RoboCupJunior Soccer Rules 2020

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These are the official Soccer rules for RoboCupJunior 2020. They are released by the RoboCupJunior Soccer Technical Committee. The English version of these rules has priority over any translations.

Teams are advised to check the RoboCupJunior Soccer site https://junior.forum.robocup.org/ for OC (Organizational Committee) procedures and requirements for the international competition. Each team is responsible for verifying the latest version of the rules prior to competition.

Preface

In the RoboCupJunior soccer challenge, teams of young engineers design, build, and program two fully autonomous mobile robots 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 consist of two sub-leagues: **Soccer Open** and **Soccer Lightweight**. These rules apply for both sub-leagues. There are two main differences between the two leagues.

- **Soccer Lightweight** is played using a special ball that emits an IR signal ball. Robots may weigh up to 1.1 kg, may have a ball-capturing zone of up to 3.0 cm, and may use batteries up to 12.0 nominal voltage.
- **Soccer Open** is played using a passive, brightly colored orange ball. Robots may weigh up to 2.4 kg, may have a ball-capturing zone of up to 2.5 cm, and may use batteries up to 15.0 nominal voltage.

Please see Rule 5, “BALL” for balls specifications and Rule 8, “LEAGUE REGULATIONS” for more details for specifications/regulations.

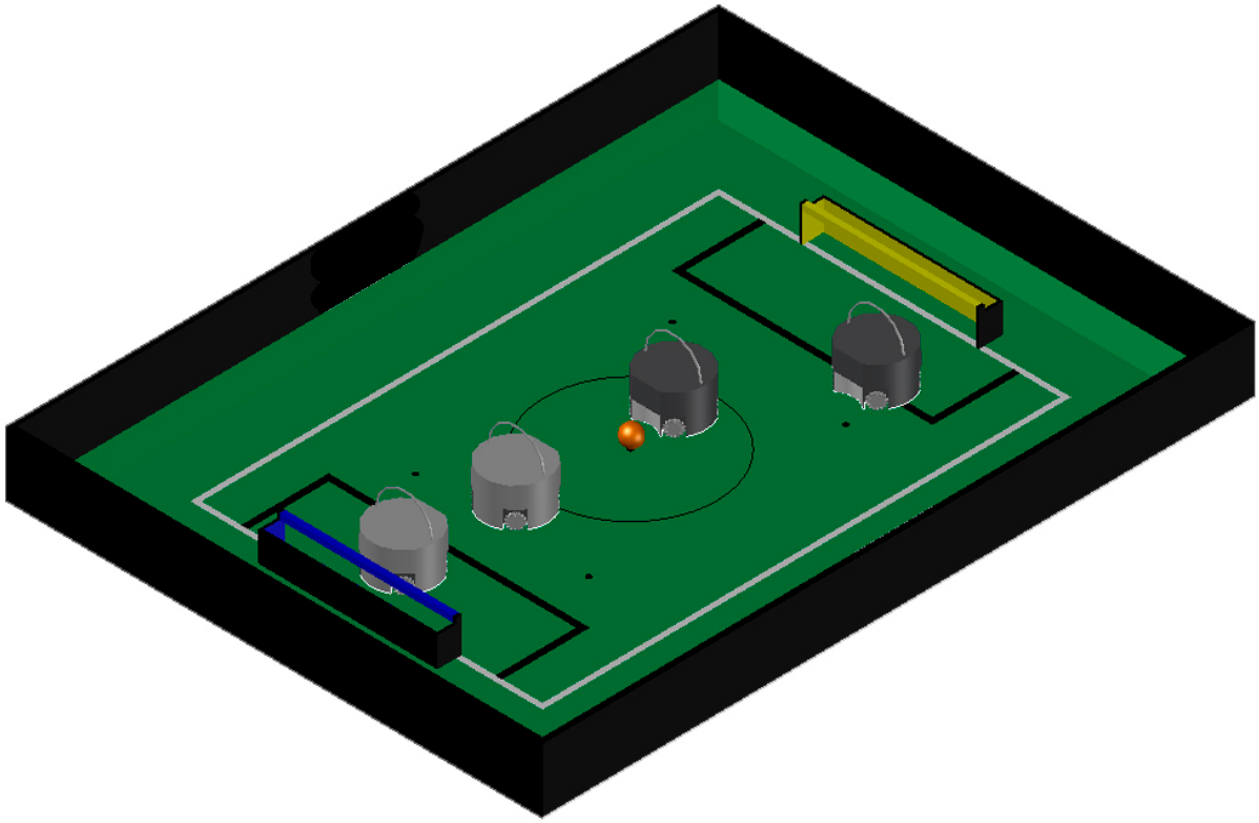


Figure 1. Two teams of two robots with an orange ball on a RoboCupJunior Soccer field.

Changes from 2019 RoboCupJunior Soccer Rules

The changes determined by the Technical Committee for this year's rules aim to make small improvements while keeping most of the rules intact.

{-~TOC-CHANGES~-}

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 Rule 8, "LEAGUE REGULATIONS", especially Rule 8.2.3, "Construction" and Rule 8.2.4, "Programming", and all other competitor's rules.

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

1. GAMEPLAY

1.1. Game procedure and length of a game

RCJ Soccer games consist of two teams of robots playing soccer against each other. Each team has two autonomous robots. 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.

