherever possible, teams will have an access to a practice field for calibration. Teams can calibrate their sensors ONLY before a game at the real field. Calibration is defined as the taking of sensor readings and modifying of the real robot's program to accommodate such sensor readings. Calibration can be done in as many locations as desired.

## 4.3     Humans

4.3.1    As the space around the competition fields is limited (and crowds can result in accidents to robots) teams should designate one member who will act as "captain" and be allowed to move the real robot, based on the stated rules and as directed by the referee.

4.3.2    The "captain" can move the real robot only when directed to by the referee.

4.3.3    Other team members (and any spectators) within the vicinity of the real world are to stand at least 150 cm (approximately  60 inches) away from the real world while their real robot is active, unless otherwise directed by the referee.

## 4.4     Game Procedure

4.4.1    A referee is an official who receives and uploads teams' programs as well as runs the games.

4.4.2    Teams should report to the registration counter at least 5 minutes before their game starts. Teams can be penalized by 20 points per minute at the Referee's discretion if they are late for the game start (teams will be given 100 points at the beginning of the game). Teams that are 5 minutes late for the time of their game will forfeit the round; therefore, the opponent will gain 500 points and be declared the winner.

## 4.5     Pre-match Meeting

4.5.1    Each team will be assigned a team colour (BLUE or RED). At the start of the game, the referee will toss a coin. The result of which determines the colour the teams use.

## 4.6     Start of Play

4.6.1    Real game (Secondary Category Only)

Teams should program and download it onto the real robot before the real game. The team "captain" is responsible for placing the real robot in the real WORLD_1 and starting the robot manually according to referee's instruction. It is team's responsibility to ensure that the correct program is downloaded to the correct robot.

4.6.2    Virtual game

Teams should give their program to the referee 10 minutes before the game starts. The referee will upload the programs to the CoSpace server, place the team's robot in the starting point in the virtual world and start the virtual game. It is team captain's responsibility to ensure the correct program is uploaded.

## 4.7     Scoring

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

4.7.2    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 colour sensor has detected the object.*

| Object Type | Points in Real World (Secondary only) | | Points in Virtual World | |
|---|---|---|---|---|
| | Regular Zone | Special Zone | Regular Zone | Special Zone |
| RED | 20 | 40 | 10 | 20 |
| GREEN | 30 | 60 | 15 | 30 |
| BLACK | 40 | 80 | 20 | 40 |
| SUPER | NA | NA | 90 | 90 |
| SUPER$^+$ | NA | NA | 180 | 180 |

(a) A real/virtual robot cannot collect more than 6 objects at any one time without placing them in the collection box.

(b) Objects in the real world will NOT disappear after it is collected. It is team's responsibility to move their real robot away from the real object and search for others. Collecting the same objects consecutively will not be counted.

(c) Objects in the virtual world will disappear after it is collected.

4.7.3    Depositing objects

When a robot successfully deposited an object in the collection box and exited the deposition area, the points of the objects deposited will be doubled. If the robot gets stuck, the points will not be doubled.

*A robot must stop and turn on the LED for 3 seconds (with a steady light) to indicate that it deposited an object. A robot is only considered to be in the collection box when both colour sensors detect the collection box.*

4.7.4    Bonus Points (only for WORLD_1)

(a) For every ONE set of RED, GREEN and BLACK objects collected and deposited (in one single trip to the collection box) in WORLD_1, 90 bonus points will be rewarded.

(b) For every TWO sets of RED, GREEN and BLACK objects collected and deposited (in one single trip to the collection box) in WORLD_1, 180 bonus points will be rewarded.

4.7.5    Communication

(a) For successful teleportation, teams will be given 100 bonus points. Team can choose the location in WORLD_2 that robot will be teleported to.

(b) For unsuccessful teleportation, the robot will be placed to a random location in WORLD_2 by the CoSpace server. No bonus points will be given.

