Rules of the RoboCup Small Size League 2019

2018-10-01

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NOTE	References to the male gender in the rules with respect to referees, team members, officials, etc. are for simplification and apply to both males and females.

1. League Overview

1.1. Committees

The Small Size League (like every other league of the RoboCup) is run by close cooperation of three different committees (executive committee, technical committee and organizing committee), all with a different set of responsibilities. The members of the respective committees can be found on the official RoboCup Small Size League website (https://ssl.robocup.org).

NOTE	In practice, there is no strict separation between the technical and the organizing committee. Members of both committees often work together on the joint set of tasks.

Additionally, the members of the local organizing committee organize the RoboCup event for all leagues.

1.1.1. Executive Committee

Executive committee members are responsible for the long term goals of the Small Size League and thus have also contact to other leagues as well as to the RoboCup federation. The executive committee presents the Small Size League and its achievements to the RoboCup federation every year and gets feedback to organize the league. Executive committee members are elected by the board of trustees of the RoboCup federation. They serve 3-year terms.

1.1.2. Technical Committee

The technical committee of the Small Size League is responsible for the technical aspects of the RoboCup, such as maintaining the rules and the shared software. All members are elected by the team leaders of the teams which have participated in the previous competition.

1.1.3. Organizing Committee

The organizing committee of the Small Size League is responsible for preparing and organizing the competition. This mainly includes making the schedule, performing the qualification process, and running the competition. The committee members are selected by the executive committee of the league and the RoboCup trustees.

1.1.4. Local Organizing Committee

The local organizing committee is responsible for planning and executing the event itself in accordance with the needs of the different leagues. This includes setting up the team areas (fields, network, tables, whiteboard, screens, etc.), creating a schedule for the event and implementing a safety and security concept.

1.2. Divisions

The Small Size League is divided into two divisions with separate tournaments, namely division A and division B. Division A is aimed at advanced teams whereas new and/or less competitive teams can play in division B. Each team will only play in one of those two divisions.

When submitting the qualification material, the team also chooses a preferred division including a short rationale. The members of the organizing committee will have the final word. Information about the qualification process can be found on the official RoboCup Small Size League website (https://ssl.robocup.org).

NOTE	Divisions allow for more radical advancements in the Small Size League without drastically raising the entry barrier for new teams. Additionally, they also considerably increase the amount of matches between teams of similar skill.

2. Playing Environment

2.1. Field Setup

2.1.1. Dimensions

The field of play must be rectangular and of the following size:

- Division A: 13.4 meters times 10.4 meters with a playing area of 12 meters times 9 meters
- Division B: 10.4 meters times 7.4 meters with a playing area of 9 meters times 6 meters

The exact field dimensions and the field markings at the venue may vary by up to ±10% in each linear dimension.

The two figures below show the dimensions of the field, the goals and special field areas, measured in millimeters. Figure 1 shows the dimensions for division A and figure 2 for division B.