The game clock will run for the duration of the halves without stopping (except if or 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 infromation on their roles).

Teams are expected to be on 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.

When the goal difference reaches 10 the game finishes regardless of the state of the game clock.

1.2. Pre-match meeting

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.

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

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.

The team kicking off places their robots on the field first. Robots cannot be placed nor remain behind the goal line or in the outer area. Robots cannot be repositioned once they have been placed.

The team not kicking off will now place their robots on the defensive end of the field. All robots on the team not kicking off must be at least 30 cm away from the ball (outside of the center circle).

Robots cannot be placed behind the goal line or out of bounds. 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.

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 treated as a damaged robot.

1.4. Human interference

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.

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

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.

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.

Other players must be able to access the ball.

1.6. Scoring

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.

Before a kick-off, all damaged or out-of-bounds robots are allowed to return to the playing field immediately if they are ready and fully functional.

1.7. Goalie

The robot moving first into the penalty area on a team's defending side completely (with every part of it) is designated as goalie until a part of it leaves the penalty area.

1.8. Pushing

Within the penalty area, the goalie has priority. Attacking robots are not supposed to push the goalie in any way.

If the attacker and the goalie touch each other and at least one of them has physical contact with the ball, the ball will be moved to the nearest unoccupied neutral spot immediately.

If a goal is scored as a result of this pushed-situation, it will not be granted.

1.9. Lack of progress

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.

After a visible and loud count [1], 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.

1.10. Out of bounds

If a robot's entire body moves out beyond the white line of the field, it will be called for being out of bounds. When this situation arises, the robot is given a one-minute penalty, and the team is asked to remove the robot from the field. There is no time stoppage for the game itself. The robot is allowed to return if a kickoff occurs before the penalty has elapsed.

The one-minute penalty starts when the robot is removed from play. Furthermore, any goal scored by the penalized team while the penalized robot is on the field will not be granted. Out-of-bounds robots can be fixed if the team needs to do so, as described in .

After the penalty time has passed, robot will be placed on the unoccupied neutral spot furthest from the ball, facing its own goal.

A referee can waive the penalty if the robot was accidentally pushed out of bounds by any other robot. In such a case, the referee may have to slightly push the robot back onto the field.

The ball can leave and bounce back into the playing field. The referee calls `out of reach`, and will move the ball to the nearest unoccupied neutral spot when one of the following condition occurs:

1. the ball remains outside the playing field too long, after a visible and loud count [2],
2. any of the robots are unable to return it into the playing field (without their whole body leaving the playing field), or
3. the referee determines that the ball will not come back into the playing field.

1.11. Damaged robots

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 kickoff is due. If all robots have moved out of bounds, the penalties are discarded and the match resumes with a neutral kickoff.

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.

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. Reprogramming of robots during the gameplay can only happen when they are out of game (i.e., damaged or out of bounds), or when explicitly allowed by the referee.

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.

Only the referee decides whether a robot is damaged. A robot can only be taken off or returned with the referee's permission.

If both robots from the same team are deemed damaged at kickoff, gameplay will be paused and the remaining team will be awarded 1 goal for each elapsed 30 seconds that their opponent's robots remain damaged. However, these rules only apply when none of the two robots from the same team were damaged as the result of the opponent team violating the rules.

Whenever a robot is removed from play, its motors must be turned off.

1.12. Multiple defense

Multiple defense occurs if more than one robot from the defending team enters its penalty area with some part and substantially affects the game. The robot farther from the ball will be moved to the nearest neutral spot. Only the referee can take this action at any time when both robots linger in their penalty area.

If multiple defense happens repeatedly in a short amount of time, the offending robot will be moved to an unoccupied neutral spot on the other side of the field, orientated towards the nearest wall. If any robot needs to be moved to an unoccupied neutral spot more than **three times** during its single uninterrupted time chunk on the field, it will be deemed damaged [3].

1.13. Interruption of Game

In principle, a game will not be stopped.

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.

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

A team must have more than one member to form a RoboCupJunior team to participate in the International event. A team member(s) and/or robot(s) cannot be shared between teams.

Each team member needs to carry a technical role.

Each team must have a **captain**. The captain is the person responsible for communication with referees. The team can replace its captain 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

Teams that do not abide by the rules are not allowed to participate.

Any person close to the playing field is not allowed to wear any orange, 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.

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.).

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.

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

3. ROBOTS

3.1. Number of robots / substitution

Each team is allowed to have at most two robots for the full tournament. The substitution of robots

during the competition within the team or with other teams is forbidden.

3.2. Interference

Robots are not allowed to be colored orange, yellow or blue in order to avoid interference. Orange, yellow, blue colored parts used in the construction of the robot must either be occluded by other parts from the perception by other robots or be taped/painted with a neutral color.

The robot must not emit infrared light. However, optical sensors (e.g. infrared-distance-sensors) may be used as long as they do not affect other robots.

Infrared light reflecting materials must not be used on the outside. If robots are painted, they must be painted matte. Minor parts that reflect infrared light could be used as long as other robots are not affected. Robots must not produce magnetic interference in other robots on the field.

Robots must not produce visible 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 robot's vision system must be covered.

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.

3.3. Control

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.

3.4. Communication

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 [4] or via any other device that communicates using the 802.15.4 protocol (e.g., ZigBee and XBee).

Teams are responsible for their communication. The availability of frequencies cannot be guaranteed.

