

# RoboCupJunior Soccer Entry Rules 2023 (Draft)

## Europe • 1:1 • Draft

### Soccer League Committee 2022:

Michael Ambrose	USA
Javier E. Delgado Moreno	Mexico
Hikaru Sugiura	Japan
Marco Dankel	Germany (CHAIR)
James Riley	Australia
Adrián Matejov	Slovakia

### Soccer Technical Committee 2020 and 2021:

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Javier E. Delgado Moreno	Mexico
Hikaru Sugiura	Japan
Marco Dankel	Germany
Felipe Nascimento Martins	Netherlands
Marek Šuppa	Slovakia (CHAIR)

These are the RoboCup Junior Soccer Entry rules for the **1:1 Open League**, proposed for the super-region of Europe for the 2023 season. They are released by the RoboCupJunior Soccer Community in coordination with the European RoboCupJunior Regional Representatives. The English version of these rules has priority over any translations.

The aim of this document is to provide an entry-level rule set for RCJ Soccer that is harmonized across countries in Europe and that may be referenced at European local and super-regional tournaments, as well as beyond Europe if needed. However, some sub-regions may have their own version of Soccer Entry rules. Teams are advised to check with their Local Organizing Committee and Regional Representative regarding updates and changes to this rule set specific to their location. Each team is responsible for verifying the correct and latest version of the rules prior to competition.

**Figure 1** Two teams with one standard kit robot each will compete using an IR ball on RCJ Soccer fields without the out-area. There is no need for using camera vision or line detection. Photo: Andreas Lander



**NOTE:** This is a draft version of these rules, subject to change.



**NOTE:** This ruleset is not intended to be used at international level, except for super-regional tournaments in Europe.

## Preface

In the RoboCupJunior Soccer Entry challenge, teams of young engineers design, build, and program **one** fully autonomous mobile robot to compete against another team in matches. The robots must detect a ball and score into a color-coded goal on a special field that resembles a human soccer field.

To be successful, participants must demonstrate skill in programming, robotics, electronics and mechatronics. Teams are also expected to contribute to the advancement of the community as a whole by sharing their discoveries with other participants and by engaging in good sportsmanship, regardless of culture, age or result in the competition. **All are expected to compete, learn, have fun, and grow.**

RoboCupJunior Soccer Entry contains rules for one entry-level league. They are based on the international rulesets. Their main differences compared to those are:

- **The Field** is based on the international field, but without the outer area which reduces the complexity of robot construction and gameplay.
- **The Ball** The league uses the same special ball that emits an IR signal that Light Weight League uses. Please see Rule 5, **BALL** for balls specifications.

## Competition Cap

**Team members can participate only twice** in leagues played according to this RoboCupJunior Soccer Entry ruleset. After their second participation, they need to move on to the international RCJ Soccer leagues instead.<sup>1</sup>

Team members that participated in the international RoboCupJunior Soccer leagues before may not participate in the Entry league(s) again.

## Construction and Programming have to be performed exclusively by the students

Robots must be constructed and programmed exclusively by student members of the team. Mentors, teachers, parents or companies should not be involved in the design, construction, assembly, programming or debugging of robots. To avoid embarrassment and possible disqualification, it is extremely important that teams abide by this league's regulations, especially Rule 7.4.A, **Construction** and Rule 7.4.B, **Programming**, and all other competitor's rules.

If in doubt, please consult with your Regional Representative before registering your team.

<sup>1</sup> Some regions will have other entry leagues that may be exempt from this rule. Please refer to your local Organizing Committee in order to find out in which leagues you may compete.