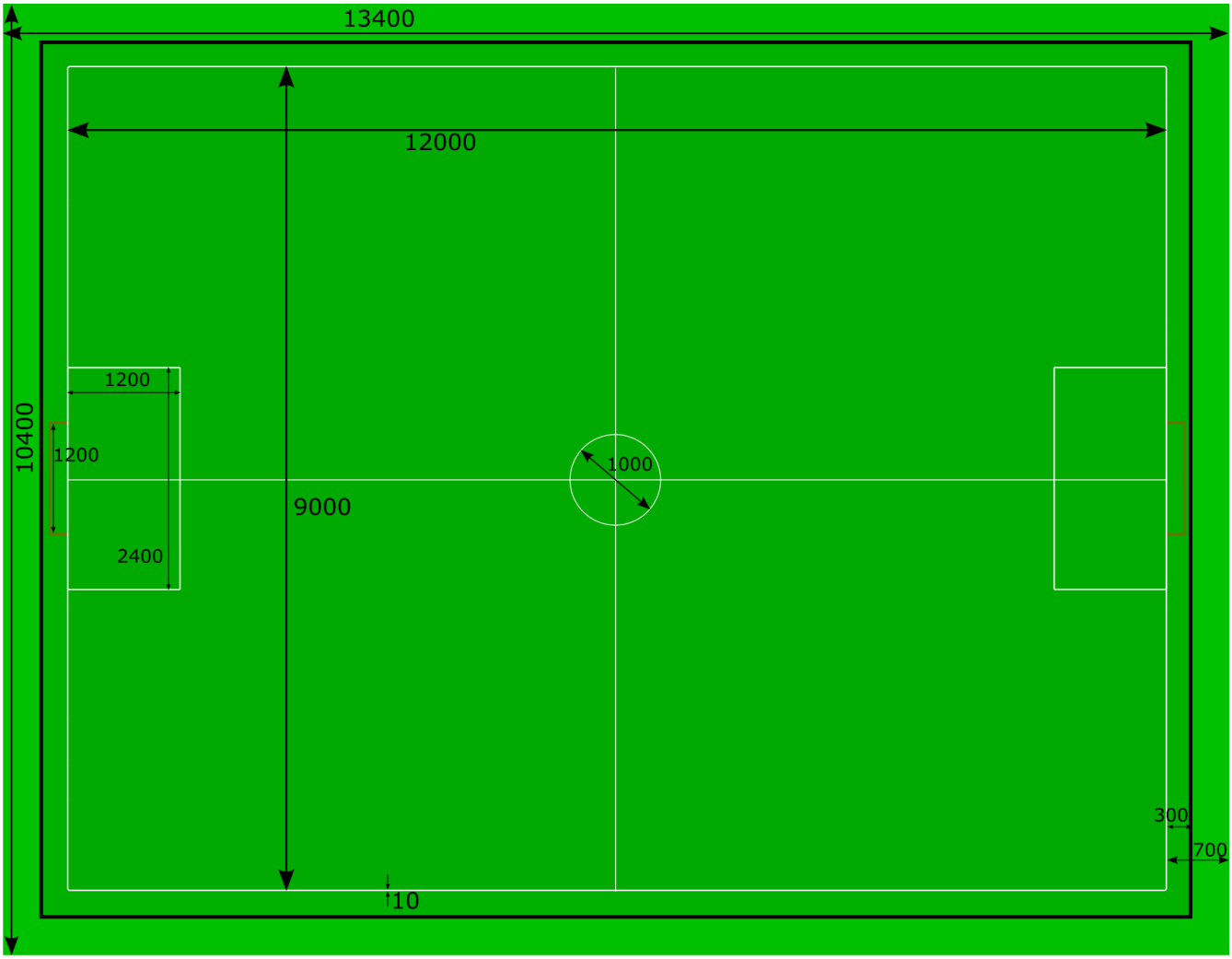

Figure 1. Field dimensions and markings for division A

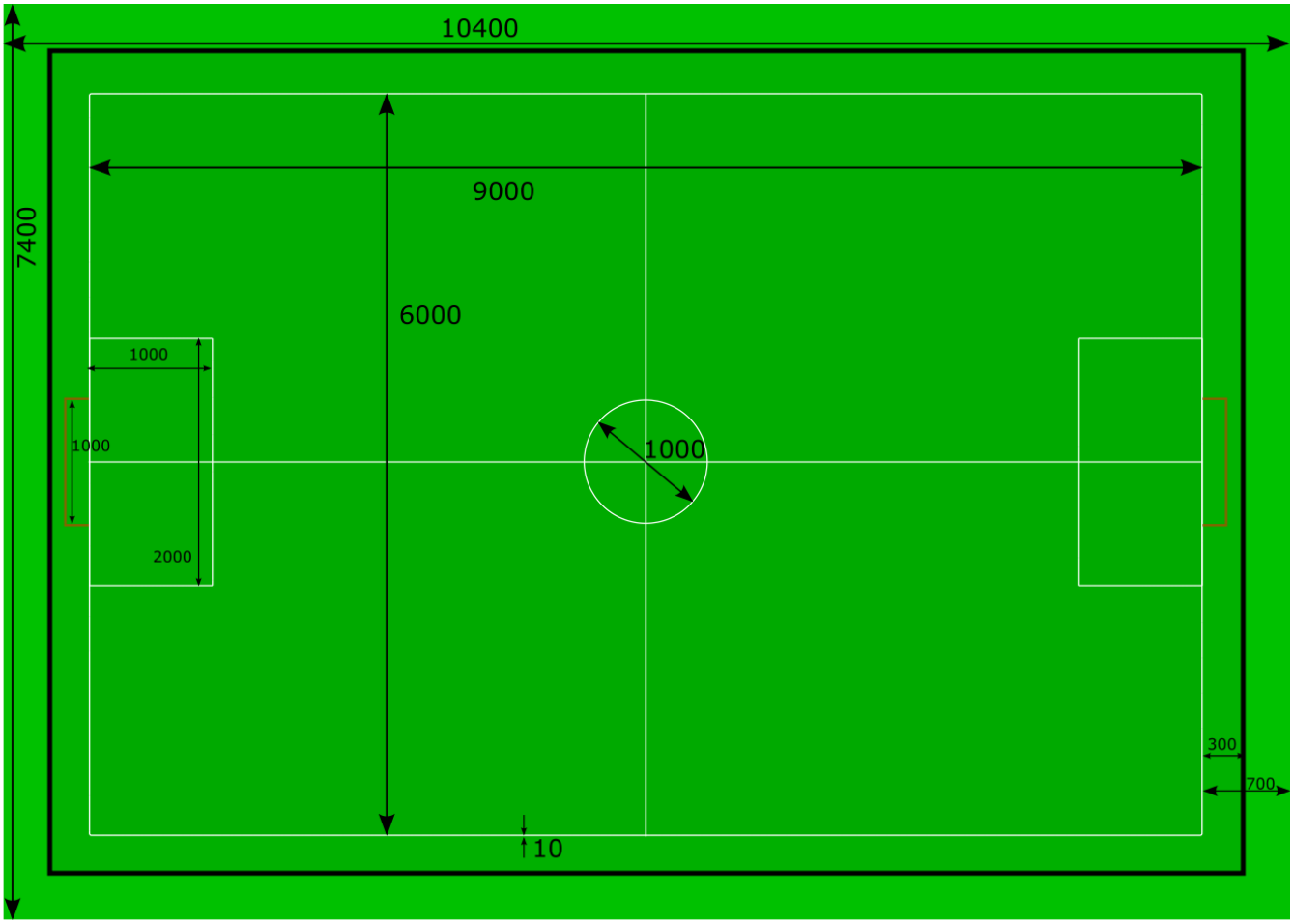

Figure 2. Field dimensions and markings for division B

2.1.2. Field Surface

The playing surface is green felt mat or carpet. The floor under the carpet is level, flat, and hard.

The field surface will continue for 0.7 meters beyond the field lines on all sides. The outer 0.4 meters of this runoff area, separated from the robot area by a 0.1 meters tall wall, is used as a designated walking area for the referee and the assistant referee.

2.1.3. Field Markings

The field of play is marked with lines. All lines are 0.01 meters wide and white (paint, spray, white carpet or strong tape). Lines belong to the areas of which they are boundaries.

Field Lines

The playing area is defined by four field lines. The two longer field lines are called touch lines. The two shorter field lines are called goal lines.

Additional Lines

The field of play is divided into two halves by a halfway line that runs along the width of the field and through the center of the field. The halfway line is parallel to the goal lines.

A mid-line runs along the length of the field, passing through the center of the field. The mid-line is

parallel to the touch lines. This line is used to provide adequate features for the geometry calibration of the vision software.

Center Circle

The center mark is indicated at the midpoint of the halfway line. A circle with a diameter of 1 meter is marked around it for both divisions.