3.5. Agility

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). They must move in all directions, for example by turning.

Robots must respond to the ball in a direct forward movement. 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. At least one team robot must be able to seek and approach the ball anywhere on the field, unless the team has only one robot on the field at that time. Goalie has to approach the ball in the whole penalty area.

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. This rule applies to all robots on the field. Any robot that moves into the goal 3 times during a period of 20 seconds is deemed to be damaged (see Damaged Robots).

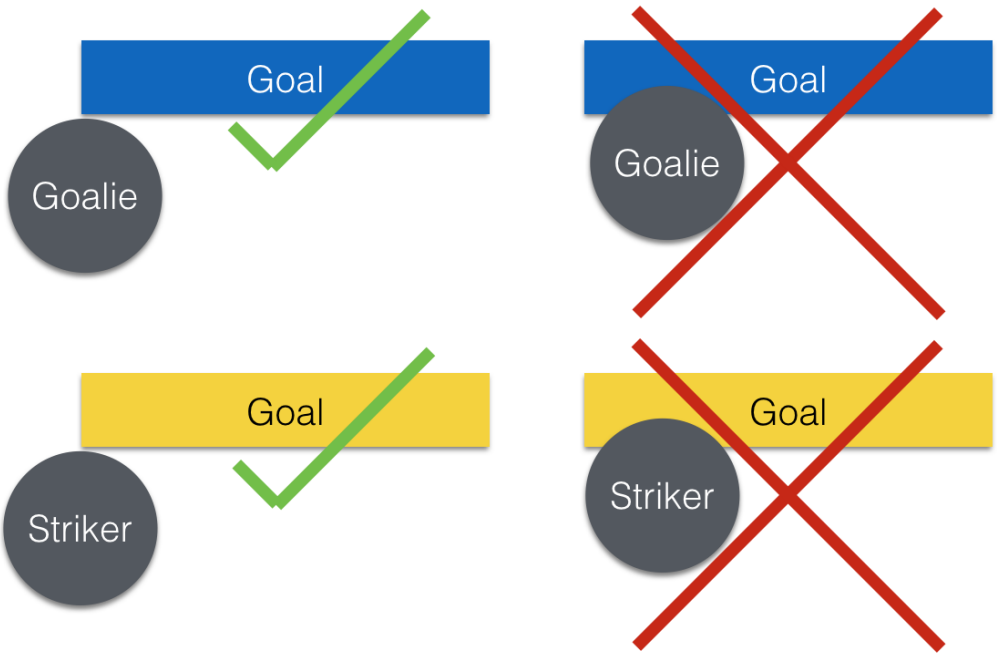


Figure 3. Acceptable and unacceptable position of Goalie and Striker

3.6. Handle

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 22 +/- 2 cm of height.

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.

3.7. Top Markers

A robot must have markings in order to be distinguished by the referee. Each robot must have a white plastic circle with a diameter of at least 4 cm mounted horizontally on top. This white circle will be used by the referee to write numbers on the robots using markers, therefore the white circles must be accessible and visible.

Before the game, the referee will designate the numbers for each robot and will write them on the top white circle. Robots not carrying the top white circle are not eligible to play.

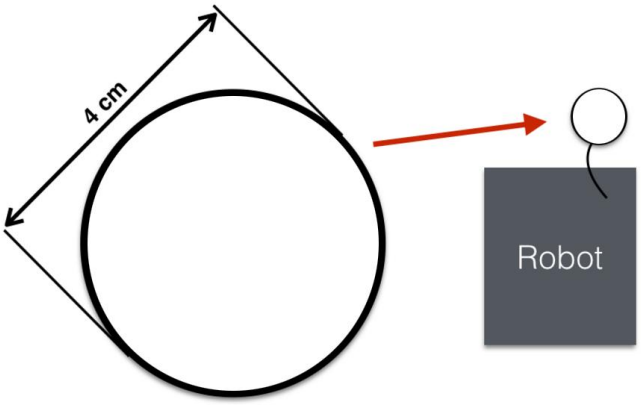


Figure 4. A visualization of the top marker

3.8. Additional regulations of the sub-leagues

A tournament may be organized in different sub-leagues. Each sub-league (e.g. **Soccer Open** and **Soccer Lightweight**) has its own additional regulations, including regulations affecting the construction of robots. They are outlined in Rule 8, “LEAGUE REGULATIONS”.

3.9. Violations

Robots that do not abide by the specifications/regulations (see Rule 8.2, “Regulations”) are not allowed to play, unless these rules specify otherwise.

If violations are detected during a running game the team is disqualified for that game.

If similar violations occur repeatedly, the team can be disqualified from the tournament.

4. FIELD

4.1. Kind of field

There is only one kind of field for all sub-leagues.

4.2. Dimensions of the field

The playing-field is 122 cm by 183 cm. The field is marked by a white line which is part of the playing-field. Around the playing-field, beyond the white line, is an outer area of 30 cm width.

The floor near the exterior wall includes a wedge, which is an incline with a 10 cm base and 2 +/- 1 cm rise for allowing the ball to roll back into play when it leaves the playing field.

Total dimensions of the field, including the outer area, are 182 cm by 243 cm. It is recommended that the field be positioned 70 to 90 cm off the ground.

4.3. Walls

Walls are placed all around the field, including behind the goals and the out-area. The height of the walls is 22 cm. The walls are painted matte black.