# 1 GAMEPLAY

## 1.1 Game procedure and length of a game

- 1.1.1 RCJ Soccer games consist of two teams of **one** robot each, playing soccer against each other. Each team has one autonomous robot. The game will consist of two halves. The duration of each half is 10-minutes. There will be a 5-minute break in between the halves.
- 1.1.2 The game clock will run for the duration of the halves without stopping (except when a referee wants to consult another official). The game clock will be run by a referee or a referee assistant (see Rule 7.1, **Referee and referee assistant** for more information on their roles).
- 1.1.3 Teams are expected to be at the field 5 minutes before their game starts. Being at the inspection table does not count in favor of this time limit. Teams that are late for the start of the game can be penalized one goal **per 30 seconds** at the referee's discretion.
- 1.1.4 The final game score will be trimmed so that there is at most 10-goal difference between the losing and the winning team.

## 1.2 Pre-match meeting

- 1.2.1 At the start of the first half of the game, a referee will toss a coin. The team mentioned first in the draw shall call the coin. The winner of the toss can choose either which end to kick towards, or to kick off first. The loser of the toss chooses the other option. After the first half, teams switch sides. The team not kicking off in the first half of the game will kick off to begin the second half of the game.
- 1.2.2 During the pre-match meeting the referee or their assistant may check whether the robots are capable of playing (i.e., whether they are at least able to follow and react to the ball). If none of the robots is capable of playing, the game will not be played and zero goals will be awarded to both teams.

## 1.3 Kick-off

- 1.3.1 Each half of the game begins with a kick-off. All robots must be located on their own side of the field. All robots must be halted. The ball is positioned by a referee in the center of the field.
- 1.3.2 The team kicking off places their robot on the field first.
- 1.3.3 The team not kicking off will now place their robot on the defensive end of the field. The robot on the team not kicking off must be at least 30 cm away from the ball (outside of the center circle).
- 1.3.4 Robots cannot be placed inside the goal. Robots cannot be repositioned once they have been placed, except if the referee requests to adjust their placement to make sure that the robots are placed properly within the field positions.
- 1.3.5 On the referee's command (usually by whistle), all robots will be started immediately by each captain. Any robots that are started early will be removed by the referee from the field and deemed damaged.
- 1.3.6 Before a kick-off, **all damaged robots** are allowed to return to the playing field immediately if they are *ready and fully functional*.
- 1.3.7 If no robots are present at a kick-off (because they are damaged Rule 1.8, **Damaged robots**), the penalties are discarded and the match resumes with a Rule 1.3.A, **Neutral kick-off**.

### 1.3.A Neutral kick-off

- 1.3.A.1 A neutral kick-off is the same as the one described in Rule 1.3, Kick-off with a small change: all robots must be at least 30 cm away from the ball (outside of the center circle).

## 1.4 Human interference

- 1.4.1 Except for the kick-off, human interference from the teams (e.g. touching the robots) during the game is not allowed unless explicitly permitted by a referee. Violating team/team member(s) can be disqualified from the game.
- 1.4.2 The referee or a referee assistant can help robots get unstuck if the ball is not being disputed near them and if the situation was created from normal interaction between robots (i.e. it was not a design or programming flaw of the robot alone). The referee or a referee assistant will pull back the robots just enough for them to be able to move freely again.

## 1.5 Ball movement

- 1.5.1 A robot cannot hold a ball. Holding a ball is defined as taking full control of the ball by removing all of degrees of freedom. Examples for ball holding include fixing a ball to the robot's body, surrounding a ball using the robot's body to prevent access by others, encircling the ball or somehow trapping the ball with any part of the robot's body. If a ball does not roll while a robot is moving, it is a good indication that the ball is trapped.
- 1.5.2 The only exception to holding is the use of a rotating drum (a "dribbler") that imparts dynamic back spin on the ball to keep the ball on its surface.
- 1.5.3 Other players must be able to access the ball.

## 1.6 Scoring

- 1.6.1 A goal is scored when the ball strikes or touches the back wall of the goal. Goals scored either by an attacking or defending robot have the same end result: they give one goal to the team on the opposite side. After a goal, the game will be restarted with a kick-off from the team who was scored against.