Defense Area

A defense area is defined at each end of the field as a rectangle of 2.4 meters times 1.2 meters for division A and 2 meters times 1 meter for division B.

Penalty Mark

For each field half the penalty mark is 1.2 meters for division A and 1 meter for division B, from the midpoint between the goalposts and equidistant to them, thus coinciding with the outer edge of the defense area.

2.1.4. Goals

Goals must be placed on the center of each goal line and anchored securely to the field surface. They consist of two 0.16 meters high vertical side walls joined at the back by a 0.16 meters high vertical rear wall. The inner face of the goal has to be covered with an energy absorbing material such as foam to help absorb ball impacts and lessen the speed of deflections. The goal walls, edges, and tops are white in color.

The distance between the side walls is 1.2 meters for division A and 1 meter for division B, and the goal is 0.18 meters deep. The goal walls are 0.02 meters thick and touch the goal line, but do not overlap or encroach on the field lines or the field. Figure 3 and Figure 4 show these details for division A and division B respectively.

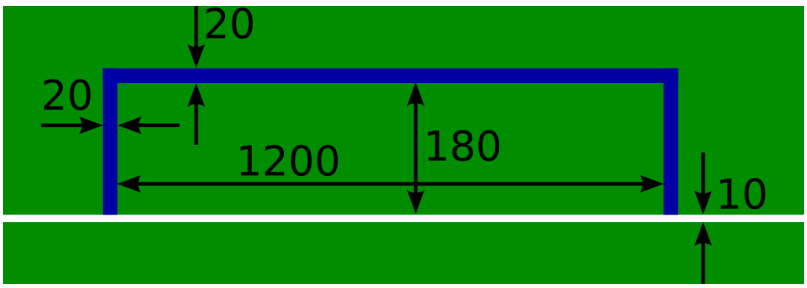

Figure 3. The goal in detail for division A

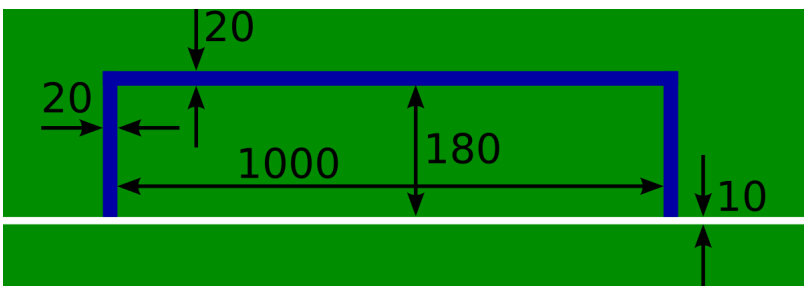

Figure 4. The goal in detail for division B

2.2. Ball

The ball is a standard orange golf ball. It weights approximately 0.046 kilograms and its diameter measures 0.043 meters.