4.7.6    Falling Into a Trap

If a virtual/real robot falls into a trap (refer to section 2.8), the robot will be frozen for 10 seconds, then be placed at the starting point. All objects that have been collected but not yet placed in the object collection box (refer to section 2.13) will disappear. Therefore, the points awarded for those objects collected will be deducted.

*A virtual/real robot is considered to be in the trap if any one of the robot has detected the trap.*

4.7.7    Falling Into a Swampland (Secondary Category - WORLD_2 Only)

If a robot falls into a swampland (refer to section 2.9), 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 colour sensor has detected the swampland.*

4.7.8 Falling Into a Signal Block Zone (Secondary Category - WORLD_2 Only)

*A virtual/real 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 in the CsBot Rescue Simulator.*

4.7.9 Out Of Boundary (Secondary Category - WORLD_2 Only)

*A virtual/real robot is considered out of boundary if the centre of the robot is outside the WORLD_2.*

4.7.10 Game Points

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

| Game | GAME POINTS |
|------|-------------|
| Win | 3 |
| Draw | 1 |
| Loss | 0 |

## 4.8 Human Interference

4.8.1 Except for a lack of progress, human interference (e.g. re-locate a real/virtual robot to any reset point) during the game is not allowed unless permitted by the referee. A violating team can be disqualified from the game.

4.8.2 In any case, only the team captain is allowed to communicate with the referee.

## 4.9 Lack of Progress

4.9.1 Lack of progress occurs when there is no progress in a game play for 10 seconds and the situation is not likely to change. A typical lack of progress situation is when a real/virtual robot is stuck. The referee will call "lack of progress" and will move the robot to a different location but close to where it was located.

4.9.2 A team may decide to stop a round early if the lack of progress cannot be resolved. 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.

## 4.10 Penalty

4.10.1 It is compulsory for teams to specify the team name in virtual games. Teams will be given a yellow card if they failed to do so for the first time. A red card will be given if the team fails to add the team name for the second time in a virtual game.

4.10.2 If a virtual/real 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.

4.10.3 If two virtual/real robots bump into each other, both robots will be separated from each other and repositions 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.

4.10.4 For the Secondary Category, if a real robot moves out of boundary, the robot will be frozen for 10 sec and then be placed inside the competition arena. There will be no point deduction.

4.10.5 If a robot repeats its action for at least 10 seconds (looping – one type of "lack of progress"), team captain can request to move the robot to a different location but close from where it was located. However, the robot will be frozen for 10 seconds after relocation.

**4.11    Interruption of Game**

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

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

4.11.3 The referee can stop 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.

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


# 5.    CONFLICT RESOLUTION

**5.1    Referee**

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

**5.2    Rule Clarification**

5.2.1 Rule clarification may be made by the members of the RoboCupJunior CoSpace Technical Committee.

**5.3    Special Circumstances**

5.3.1 Specific modifications to the rules to accommodate special circumstances, such as unforeseen problems and/or capabilities of a team's robot, may be agreed upon at the time of the tournament when majority of the contestants agree with the proposed modifications.


# 6.    DOCUMENTATION

**6.1    Learning Journal**

Each team must bring a learning journal or any form of documentation describing the information about the team, their preparation efforts in programming and how they prepared for RoboCupJunior. The learning journal must be presented during the interview, and may be called upon to help establish the authenticity of a team's performance.

**6.2    Poster**

Teams will be given some public space to display their poster. The size of the poster should be no larger than A1 (60 x 84 cm). The poster should be brought along to the technical interview. After the interview the poster should be displayed in the location indicated.
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 location within country;
- Team's school and district;
- Development of the searching and placement strategies.
- Any interesting or unusual features of their programs;
- What the team hopes to achieve in robotics.

# 7.    JUDING AND AWARD

**7.1    Interview**

7.1.1   It is compulsory for all teams to attend the technical interview.

7.1.2   Teams are required to present the learning journal or posters for the interview. Teams may take the interview score sheet for reference while preparing their interview.