## 1.7 Lack of progress

- 1.7.1 Lack of progress occurs if there is no progress in the gameplay for a reasonable period of time and the situation is not likely to change. Typical lack of progress situations are when the ball is stuck between robots, when there is no change in ball and robot's positions, or when the ball is beyond detection or reach capability of all robots on the field.
- 1.7.2 After a visible and loud count <sup>2</sup>, a referee will call "lack of progress" and will move the ball to the nearest unoccupied neutral spot. If this does not solve the lack of progress, the referee can move the ball to a different neutral spot.

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<sup>2</sup> usually a count of three, the length of the count could be decided by the OC before a competition as long as it's the same length within a sub-league

## 1.8 Damaged robots

- 1.8.1 If a robot is damaged, it has to be taken off the field and must be fixed before it can play again. Even if repaired, the robot must remain off the field for at least one minute or until the next kick-off is due.
- 1.8.2 Some examples of a damaged robot include:
- it does not respond to the ball, or is unable to move (it lost pieces, power, etc.).
  - it continually moves into the goal or out of the playing field.
  - it turns over on its own accord.
- 1.8.3 Computers and repair equipment are not permitted in the playing area during gameplay. Usually, a team member will need to take the damaged robot to an “approved repair table” near the playing area. A referee may permit robot sensor calibration, computers and other tools in the playing area, only for the 5 minutes before the start of each half.
- 1.8.4 After a robot has been fixed, it will be placed on the unoccupied neutral spot furthest from the ball, facing its own goal. A robot can only be returned to the field if the damage has been repaired. If the referee notices that the robot was returned to the field with the same original problem, s/he may ask the robot to be removed and proceed with the game as if the robot had not been returned.
- 1.8.5 **Only the referee decides whether a robot is damaged.** A robot can only be taken off or returned with the referee’s permission.
- 1.8.6 Whenever a robot is removed from play, its motors must be turned off.

## 1.9 Interruption of Game

- 1.9.1 In principle, a game will not be stopped.
- 1.9.2 A referee can stop the game if there is a situation on or around the field which the referee wants to discuss with an official of the tournament or if the ball malfunctions and a replacement is not readily available.
- 1.9.3 When the referee has stopped the game, all robots must be stopped and remain on the field untouched. The referee may decide whether the game will be continued/resumed from the situation in which the game was stopped or by a kick-off.

# 2 TEAM

## 2.1 Regulations

- 2.1.1 A team must have more than one member to form a RoboCupJunior team to participate in the competition. A team member(s) and/or robot(s) cannot be shared between teams. The maximum number of team members is defined by each local competition respectively, but is usually 4.
- 2.1.2 Each team member needs to carry a technical role.
- 2.1.3 Each team must have a **captain**. The captain is the person responsible for communication with referees. The team can replace its captain with another team member during the competition. Team is allowed to have at most two members beside the field during game play: they will usually be the captain and an assistant team member.

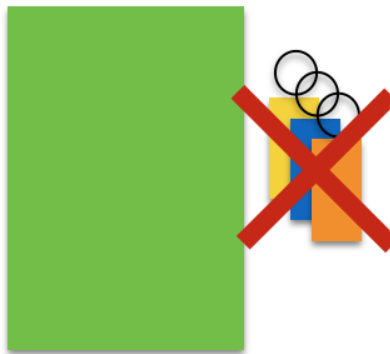
## 2.2 Violations

- 2.2.1 Teams that do not abide by the rules are not allowed to participate.
- 2.2.2 **Any person close to the playing field is not allowed to wear any yellow or blue clothes that can be seen by the robots (to avoid interference). A referee can require a team member to change clothes or to be replaced by another team member if interference is suspected.** <sup>3</sup>
- 2.2.3 The referee can interrupt a game in progress if any kind of interference from spectators is suspected (color clothing, IR emitters, camera flashes, mobile phones, radios, computers, etc.).
- 2.2.4 This needs to be confirmed by an OC member if a claim is placed by the other team. A team claiming that their robot is affected by colors has to show the proof/evidence of the interference.