For official matches, the organizing committee provides the ball.

2.3. Shared Software

2.3.1. Vision

Each field is provided with a shared central vision server and a set of shared cameras. This shared vision equipment uses the community-maintained SSL-Vision software (https://github.com/RoboCup-SSL/ssl-vision) to provide localization data to teams via Ethernet in a packet format that is to be announced by the shared vision system developers before the competition. Teams need to ensure that their systems are compatible with the shared vision system output and that their systems are able to handle the typical properties of real-world sensory data as provided by the shared vision system (including noise, latency, or occasional failed detections and misclassifications). The vision patterns on the top of the robots must adhere to the specifications of SSL-Vision, and must be of the standard color paper as specified in the SSL-Vision documentation.

Besides the shared vision equipment, teams are not allowed to mount their own cameras or other external sensors, unless specifically announced or permitted by the respective competition organisers.

2.3.2. Game Controller

A game is controlled by the community-maintained ssl-game-controller (https://github.com/RoboCup-SSL/ssl-game-controller). It is operated by the game controller operator. The software translates decisions of the referee and the automatic referee into Ethernet communication signals that are broadcast to the network. It maintains the state of the game, tracks all events and acts as a proxy between all participating parties in the game.

The game-controller has a network interface for the playing teams. They can automatically change their keeper id when the ball is not in play and they can reply to requests of the advantage rule.

2.3.3. Automatic Referee

One or more automatic referee applications can supervise a game and report offenses to the game controller. At least one automatic referee is required per game. If more than one automatic referee is connected to the game controller, a majority vote can be applied.

New automatic referee implementations can be provided, given that the source code is open-sourced. New implementations must be announced at least three months before the competition. The technical committee decides if an implementation will be used or not.

Existing implementations can be found on Github: https://github.com/RoboCup-SSL/ssl-autorefs.

3. Robots

3.1. Number Of Robots

A match is played by two teams, each consisting of not more than 8 robots in division A and 6 robots in division B, one of which may be the keeper. Each robot must be clearly numbered according to its vision pattern so that the referee can identify it during the match. The keeper must be designated before the match starts (see Choosing Keeper Id).

3.2. Hardware And Software Constraints

The referee may force a team to remove a robot from the field if it does not satisfy the rules. Members of the technical committee may also check the hardware and software constraints of robots at any point of the tournament.

If a team is not able to provide at least one robot that satisfies the rules, the team may be forced to forfeit.

3.2.1. Safety

A robot must not pose danger to itself, another robot, or humans. It must not damage or modify the ball or the field.

The referee has to force a team to remove a robot from the field if he considers it a potential safety threat.

3.2.2. Shape

A robot must fit inside a 0.18 meters wide and 0.15 meters high cylinder at any point in time. Additionally, the top of the robot must adhere to the standard pattern size and surface constraints.

3.2.3. Dribbling Device

Dribbling devices that actively exert spin on the ball, which keep the ball in contact with the robot are permitted under certain conditions:

- The dribbling device must not elevate the ball from the ground
- Another robot must be able to remove the ball from a robot with the ball.
- A robot must not take full control of the ball by removing all of its degrees of freedom.
- 80% of the area of the ball when viewed from above should be outside the convex hull around the robot. This limitation applies as well to all kicking devices, even if such infringement is momentary.

3.2.4. Vision Pattern

All participating teams must adhere to the given operating requirements of the shared vision

system. In particular, teams are required to use a certain set of standardized colors and patterns on top of their robots.

To ensure compatibility with the standardized patterns for the shared vision system, all teams must ensure that all robots have a flat surface with sufficient space available on the top side. The color of the robot top must be black or dark grey and have a matte (non-shiny) finish to reduce glare. The standard vision pattern is guaranteed to fit within a circle with a radius of 0.085 meters that is linearly cut off on the front side of the robot to a distance of 0.055 meters from the centre, as shown in figure 5. Teams must ensure that their robot tops fully enclose this area.

The standard pattern to be used by all teams is shown in figure 5. Note that the technical committee and the organizing committee reserve the right to change this pattern at any time, if required. Teams must therefore make sure to still adhere to the standard robot top area size.