7.1.3   Interviews will take place in English, if teams require a translator they should inform the local organizing committee by e-mail prior to the event to allow translators to be organized.

7.1.4   Teams may be asked to have second interview if judges consider it is necessary.

**7.2     Technical Challenge** (Note: Rule 7.2 applies specifically for the World Championship)

7.2.1   It is compulsory for teams to take part in the Technical Challenge. The task will be released on site. Teams are not allowed to bring a pre-written program to attempt the challenge. During the challenge, teams will not be allowed to consult mentors or other students who are not participating in the technical challenge.

7.2.2   Primary age group:

All members are required to work as a team to take part in the Technical Challenge.

7.2.3   Secondary age group:

50% or more of team members are required to attend the Technical Challenge. i.e. minimum 2 members are required for a team of 4. Minimum 3 members are required for a team of 5. Each member will work on the task independently. The average score will be considered as the team result.

**7.3     Best Programmer Challenge**

7.3.1   The Best Programmer Challenge is not compulsory for every participant. Only participants aiming for the Best Programmer Award is required to sit in the Challenge.

7.3.2   Participants can only take part in the challenge as individual candidate.

**7.4     Winner**

7.4.1   Round Robin

- The winner of the round robin is determined based on Technical Challenge results (30%) and total points from round robin games (70%).

- If two teams gained the same total points, the winner will be decided based on the technical challenge result. If the technical challenge results are still the same, the winner will be decided based on the total round robin game points.

7.4.2   Quarter-Finals, Semi-finals and Final

- The winner of the semi-finals and final will be decided solely based on the semi-final/final game result.

- If the match points are the same for two competing teams, the winner will be decided based on the total game points. If the total game points are still the same, the team with the higher points in WORLD_2 will be the winner.

7.4.3   Best Programmer

- Primary Category:

The winner will solely depends on the Best Programmer Challenge Result

- Secondary Category:

The winner will be determined based on the combination of 30% of technical challenge result and 70% of the Best Programmer Challenge result.

**7.5    Awards**

Depending on the number of teams entering the competition, there will be awards for trophies and certificates.

7.5.1    Trophy

- RoboCupJunior CoSpace Rescue winning teams
- Best Presentation Award

7.5.2    Certificate

- RoboCupJunior CoSpace Rescue Technical Challenge winning teams.
- Best Programmer Award

# 8.    CODE OF CONDUCT

## 8.1    Fair Play

8.1.1    Humans that cause a deliberate interference with real robots or damage to the real world setup will be disqualified.

8.1.2    It is expected that the aim of all teams is to participate fairly.

## 8.2    Behaviour

8.2.1    If one team copies a program from another team, both teams will be disqualified.

8.2.2    Teams will be disqualified for deliberately trying to lose the game or tie with the opponent team.

8.2.3    Participants should be mindful of other people and their robots when moving around the tournament venue.

8.2.4    Participants are not to enter setup areas of other leagues or other teams, unless expressly invited to do so by team members.

8.2.5    Participants who misbehave may be asked to leave the building and risk being disqualified from the tournament.

8.2.6    These rules will be enforced at the discretion of the referees, officials, tournament organizers and local law enforcement authorities.

8.2.7    Mentors (teachers, parents, chaperones, translators, and other adult team members) are not allowed in the student work area.

8.2.8    Mentors are not allowed to be involved in programming of students' robots.

8.2.9    Mentor interference with robots or referee decisions will result in a warning in the first instance. If this reoccurs, the team will risk being disqualified.

## 8.3    Sharing

8.3.1    Teams and students are encouraged to share their programming and strategies to the participants. A certificate of appreciation will be presented to the presenters.