4.4. Goals

The field has two goals, centered on each of the shorter sides of the playing field. The goal inner space is 60 cm width, 10 cm high and 74 mm deep, box shaped. It has a cross-bar on top (to prevent robots from entering the goal and to allow checking if the ball scored). The height of the cross-bar is 2 +/- 1 cm.

The goal "posts" are positioned over the white line marking the limits of the field. The cross-bar is exactly over the white line. The interior walls and the cross-bar of each goal are painted, one goal yellow, the other goal blue. The exterior (including the goal post and frame) are painted black (see FIELD DIAGRAMS).

4.5. Floor

The floor consists of dark green carpet on top of a hard level surface. All straight lines on the field should be painted and have a width of 20 mm.

4.6. Neutral spots

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

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

In front of each goal there is a 30 cm wide and 90 cm long penalty area.

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

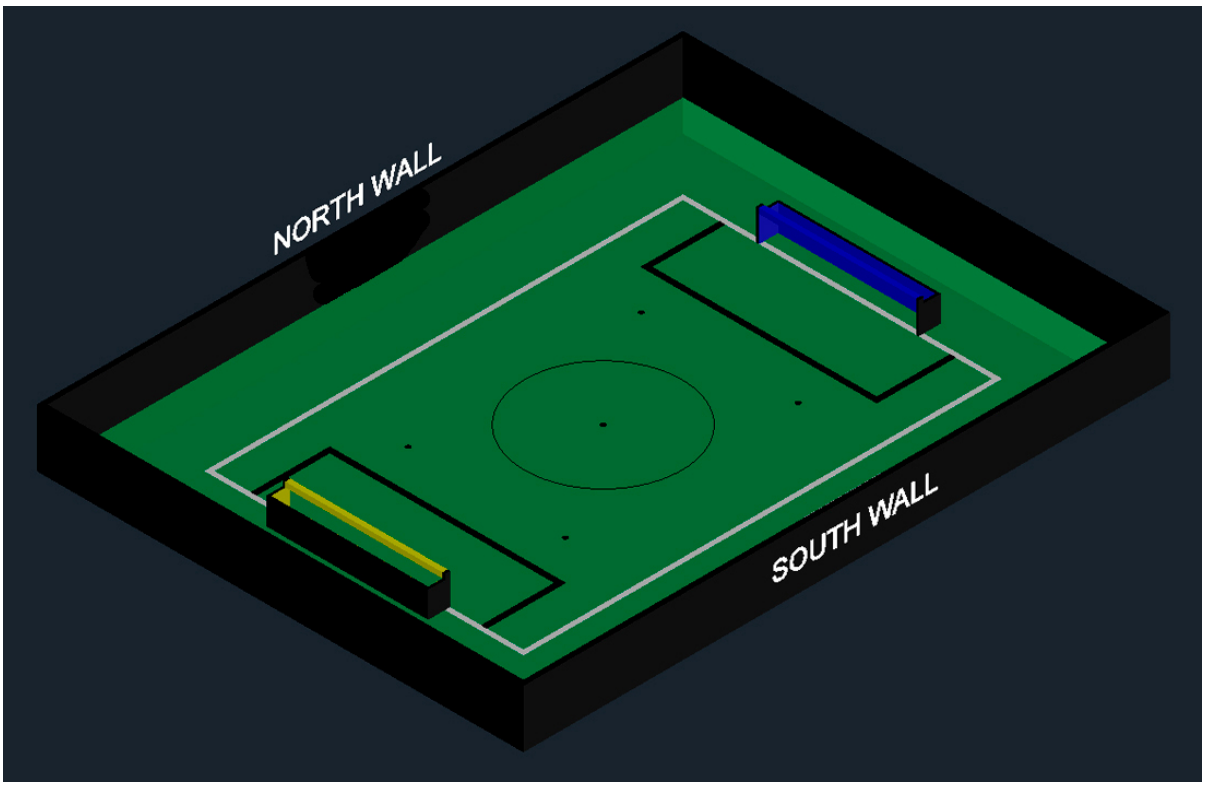
A robot is considered inside the Penalty Area when it is completely inside.