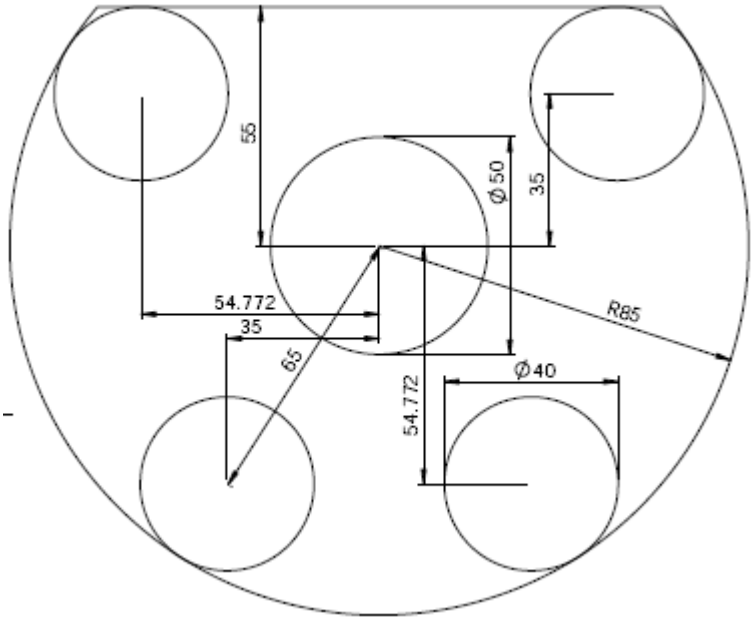

Figure 5. Standard Vision Pattern Dimensions

Every robot must have one of the 16 patterns shown in figure 6. No two robots are allowed to use the same pattern.

The center dot color determines the team and is either blue or yellow (see Choosing Team Colors). The other four dot colors encode the id of the robot. To ensure that every team uses the same colors, the organizing committee provides enough colored paper at the competition.

NOTE	Teams are encouraged to prefer color assignments with ids 0 to 7 because they have been experimentally found more stable, as there is no risk that the back two dots “color-bleed” into each other.