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**Figure 2** Anyone close to the playing field is not allowed to wear orange, yellow or blue clothes

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## 3 ROBOTS

### 3.1 Number of robots / substitution

- 3.1.1 **Each team is allowed to have only one robot for the full tournament.** The substitution of this robot during the competition within the team or with other teams is forbidden.

### 3.2 Construction

- 3.2.1 **Top markers (as mentioned in the international rule sets) are not required.**

### 3.3 Ball Capturing Zone

- 3.3.1 The ball must not be absorbed by the robot, which is measured by a ball-capturing zone of 3 cm:
- 3.3.2 The ball-capturing zone is defined as any internal space created when a straight edge is placed on the protruding points of a robot. This means the ball must not enter the concave hull of a robot by more than 3 cm depth. Furthermore, it must be possible for another robot to take possession of the ball.

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<sup>3</sup> In previous version this said "Robots are expected to be capable of dealing with any colors above the walls (e.g. blue, yellow, green or orange shirts) either in hardware (e.g. blocking FoV from looking up) or in software (e.g. masking the input image)."

### 3.4 Interference

- 3.4.1 Robots are not allowed to be colored yellow or blue in order to avoid interference. Yellow or blue colored parts used in the construction of the robot must either be occluded by other parts from the perception by another robot or be taped/painted with a neutral color.
- 3.4.2 Robots must not produce magnetic interference in another robot on the field.
- 3.4.3 Robots must not produce visible or infrared light that may prevent the opposing team from playing when placed on a flat surface. Any part of a robot that produces light that may interfere with the opposing robots vision system must be covered.
- 3.4.4 Infrared light reflecting materials must not be used on the outside of the robot. If robots are painted, they must be painted matte. Minor parts that reflect infrared light can be used as long as other robots are not affected. Tournament organizers may require them to be covered if they are convinced of the danger of interference.
- 3.4.5 A team claiming that their robot is affected by the other team's robot in any way must show the proof/evidence of the interference. Any interference needs to be confirmed by an OC member if a claim is placed by the other team.

### 3.5 Control

- 3.5.1 The use of remote control of any kind is not allowed during the match. Robots must be started and stopped manually by humans and be controlled autonomously.

### 3.6 Communication

- 3.6.1 Robots are not allowed to use any kind of communication during game play unless the communication between two robots is via Bluetooth class 2 or class 3 <sup>4</sup> or via any other device that communicates using the 802.15.4 protocol (e.g., ZigBee and XBee).
- 3.6.2 Teams are responsible for their communication. The availability of frequencies cannot be guaranteed.

### 3.7 Agility

- 3.7.1 Robots must be constructed and programmed in a way that their movement is not limited to only one dimension (defined as a single axis, such as only moving in a straight line). They must move in all directions, for example by turning.
- 3.7.2 Robots must respond to the ball in a direct forward movement towards it. For example, it is not enough to basically just move left and right in front of their own goal, it must also move directly towards the ball in a forward movement. A robot must be able to seek and approach the ball anywhere on the field.
- 3.7.3 A robot must touch the ball that is placed no further than 20 cm from any point on its convex hull within 10 seconds. If a robot does not do so within the time limit, it is deemed to be damaged. (See **Damaged Robots**.)
- 3.7.4 Robots must be constructed in a way that they do not enter the goal. Robots are allowed to use the cross-bar in order to avoid entering the goal. Any robot that moves into the goal 3 times during a period of 20 seconds is deemed to be damaged (see **Damaged Robots**).

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<sup>4</sup> range shorter than 20 meters



### 3.8 Handle

- 3.8.1 All robots must have a stable and easily noticeable handle to hold and to lift them. The handle must be easily accessible and allow the robot to be picked up from at least 5 cm above the highest structure of the robot.
- 3.8.2 The dimensions of the handle may exceed the 22 cm height limitation, but the part of the handle that exceeds this 22 cm limit cannot be used to mount components of the robot.