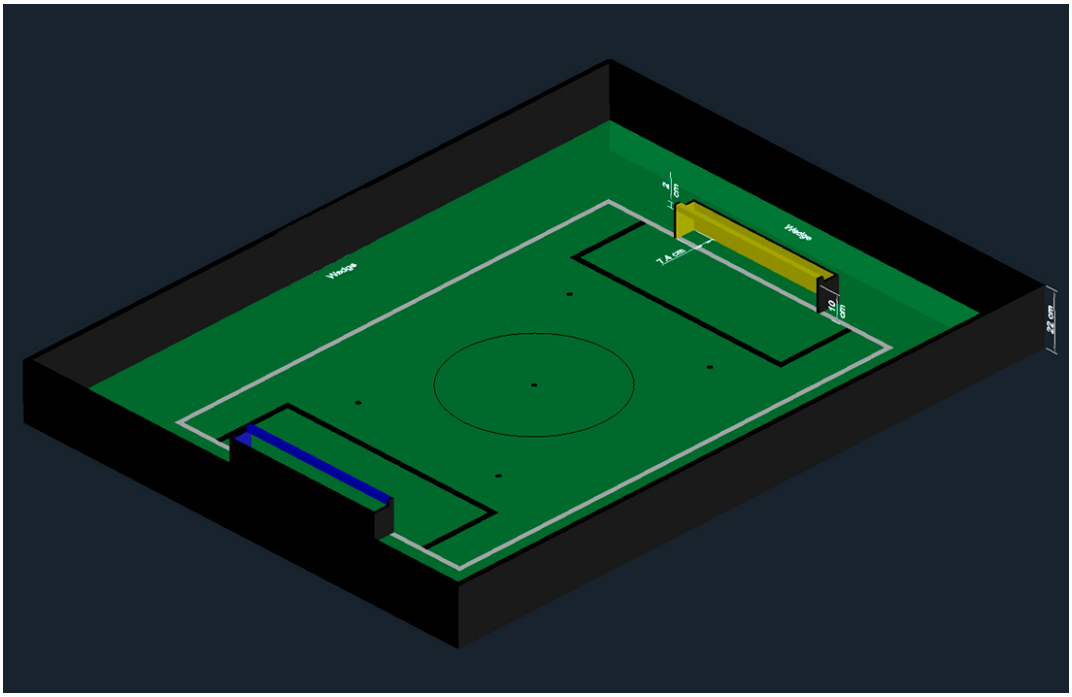
4.9. Lighting and Magnetic Conditions

The fields should be placed in a way that the influence by external infrared light is as low as possible and that the magnetic field of the earth is disturbed as little as possible. Perfect conditions

cannot be guaranteed, however. Teams must come to tournaments being prepared to calibrate their robots based on the lighting and magnetic conditions at the venue.

FIELD DIAGRAMS





5. BALL

5.1. Specification for Soccer Lightweight Ball

See Appendix A, *Technical Specification for pulsed Soccer Ball*.

5.2. Specification for Soccer Open Ball

See Appendix B, *Technical Specification for passive Soccer Ball*.

5.3. Tournament balls

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

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.

Robots are not allowed to cause deliberate interference with or damage to other robots during normal game play.

Robots are not allowed to cause damage to the field or to the ball during normal game play.

A robot that causes damage may be disqualified from a specific match at the referee's discretion.

The OC will also be informed.

Humans are not allowed to cause deliberate interference with robots or damage to the field or the ball.

6.2. Behavior

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

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.

Mentors must not touch, build, repair, or program any robots.

6.4. Sharing

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

It is expected that all participants, students, mentors, and parents will respect the RoboCupJunior mission.

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

6.6. Violations / Disqualification

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.

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

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.

During gameplay, the decisions made by the referee and/or the referee assistant are final.

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.

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.

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

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

7.3. Rule modification

If special circumstances, such as unforeseen problems or capabilities of a robot occur, rules may be modified by the RoboCupJunior Soccer Organizing Committee Chair in conjunction with available Technical Committee and Organizing Committee members, if necessary even during a tournament.

7.4. Regulatory statutes

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.

8. LEAGUE REGULATIONS

8.1. Preamble

According to rule 3.8 of the RoboCupJunior Soccer Rules, each league has its own additional regulations. They become a part of the rules.

For RoboCupJunior 2020, there are two sub-leagues as follows [5]:

- Soccer Lightweight
- Soccer Open

All team members need to be within the minimum and maximum age as specified in the RoboCupJunior General Rules which can be found at http://junior.robocup.org/robocupjunior-general-rules/.

As described in Rule 5.1, “Specification for Soccer Lightweight Ball” and Rule 5.2, “Specification for Soccer Open Ball”, the matches in the Soccer Open sub-league are conducted using a passive ball, whereas the matches in the Soccer Lightweight sub-league are played using the IR ball.

8.2. Regulations

8.2.1. Dimensions

Robots will be measured in an upright position with all parts extended. A robot’s dimensions must not exceed the following limits:

sub-league	**Soccer Open**	**Soccer Lightweight**
size / diameter	Ø 22.0 cm	Ø 22.0 cm
height	22.0 cm [1]	22.0 cm [1]
weight	2400 g [2]	1100 g [2]
ball-capturing zone	2.5 cm	3.0 cm
voltage	15.0 V [3]	12.0 V [3]

[1] The handle and the top markers of a robot may exceed the height.

[2] The weight of the robot includes that of the handle.

[3] We encourage teams to include protection circuits for Lithium-based batteries

[3] Voltage limits relate to the **nominal values**, deviations at the power pack due to the fact that charged will be tolerated.

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 the specified depth. Furthermore, it must be possible for another robot to take possession of the ball.

8.2.2. Limitations

A single robot can only use one camera. All commercial omnidirectional lenses/cameras are not permitted. Only omnidirectional lenses/cameras made by students are permitted, meaning that their construction needs to be primarily and substantially the original work of a team. Teams using them on their robots must prove how they made them on their presentation poster and at an interview. For the purpose of these rules omnidirectional is defined as having a field-of-view of more than 140 degrees horizontally and more than 80 degrees vertically (these values reflect the optical system of the human eye).

Voltage pump circuits are permitted only for a kicker drive. All other electrical circuits inside the robot cannot exceed 15.0 V for Soccer Open and 12.0 V for Soccer Lightweight. Each robot must be designed to allow verifying the voltage of power packs and its circuits, unless the nominal voltage is

obvious by looking at the robot, its power packs and connections.