8.3.2    Any developments may be published on the RoboCupJunior website after the event.

8.3.3    This furthers the mission of RoboCupJunior as an educational initiative.

## 8.4    Spirit

8.4.1    It is expected that all participants (students and mentors alike) will respect the RoboCupJunior mission.

8.4.2    The referees and officials will act within the spirit of the event.

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


Queries regarding these rules or their interpretation may be sent to the CoSpace Technical Committee, Shen Jiayao (Singapore), at jyshen@sp.edu.sg.
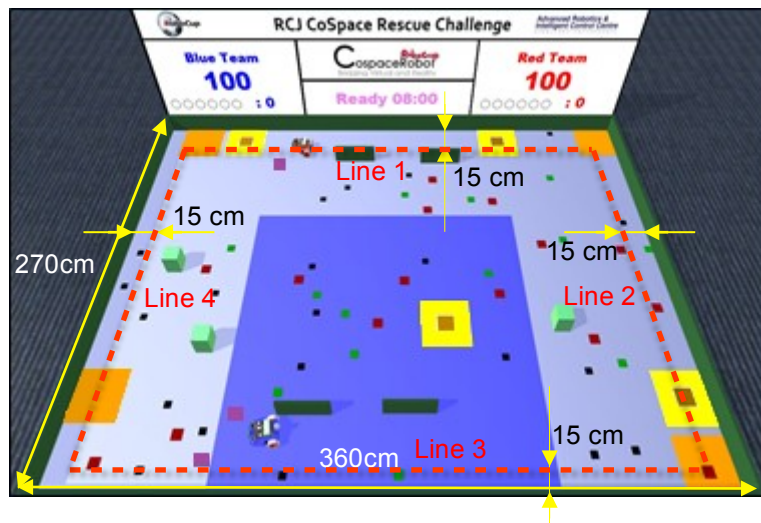