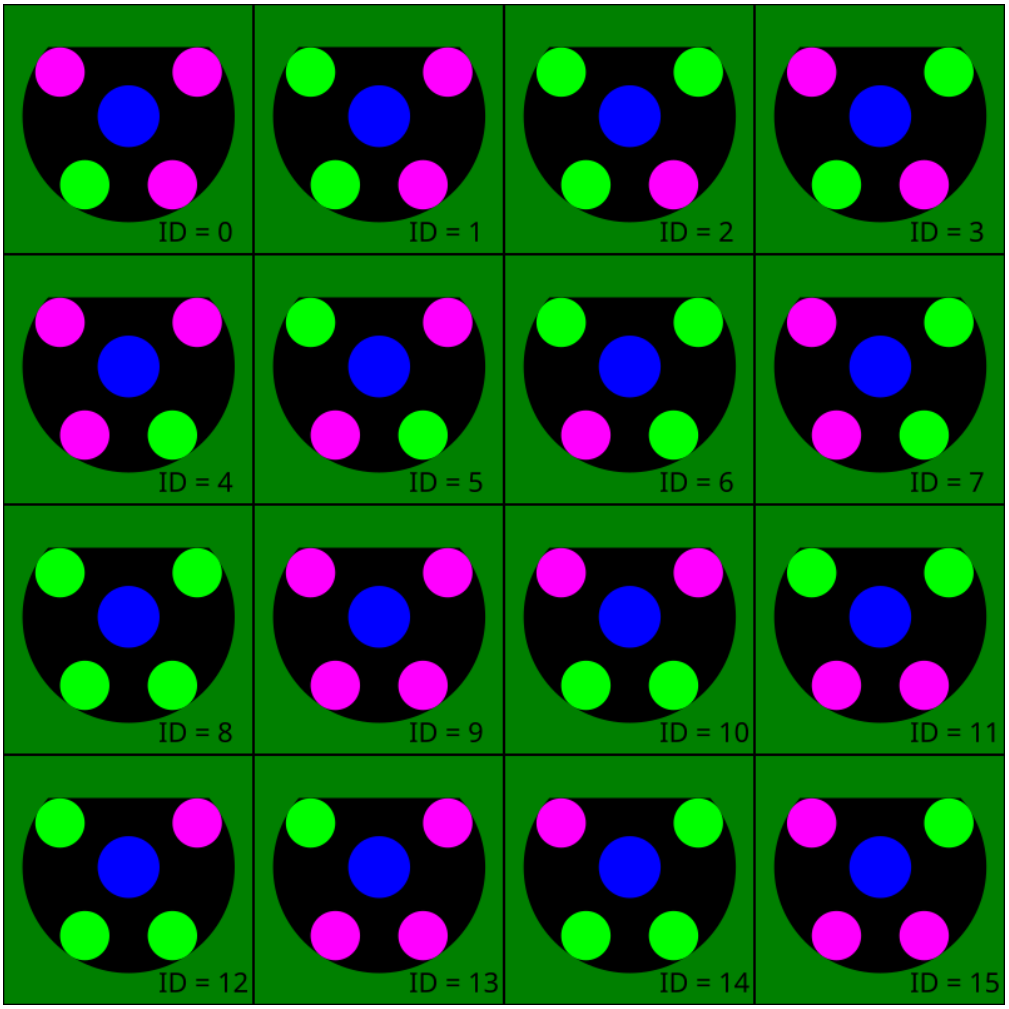

Figure 6. Standard Vision Pattern Colors

3.2.5. Radio Communication

Participants using wireless communications must notify the organizing committee of the method of wireless communication, power, and frequency. The organizing committee must be notified of any change after registration as soon as possible. In order to avoid interference, a team should be able to select from two carrier frequencies before the match. The type of wireless communication has to follow legal regulations of the country where the competition is held. Compliance with local laws is the responsibility of the competing teams, not the RoboCup Federation.

The type of wireless communication may also be restricted by the local organizing committee. The local organising committee will announce any restrictions to the community as early as possible.

NOTE	Communication technolgies that use carrier frequencies in the 2.4 GHz or 5 GHz band (like Bluetooth) are usually prohibited to prevent interference with other leagues.

3.2.6. Autonomy

The robotic equipment has to be fully autonomous. Human operators are not permitted to enter any information to the system during a match, except in breaks or during a timeout. Disregarding this rule is considered unsporting behavior.

4. Game Structure

4.1. Impartial Roles

To play an official match in the Small Size League, four impartial roles must be filled:

- the referee
- the assistant referee
- the game controller operator
- the vision expert

Usually, these roles are filled by two non-playing teams, with one team providing the referee and the game controller operator and the other team providing the assistant referee and the vision expert. The assignment of the roles is up to the organizing committee.

Every participating team is required to be able to provide enough people who are familiar with these roles.

4.1.1. Referee

Each match is controlled by the referee. He has full authority to enforce the rules of the Small Size League in connection with the match to which he has been appointed. The referee is encouraged to use the designated walking area next to the field (see Field Setup).

The referee is assisted by the automatic referee software. The human referee is allowed to override any decision made by the automatic referee software.

The decisions of the referee regarding facts connected with play are final. The referee may only change a decision on realising that it is incorrect or, at his discretion, on the advice of an assistant referee, provided that he has not restarted play.

The referee is not held liable for any kind of injury suffered by an official or spectator, any damage to property of any kind nor any other loss suffered by an individual, club, company, association, or other body.

The robot handler is the only team member that may talk to the referee.

Duties

- The referee ensures a safe match for all humans and robots
- The referee ensures a fair match according to the rules of the Small Size League
- The referee ensures that there is no interference by unauthorized persons or team members
- The referee or assistant referee places the ball for kick-offs and penalties (division A) or after every stoppage (division B). Subsequently, the referee resumes the match
- The referee ensures that the game is started and resumed in time

4.1.2. Assistant Referee

The assistant referee supports the referee wherever he can. He is encouraged to use the designated walking area next to the field, opposite the referee.

No team members are allowed to talk to the assistant referee.

Duties

- The assistant referee indicates when misconduct or any other incident has occurred out of the view of the referee
- The assistant referee discusses unclear situations with the referee
- The referee or assistant referee places the ball for kick-offs and penalties (division A) or after every stoppage (division B)

4.1.3. Game Controller Operator

During a match, the game controller operator uses the game controller software as an interface between the referee, the automatic referee and the team software.

No team members are allowed to talk to the game controller operator.

Duties

- The game controller operator configures the game controller before the game begins
- The game controller operator enters the signals of the referee into the game controller
- The game controller operator watches the game event log for any events that need attention, like detections of an automatic referee or elapsed timers and notifies the referee

4.1.4. Vision Expert

During a match, the vision expert is in charge of the shared vision system on the field.

Team members are generally advised not to talk to the vision expert, unless they experience major vision problems.

Duties

- The vision expert checks the vision hardware and reports any kind of hardware problems to the technical committee
- The vision expert monitors the shared vision system during the match and reports any kind of problems to the referee instantly
- The vision expert recalibrates the vision system if the referee deems it necessary

4.2. Team-Specific Roles

4.2.1. Robot Handler

Before the start of the match, every team has to designate one robot handler. The robot handler

represents the team during the match.

Duties

- The robot handler helps preparing the match.
- The robot handler asks the referee for timeouts if necessary.
- The robot handler asks the referee for the permission to substitute a robot in the next stoppage and, if the referee agrees, substitutes the robot.
- The robot handler voices concerns of the team (for example network issues or vision problems).