Pneumatic devices are allowed to use ambient air only.

Kicker strength is subject to compliance check at any time during the competition. During gameplay, a referee can ask to see a sample kick on the field before each half, when a damaged robot is returned to the field, or when the game is about to be restarted after a goal. If the referee strongly suspects that a kicker exceeds the power limit, he can require an official measurement with the 'Kicker Power Measure Device'. (See Appendix C, *Kicker Power Measuring Device* for more details.)

8.2.3. 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.

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.

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.

Robots must be constructed in a way that they can be started by the captain without the help of another person.

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.

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.

8.2.4. Programming

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.

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.

8.2.5. Inspections

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 Rule 8.2.1, “Dimensions”).
- Robot dimensions (see Rule 8.2.1, “Dimensions”).
- Voltage restrictions (see Rule 8.2.1, “Dimensions” and Rule 8.2.2, “Limitations”).
- Kicker strength limits, if the robot has a kicker (see Appendix C, *Kicker Power Measuring Device*).

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

See an example of the inspection sheet that members of the OC will use in Appendix D, *Inspections sheet example*. Note that the sheet will be updated by OC members before the competition to match this year’s rules, but the important aspects which are checked will stay the same.

9. INTERNATIONAL COMPETITION

9.1. Team

Maximum team size is 4 members for RoboCupJunior 2020.

Starting in 2017, Soccer Lightweight team members can participate in the World Championship only twice. After their second participation, they need to move to Soccer Open. Note that counting starts with the 2017 World Championship.

9.2. Interviews

During the international competition, the Organizing Committee will arrange to interview teams during the Setup Day of the event. This means that the teams need to be already present early on this day. Teams must bring robots, the code that is used to program them and any documentation to the interview.

During an interview, at least one member from each team must be able to explain particularities about the team’s robots, especially with regards to its construction and its programming. An interviewer may ask the team for a demonstration. The interviewer may also ask the team to write a simple program during the interview to verify that the team is able to program its robot.

All teams are expected to be able to conduct the interview in English. If this poses a problem, the team may ask for a translator to be present at the interview. If the OC is not able to provide a

translator, the team is required to do so. During the interview, the team will be evaluated using so called Rubrics, which are published on the website mentioned in the beginning of these rules.

The Technical Committee recommends the implementation of interviews in regional competitions as well, but this is not mandatory.

9.3. Technical Challenges

Inspired by the major leagues and the need for further technological advancement of the leagues, the Technical Committee has decided to introduce so called **Technical Challenges**.

The idea of these challenges is to give the teams an opportunity to show off various abilities of their robots which may not get noticed during the regular games. Furthermore, the Technical Committee envisions these challenges to be a place for testing new ideas that may make it to the future rules, or otherwise shape the competition.

Any RoboCupJunior Soccer team will be eligible to try to tackle these challenges. Unless otherwise stated, any robot taking part in these challenges needs to abide by these rules in order to successfully complete it.

9.3.1. Precision shooter

The results in soccer are evaluated by the number of scored goals. History usually does not care how they were scored. For the spectators, however, this usually makes all the difference.

This challenge consists of six rounds. In each round, the robot starts from its own penalty area oriented towards the goal. The ball is placed randomly (by rolling a die) inside this half of the field on one of the following spots:

1. Left neutral spot
2. Right neutral spot
3. Left corner of the penalty area
4. Right corner of the penalty area
5. Left corner of the field
6. Right corner of the field

The robot needs to locate the ball and score a goal while staying on its own half of the field. Each round takes at most 20 seconds.

- The team is free to pick which side to kick from.
- The same robot must be used for all rounds.
- The robot must stay on its half of the field for the goal to count, but ”out of bounds” rules do not apply.

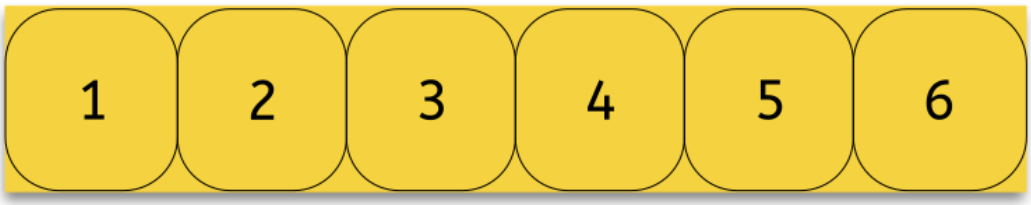


Figure 5. Partitioning of the goal into 6 parts.

Initially, the opposite goal is completely open (see Figure 5, “Partitioning of the goal into 6 parts.”). After each scored goal a member of the team rolls a die and the part of the goal that corresponds to the number on the dice will be covered with a black box. If this part of the goal is already covered, the die will be rolled again. See Figure 6, “An example state of the goal after two rounds”, where the number 3 and number 5 were rolled on a die after each round and the respective parts of the goal are covered. Note that if number 3 or 5 will get rolled in the next rounds, a new roll of a die will follow.

The result of this challenge is the number of scored goals.