Further Information about CoSpace Robotics

CoSpace Robot Home Page: www.CoSpaceRobot.org

# Appendix A:   Primary Category Competition Setup

**WORLD_1 (Virtual):**
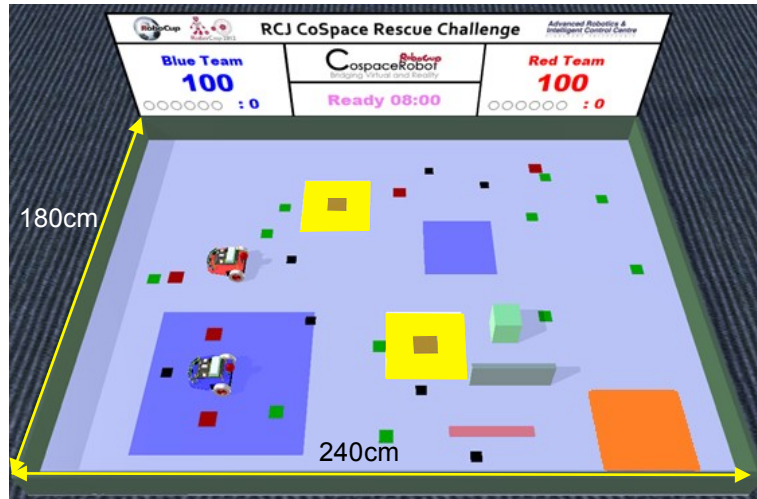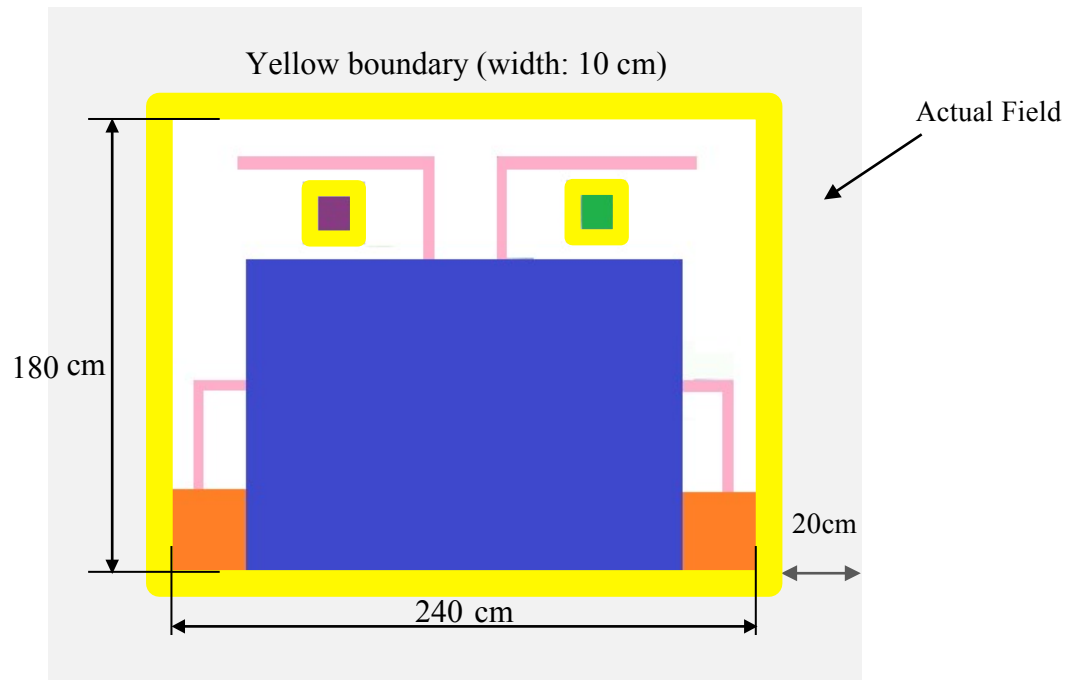


**WORLD_2 (Virtual):**



- 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 WORLD_2) upon generation.
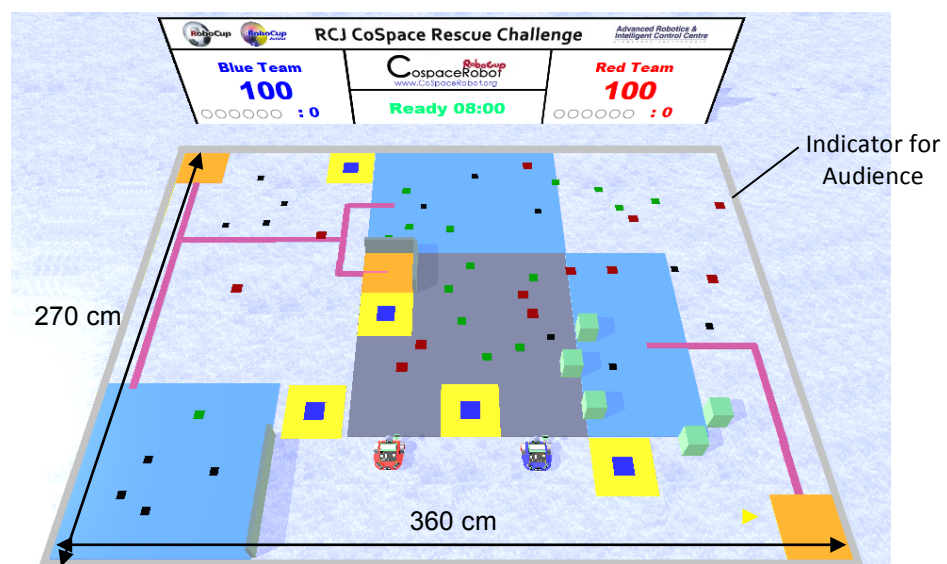
## Appendix B: Secondary Category Competition Setup

**WORLD_1 (Real):**



Yellow boundary (width: 10 cm)

Actual Field

180 cm

20cm

240 cm

- The location (X& Y coordinates) of any objects including real robot, real objects, special zones, traps, marker, collection boxes, and obstacles will not be disclosed to teams..

**WORLD_2 (Virtual)**



Indicator for Audience

270 cm

360 cm

- 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.