### 3.9 Violations

- 3.9.1 Robots that do not abide by these specifications/regulations are not allowed to play.
- 3.9.2 If violations are detected during a running game the team is disqualified for that game.
- 3.9.3 If similar violations occur repeatedly, the team can be disqualified from the tournament.

## 4 FIELD

### 4.1 Kind of field

- 4.1.1 There is only one kind of field for RoboCupJunior Soccer Entry leagues. However, this field type can vary in size.

### 4.2 Dimensions of the field

- 4.2.1 The playing field is between **110 cm and 125 cm** in width.
- 4.2.2 The playing field is between **180 cm and 195 cm** in depth.
- 4.2.3 This allows for re-using existing equipment such as older RCJ soccer fields (122 cm by 183 cm) which is recommended, FLL fields (114 cm in width) or for regular RCJ Soccer fields to be temporarily converted by some temporary wooden walls. Teams should contact the organizers of their tournament about the exact dimensions used within the competition.

### 4.3 Walls

- 4.3.1 Walls are placed all around the field. The height of the walls is **at least 10cm** . A height of 14 cm is recommended. The walls are painted matte black.
- 4.3.2 **The four corners of the field are flattened in order to make it easier for robots to retrieve the ball from a corner. The flat area is approx. 14cm in width.**
- 4.3.3 **There is no outer area.**

### 4.4 Goals

- 4.4.1 The field has two goals, centered on each of the shorter sides of the playing field. The goal inner space is **45 cm wide and 74 mm deep**. It is box shaped and outside the playing field (submerged into the walls). The height of the goal is equal to the height of the walls.



4.4.2 **It has a cross-bar on top (to prevent robots from entering the goal). The size of the cross-bar is 2 +/- 1 cm in height.**

4.4.3 The interior walls and the crossbar of each goal are painted, one goal in yellow, the other goal in blue.

4.4.4 It is recommended that the blue be of a brighter shade so that it is different enough from the black exterior.

## 4.5 Floor

4.5.1 The floor consists of dark green carpet on top of a hard level surface. All straight lines on the field should be painted or fixed with strong adhesive tape, and have a width of 20 mm.

## 4.6 Neutral spots

4.6.1 There are five neutral spots defined in the field. One is in the center of the field. The other four are adjacent to each corner, located 45 cm along the long edge of the field, aligned with each goal post towards the middle of the field (from the goal post). The neutral spots can be drawn with a thin black marker. The neutral spots ought to be of circular shape measuring 1 cm in diameter.

## 4.7 Center circle

4.7.1 A center circle will be drawn on the field. It is 60 cm in diameter. It is a thin black marker line. It is there for Referees and Captains as guidance during kick-off.