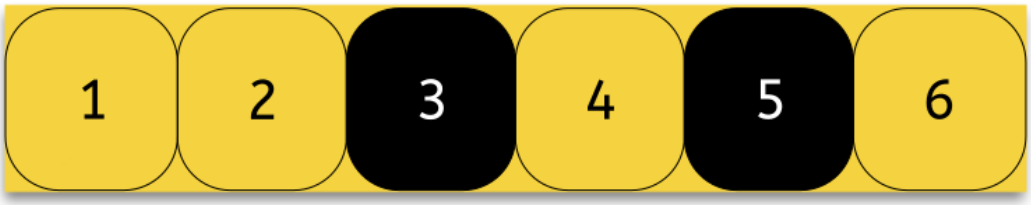


Figure 6. An example state of the goal after two rounds

9.3.2. Innovative usage of landmarks

The six landmarks on the field were introduced in the previous version of the rules in an attempt to provide more opportunities for experimentation with localization on the field. However, the change has shown to be quite disruptive (in many cases it caused more harm than good) and so a new version of landmarks has been designed for this year in order to fix this.

Since these landmarks have been in the rules for quite some time now and some teams may have invested into using them, this challenge has been designed to give them an opportunity to present their work and receive some bonus points for it as well.

The result of this challenge is a binary decision: a set of bonus points awarded to a team which manages to persuade the OC that they use the landmarks in an innovative way.

9.4. Further information on International Competition

All teams qualified to the international competition **must** share their designs, both hardware and software, with all present and future participants. These teams are also required to send a digital portfolio before the competition. Further details on how will be provided by the Organizational Committee.

During the competition days of the International Competition (as well as before the event) the team members are responsible for checking all relevant information published by the Soccer Organizational Committee, General Chairs, or any other RoboCup official.

Teams competing in the International Competition can receive awards for their performance. These awards are decided and introduced by the Organizational Committee, which publishes all necessary details well before the actual event. In the past years they were awarded for best poster, presentation, robot design, team spirit and individual games.

Note that as stated in Rule 6.5, “Spirit”, ***it is not whether you win or lose, but how much you learn that counts!***

Appendix A: Technical Specification for pulsed Soccer Ball

A.1. Preamble

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 Technical Committee defined the following technical specifications with the special collaboration from EK Japan and HiTechnic.

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.

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, … - on-off detection with a possible gross indication of distance).

A.2. Specifications

A.2.1. IR light

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.

A.2.2. Diameter

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

A.2.3. Drop Test

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.

A.2.4. Modulation

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.

A.2.5. Battery Life

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.

A.2.6. Coloration

The ball must not have any marks or discoloration that can be confused with a field landmark, goals, or the field itself.

A.3. Official suppliers for pulsed balls

Currently, there is one ball that has been approved by the RoboCupJunior Soccer Technical Committee:

- RoboSoccer ball operating in MODE A (pulsed) made by EK Japan/Elekit (https://elekit.co.jp)

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 TC.

Appendix B: Technical Specification for passive Soccer Ball

B.1. Preamble

In order to push the state of the art in the Soccer competition forward, the RCJ Soccer Technical Committee has the defined the following technical specifications for the "passive" ball. The chosen values and characteristics reflect the desire of the Technical Committee to make sure that the selected ball is not fundamentally different from the IR ball that was used before, and that it is close to balls used in the Soccer leagues in the Major category, where the Junior competitors may continue to compete once they pass the age limits.

The Technical Committee has been able to identify two balls that meet the technical specifications outlined below and are available worldwide. None of these balls have been marked official. That means it is not guaranteed that one of these balls will be used at the international event. However, the official ball will not be much different. These balls are:

1. https://www.schweikert-hundesport.de/index.php/en/Ball%2C-orange%2C-hollow%2C-plastic/c-220910/a-93011 Note that since the e-shop may also send you a semi-glossy ball by mistake, it is safer to mention that you would like to receive a matte ball when finishing your order or in an email after you finish it.
2. https://www.amazon.com/Mylec-Weather-Bounce-Hockey-Orange/dp/B002LBDA30

The Technical Committee found the first ball preferable, as the second one might reflect light to some extent (for instance from camera flashes).

B.2. Specifications

B.2.1. Diameter

The diameter of the ball is required to be 65mm +- 5mm. A well-balanced ball shall be used.

B.2.2. Drop Test

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.

B.2.3. Coloration

The ball shall be of orange color. Since the definition of the orange color in general is not easy, any color that a human would deem to be orange and is substantially different from the other colors used on the field is acceptable. There should be no distractive markings on the ball.

B.2.4. Surface

The surface of the ball shall be smooth and matte. Engravings on the ball's surface are tolerated. The ball should not reflect light. The inside of the ball should be hollow.

B.2.5. Weight

The ball should be no heavier than 80 grams and no lighter than 60 grams.

Appendix C: Kicker Power Measuring Device

All robot kickers will be tested with the ball used in the sub-league they participate in.

C.1. Preamble

This Kicker Power Measuring Device can measure the power of a robot's kicker. It is easy to build with commonly accessible materials.

This device can measure the power of a robot's kicker up to a length of 22cm.

C.2. Materials

Plastic Board	A4 paper size
M3 Spacers (40mm length)	5
M3 Screw	10

C.3. Device schematics

The device schematics can be printed out from the diagram located at the end of the document. Please be advised to check that the software you use to print the schematic does not have a **scale to fit** option activated (i.e. check that it is configured to print at 100% or **actual size** scale).

The device schematics shows a straight line past the 22cm mark, while the photo shows the line at that point to be curved. Either straight or curved lines are acceptable, but a curved line will request more difficult cutting and the attached device schematic is simple enough for quick construction.