4.3. Match Preparation

All people that fill a role in the match (impartial or team-specific) have to be ready at least 10 minutes before the start of the match to allow the referee to make the following preparations:

4.3.1. Game Result Sheet

The referee obtains a game result sheet from the organizing committee. After the game, the referee fills in the final score, collects the required signatures and submits the sheet to the organizing committee.

NOTE	While obtaining the game result sheet, the referee can also take an official ball and referee equipment such as a whistle or red and yellow cards (if provided).

4.3.2. Testing The Network

The referee ensures that both teams receive vision data and referee commands.

4.3.3. Choosing Team Colors

The referee asks the robot handlers of the teams about their preferred team color (either blue or yellow). If the teams agree on a color assignment, the colors will be used for the entire match.

However, if both teams prefer the same color, the referee assigns the colors by chance. In this case, the teams switch the colors after the first half of the match as well as after the first half of the overtime if applicable.

4.3.4. Choosing Side And Kick-Off

The referee tosses a coin with both robot handlers. The winning team chooses the goal it will attack in the first half of the match. The other team takes the kick-off to start the match.

4.3.5. Choosing Keeper Id

The referee asks both robot handlers which robot they will use as the keeper and forwards this information to the game controller operator.

4.4. Game Stages

4.4.1. Overview

An official match of the Small Size League consists of the following stages:

Game Stage	Duration
First Half	300 seconds of playing time
Half-Time Break	300 seconds pause
Second Half	300 seconds of playing time

If the match is an elimination match (draw is not a possible outcome) and the score is even after the regular game time, the match goes into overtime and the following game stages are added:

Game Stage	Duration
Pre-Overtime Break	300 seconds of pause
Overtime First Half	150 seconds of playing time
Overtime Half-Time Break	120 seconds of pause
Overtime Second Half	150 seconds of playing time

If the score is even after overtime has been played, the following stages are added:

Game Stage	Duration
Pre-Shoot-Out Break	120 seconds of pause
Shoot-Out	unlimited

NOTE The actual time is much greater than the playing time, since the game timer is paused when the game is stopped.

4.4.2. Timeouts

The robot handler has to ask the referee for a timeout. Timeouts are handled like breaks, meaning that both teams are allowed to make modifications to their software and hardware (see Autonomy).

Each team is allocated 4 timeouts at the beginning of the match. A total of 300 seconds is allowed for all timeouts. Timeouts may only be taken during a game stoppage. The time is monitored and recorded by the game controller operator.

NOTE For example, a team may take 3 timeouts of 60 seconds duration and thereafter have only one timeout of up to 120 seconds duration.

During overtime, both teams can use 2 timeouts with a total time of 150 seconds. The number of timeouts and the time not used in regular game are not added.

No timeouts are possible in the shoot-out stage.

4.4.3. Early Termination At A Score Of 10

When a team manages to shoot 10 goals, the match is automatically terminated and the team with more goals is declared the winner, regardless of the current game stage.

5. Referee Commands

5.1. Stopping The Game

When the game is stopped, the ball is considered out of play until it has been brought into play.

The game time is paused during stop, halt and ball placement.

NOTE	The game time is not paused during other referee commands, even if the ball is still out of play.

5.1.1. Stop

Definition

When the stop command is issued, all robots have to slow down to less than 1.5 m/s. Additionally, all robots have to keep at least 0.5 meters distance to the ball and are not allowed to manipulate the ball.

NOTE	If the ball moves very quickly, it is hard to always keep the required distance to the ball, especially since the speed of the robots is limited during stop. Therefore, it is sufficient if it is obvious to the referee that the robots try their best to follow the distance rule.

Usage

The stop command is used to pause the game after the ball crossed the field lines (including goals) or an offense occurred as well as to prepare the start or resumption of the game after halt, timeouts and automatic ball placement. The robot speed limit and the minimum distance to the ball allow the referee or assistant referee to place the ball safely and without interference.

5.1.2. Halt

Definition

When the halt command is issued, no robot is allowed to move or manipulate the ball.

There is a grace period of 2 seconds for the robots to brake.

Usage

The halt command allows the referee to interrupt the game immediately whenever an emergency occurs (for example when a robot gets out of contol). It is also used to recalibrate the vision software during a game if the vision expert considers it necessary and the referee agrees and for robot substitution. Additionally, the referee is free to issue the halt command at will.

The halt command is always followed up by stop.

5.2. Resuming The Game

To resume the game after a stoppage or start the game in the first place, the ball has to be placed at a certain position on the field first. The main referee or assistant referee is advised to use a so-called ball handler (a long, preferably black stick-like device) to move the ball.

In division A, the ball will be placed automatically by the robots if the following command is a free kick or force start (see Ball Placement).

When force start has been issued or the ball moved at least 0.05 meters following a kick-off, direct free kick, indirect free kick or penalty kick, the ball is considered in play (see Double Touch for the rationale of the 0.05 meter distance).