## 4.8 Penalty areas

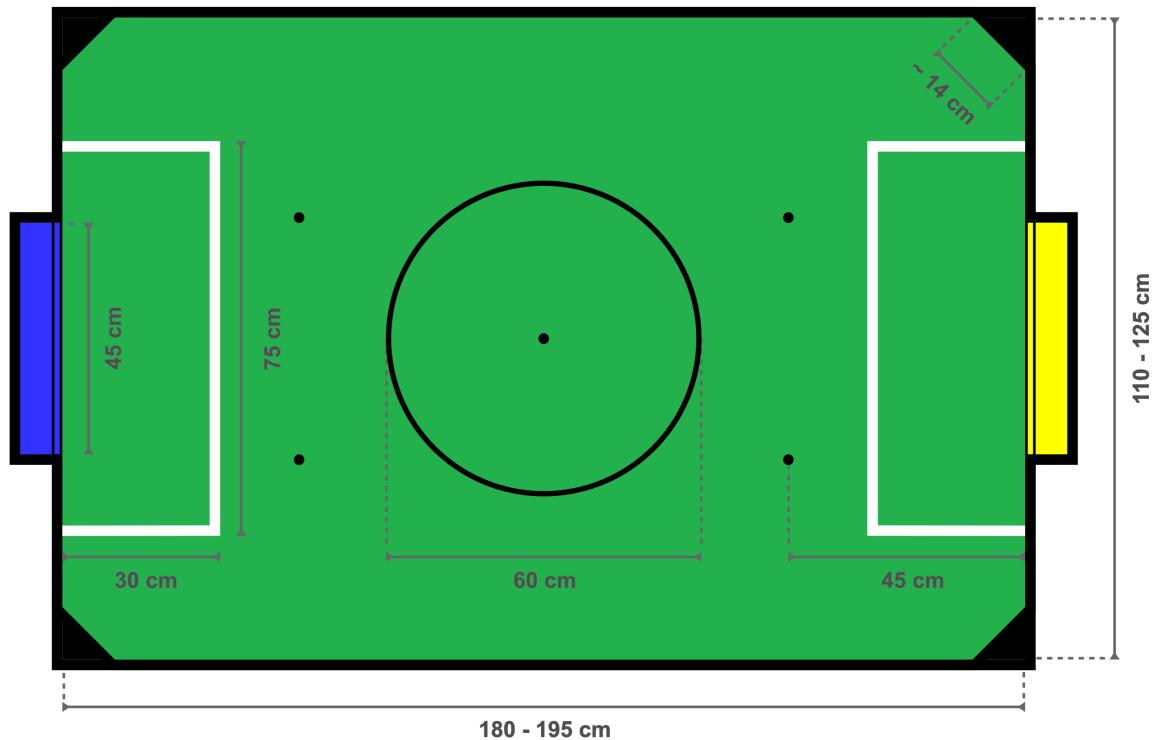
4.8.1 In front of each goal there is a **30 cm wide and 75 cm** long penalty area.

4.8.2 The penalty areas are marked by **a white line** of 20 mm width. The line is part of the area.

## 4.9 Lighting and Magnetic Conditions

4.9.1 The organizers will do their best to limit the amount of external lightning and magnetic interference. However, the robots need to be constructed in a way which allows them to work in conditions that are not perfect (i.e. by not relying on compass sensors or specific lightning conditions).

## FIELD DIAGRAM



4.9.2

## 5 BALL

### 5.1 Specification for Soccer Entry Ball

5.1.1 See Appendix A, [Technical Specification for pulsed Soccer Ball](#).

### 5.2 Tournament balls

5.2.1 Balls for the tournament must be made available by the organizers. Organizers are not responsible for providing balls for practice.

## 6 CODE OF CONDUCT

### 6.1 Fair Play

6.1.1 It is expected that the aim of all teams is to play a fair and clean game of robot soccer. It is expected that all robots will be built with consideration to other participants.

- 6.1.2 Robots are not allowed to cause deliberate interference with or damage to other robots during normal game play.
- 6.1.3 Robots are not allowed to cause damage to the field or to the ball during normal game play.
- 6.1.4 A robot that causes damage may be disqualified from a specific match at the referee's discretion. The OC will also be informed.
- 6.1.5 Humans are not allowed to cause deliberate interference with robots or damage to the field or the ball.

## 6.2 Behavior

- 6.2.1 All participants are expected to behave themselves. All movement and behavior is to be of a subdued nature within the tournament venue.

## 6.3 Help

- 6.3.1 Mentors (teachers, parents, chaperones, and other adult team-members including translators) are not allowed in the student work area unless it is explicitly but temporarily permitted by a member of the Organizing Committee. Only participating students are allowed to be inside the work area.
- 6.3.2 **Mentors must not touch, build, repair, or program any robots.**

## 6.4 Sharing

- 6.4.1 The understanding that any technological and curricular developments should be shared among the RoboCup and RoboCupJunior participants after the tournament has been a part of world RoboCup competitions.