C.4. Example of device construction

1. Print out the device schematics.
2. Paste the paper on a plastic board. The incline line (red lines) should be straight.
3. Cut out along the lines, and drill the holes.
4. The two boards should be connected using the 40mm spacers.

C.5. Inspection

1. Place a ball at the bottom of the ramp run of the device, and put the robot in front of the ball, aiming the kicker towards the top of the ramp.
2. Activate the robot's kicker for a single shot.
3. Measure the distance that the ball traveled on the device. The distance should not exceed 22 cm.

Appendix D: Inspections sheet example

TEAM/ROBOTS INSPECTION SHEET

DATE	[ ]30th June, Thu [ ]1st July, Fri [ ]2nd July, Sat [ ]3rd July, Sun		
ROUND			
CATEGORY	[ ]Lightweight	[ ]Open	
TEAM NAME		TEAM CODE	

Basic: !! Before EVERY game, REFEREE check AGAIN !!

1.SIZE (spread all moving part then ≤22.0cm, HANDLE is not included)			[ ]OK
2.WEIGHT (including batte ry ≤2.4kg Open≤1.1 Light) [g] [g]			[ ]OK
3.BALL CAPTURE ZONE (<3cm)	[ ]OK	4.Top Marker	[ ]OK
5.BATTERY VOLTAGE (≤15V O, ≤12V L) [V] [V]	[ ]P ower pump used		[ ]OK
6.KICKER POWER	[ ] Electric [ ]Air Power[ ]		[ ]OK
7.EMITTING LIGHT, BLUE and YELLOW colored parts (or other equipments disturbing any sensors)	OK [ ] COMMENTS		
8.DANGER EQUIPMENT (damage the field, ball, other robots and referees!)	OK [ ] COMMENTS		

Need Special Interview/TC discussion

9.Check if you think need special interview [ ] Sensor issues (i.e. IR distance sensor) [ ] Battery Voltage issues [ ] Kicker Power issues [ ] Construction issues (i.e. danger equipments, commercial kit etc)	10.COMMENTS TO TC/Interviewers [ ] Special Interview [ ] TC discus sion sign……..…….….

Appendix E: Landmarks Template (2018 version)

There are colored landmarks positioned on each wall. They consist of two magenta circles printed on letter paper (A4, 210mm x 297mm). They measure 70mm in diameter and their centers are 150mm apart from each other. Their position within the landmark as well as the position of the respective landmarks on the field can be seen in Figure [fig:landmarks_blueprint]. Note that these landmarks are always positioned in the middle of the wall.

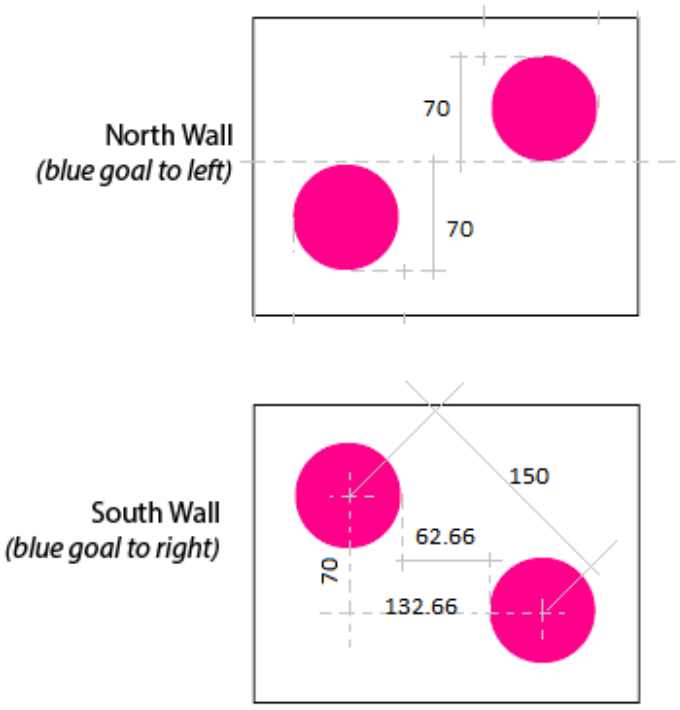


Figure 7. Position of magenta circles on each of the two landmarks, as well as the position of each of the two landmarks on the field. Note that in this case "blue goal to the left/right" here to the situation when one is looking directly at the blue goal from the center of the field. For more information on the position of landmarks please consult the Field diagrams section.

The color used for these landmarks (magenta) is defined (for the purpose of this section) to be one of the following:

- `RGB (217, 1, 2)`
- `CMYK (0, 255, 0, 0)`
- PANTONE Process Magenta C (https://www.pantone.com/color-finder/Process-Magenta-C)

The following two pages contain a template for the landmarks that are to be put on the walls of the field. When printed on ordinary A4 paper, they should have the measures described by these rules. While the color on the printed papers will differ from printer to printer, printing these pages using the sRGB "printer profile" (color scheme) produces the best results.

[1] 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

[2] 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

[3] For the purpose of this rule a time chunk is defined as time between two events when the robot is taken off the field for some reason (e.g. at the end of the first half of the game, when it is deemed damaged or out of bounds).

[4] range shorter than 20 meters

[5] biggest differences are described in 8.2.1 Dimensions