## 6.5 Spirit

- 6.5.1 It is expected that all participants, students, mentors, and parents will respect the RoboCupJunior mission.
- 6.5.2 ***It is not whether you win or lose, but how much you learn that counts!***

## 6.6 Violations / Disqualification

- 6.6.1 Teams that violate the code of conduct can be disqualified from the tournament. It is also possible to disqualify only single person or single robot from further participation in the tournament.
- 6.6.2 In less severe cases of violations of the code of conduct, a team will be given a warning by showing it a yellow card. In severe or repeated cases of violations of the code of conduct a team can be disqualified immediately without a warning by showing it the red card.

## 7 CONFLICT RESOLUTION

### 7.1 Referee and referee assistant

- 7.1.1 The referee is a person in charge of making decisions with regards to the game, according to these rules, and may be assisted by a referee assistant.
- 7.1.2 **During gameplay, the decisions made by the referee and/or the referee assistant are final.**
- 7.1.3 Any argument with the referee or the referee assistant can result in a warning. If the argument continues or another argument occurs, this may result in immediate disqualification from the game.
- 7.1.4 Only the captain has a mandate to freely speak to the referee and/or their assistant. Shouting at a referee and/or their assistant, as well as demanding a change in ruling can be directly penalized by a warning at the referee's discretion.
- 7.1.5 At the conclusion of the game, the result recorded in the scoresheet is final. The referee will ask the captains to add written comments to the scoresheet if they consider them necessary. These comments will be reviewed by the OC members.

### 7.2 Rule clarification

- 7.2.1 Rule clarification may be made by members of the RoboCupJunior Soccer League Committee and Organizing Committee, if necessary even during a tournament.

### 7.3 Rule modification

- 7.3.1 If special circumstances, such as unforeseen problems or capabilities of a robot occur, rules may be modified by the RoboCupJunior Soccer League Committee, if necessary even during a tournament.

### 7.4 Regulatory statutes

- 7.4.1 Each RoboCupJunior competition may have its own regulatory statutes to define the procedure of the tournament (for example the SuperTeam system, game modes, the inspection of robots, interviews, schedules, etc.). Regulatory statutes become a part of this rule.

#### 7.4.A Construction



Robots must be constructed exclusively by the student members of a team. Mentors, teachers, parents or companies may not be involved in the design, construction, and assembly of robots.

- 7.4.A.1 For the construction of a robot, any robot kit or building block may be used as long as the design and construction are primarily and substantially the original work of a team. This means that commercial kits may be used but must be substantially modified by the team. It is neither allowed to mainly follow a construction manual, nor to just change unimportant parts.

- 7.4.A.2 Indications for violations are the use of commercial kits that can basically only be assembled in one way or the fact that robots from different team(s), build from the same commercial kit, all basically look or function the same.
- 7.4.A.3 Robots must be constructed in a way that they can be started by the captain without the help of another person.
- 7.4.A.4 Since a contact with an opponent robot and/or dribbler that might damage some parts of robots cannot be fully anticipated, **robots must have all its active elements properly protected with resistant materials**. For example, electrical circuits and pneumatic devices, such as pipelines and bottles, must be protected from all human contact and direct contact with other robots.



All driven dribbler gears must be covered with metal or hard plastic.

- 7.4.A.5 When batteries are transported or moved, it is recommended that safety bags be used. Reasonable efforts should be made to make sure that in all circumstances robots avoid short-circuits and chemical or air leaks.



The use of swollen, tattered or otherwise dangerous battery is not allowed.

#### 7.4.B Programming

- 7.4.B.1 Robots must be programmed exclusively by student members of the team. Mentors, teachers, parents or companies should not be involved in the programming and debugging of robots.
- 7.4.B.2 For the programming of the robots, any programming language, interface or integrated development environment (IDE) may be used. The use of programs that come together with a commercial kit (especially sample programs or presets) or substantial parts of such programs are not allowed. It is not allowed to use sample programs, not even if they are modified.

#### 7.4.C Inspections

- 7.4.C.1 Robots must be inspected and certified every day before the first game is played. The Organizing Committee may request other inspections if necessary, including random inspections which may happen at any time. The routine inspections include:
- Weight restrictions for the particular sub-league (see [?]).
  - Robot dimensions (see [?]).
  - Voltage restrictions (see [?] and [?]).
  - Kicker strength limits, if the robot has a kicker (see[?]).

- 7.4.C.2 Proof must be provided by each team that its robots comply with these regulations, for example, by a detailed documentation or logbook. Teams may be interviewed about their robots and the development process at any time during a tournament.

## **A Technical Specification for pulsed Soccer Ball**

### **1.1 Preamble**

- 1.1.1 Answering to the request for a soccer ball for RCJ tournaments that would be more robust to interfering lights, less energy consuming and mechanically more resistant, the RCJ Soccer League Committee defined the following technical specifications with the special collaboration from EK Japan and HiTechnic.
- 1.1.2 Producers of these balls must apply for a certification process upon which they can exhibit the RCJ-compliant label and their balls used in RCJ tournaments.
- 1.1.3 Balls with these specifications can be detected using specific sensors from HiTechnic (IRSeeker - information on distance and angle) but also common IR remote control receivers (TSOP1140, TSOP31140, GP1UX511QS, etc. - on-off detection with a possible gross indication of distance).

### **1.2 Specifications**

#### **1.2.A IR light**

- 1.2.A.1 The ball emits infra-red (IR) light of wavelengths in the range 920nm - 960nm, pulsed at a square-wave carrier frequency of 40 KHz. The ball should have enough ultra-bright, wide-angle LEDs to minimize unevenness of the IR output.

#### **1.2.B Diameter**

- 1.2.B.1 The diameter of the ball is required to be 74mm. A well-balanced ball shall be used.

#### **1.2.C Drop Test**

- 1.2.C.1 The ball must be able to resist normal game play. As an indication of its durability, it should be able to survive, undamaged, a free-fall from 1.5 meters onto a hardwood table or floor.

#### **1.2.D Modulation**

- 1.2.D.1 The 40 KHz carrier output of the ball shall be modulated with a trapezoidal (stepped) waveform of frequency 1.2 kHz. Each 833-microsecond cycle of the modulation waveform shall comprise 8 carrier pulses at full intensity, followed (in turn) by 4 carrier pulses at 1/4 of full intensity, four pulses at 1/16 of full intensity and four pulses at 1/64 of full intensity, followed by a space (i.e. zero intensity) of about 346 microseconds. The peak current level in the LEDs shall be within the range 45-55mA. The radiant intensity shall be more than 20mW/sr per LED.

### **1.2.E Battery Life**

- 1.2.E.1 If the ball has an embedded rechargeable battery, when new and fully charged it should last for more than 3 hours of continuous use before the brightness of the LEDs drops to 90% of the initial value. If the ball uses replaceable batteries, a set of new high-quality alkaline batteries should last for more than 8 hours of continuous use before the brightness of the LEDs drops to 90% of the initial value.

### **1.2.F Coloration**

- 1.2.F.1 The ball must not have any marks or discoloration that can be confused with goals, or the field itself.

## **1.3 Official suppliers for pulsed balls**

- 1.3.1 Currently, there is one ball that has been approved by the RoboCupJunior Soccer League Committee:
- RoboSoccer ball operating in MODE A (pulsed) made by EK Japan/Elekit (<https://elekit.co.jp>)
- 1.3.2 Note that this ball was previously called RCJ-05. While you may not be able to find a ball with this name anymore, any IR ball produced by EK Japan/Elekit is considered to be approved by the Soccer League Committee.