5.2.1. Kick-Off

Definition

The ball has to be placed in the center of the field by the human referee.

When the kick-off command is issued, all robots have to move to their own half of the field excluding the center circle. However, one robot of the attacking team is also allowed to be inside the whole center circle. This robot will be referred to as the kicker. No robot is allowed to touch the ball.

When the normal start command is issued, the kicker is allowed to shoot the ball. A goal may be scored directly from the kick-off.

When the ball is in play, the kicker may not touch the ball until it has been touched by another robot or the game has been stopped (see double touch). Also, the restrictions regarding the robot positions are lifted.

Usage

Both half times as well as both overtime periods (if needed) start with a kick-off. Chapter Match Preparation describes how to determine the attacking team.

Additionally, after a goal has been scored, the receiving team restarts the game with a kick-off.

5.2.2. Direct Free Kick

Definition

The ball placement position for a free kick depends on the event that led to the free kick. This position is valid if there is at least 0.2 meters distance to all field lines and 1 meter distance to either defense area. If an event requires the ball to be placed at a position that contravenes this rule, it has to be placed at the closest valid position instead.

When the direct free kick command is issued, robots of the attacking team are allowed to approach the ball while robots of the defending team still have to stay at least 0.5 meters distance away from the ball (the same distance as in stop). One robot of the attacking team is allowed to shoot the ball.

This robot will be referred to as the kicker. A goal may be scored directly from the direct free kick.

When the ball is in play, the kicker may not touch the ball until it has been touched by another robot or the game has been stopped (see double touch). Also, the restrictions regarding the robot positions are lifted.

Usage

Direct free kicks are used to restart the game after a foul has occured. Additionally, goal kicks and corner kicks are mapped to direct free kicks.

5.2.3. Indirect Free Kick

Definition

An indirect free kick behaves like a direct free kick, except: After an indirect free kick, a goal can only be scored if the ball touches a robot of the attacking team after the ball entered play and before it entering the goal of the defending team. If the ball enters the goal of the defending team without touching an attacking robot, it will be treated like it crossed the goal line outside the goal.

If the ball enters the goal of the attacking team (an own goal), a goal will be awarded to the defending team.

NOTE	Scoring a goal from an indirect free kick does not require more than one attacking robot. The goal can also be shot by the same robot that kicked the free kick if a robot of the defending team touches the ball before the attacker shoots the goal.

NOTE	In association football, it is sufficient if any player (including the keeper) touches the ball before it enters the goal. To discourage the teams to shoot directly at the goal and hope that the keeper touches it, the rules of the Small Size League require a second touch of an attacking robot.

Usage

Indirect free kicks are used to restart the game after a minor offense has occured. Additionally, throw-ins are mapped to indirect free kicks.

5.2.4. Force Start

Definition

When the force start command is issued, the game is immediately resumed and both teams are allowed to approach and manipulate the ball again.

Usage

The referee can issue a stop command followed by force start if there is a clear lack of progress for at least 10 seconds while both teams are allowed to approach and manipulate the ball.

It can also be used to resume the game when the game had to be stopped and no team or both teams are at fault.

5.2.5. Penalty Kick

Definition

To initiate a penalty kick, the stop command has to be sent and the ball has to be placed on the penalty mark by the human referee.

When the penalty command is issued, one attacking robot is allowed to approach but not touch the ball. This robot will be referred to as the kicker. The defending keeper has to touch the goal line. All other robots have to move behind a line parallel to the goal line and 0.4 meters behind the penalty mark. When these constraints are met, the referee may continue with a normal start command.

When the normal start command is issued, the kicker is allowed to shoot the ball. A goal may be scored directly from the penalty kick.

When the ball is in play, the kicker may not touch the ball until it has been touched by another robot or the game has been stopped (see double touch). Also, the restrictions regarding the robot positions are lifted.

Additional time is allowed for a penalty kick to be taken at the end of each half or at the end of periods of overtime.

The penalty kick is retaken if the attacking team infringes the rules and the ball enters the goal or the defending team infringes the rules and the ball does not enter the goal.

Usage

Penalty Kicks are used to punish teams that received multiple yellow cards, as well as to punish unsporting behavior and multiple defenders.

5.3. Sanctions

5.3.1. Yellow Card

Definition

A yellow card can only be given during halt.

If the yellow card is shown as a result of unsporting behavior, the referee may decide to immediately halt the match. In this case, the match continues with a direct free kick for the other team.

Upon receipt of a yellow card, the number of robots allowed on the field for the penalised team decreases by one. If, after this decrease, the team has more robots than permitted on the field, a robot must immediately be taken out before play resumes. The penalized team can choose the robot to remove.

After 120 seconds of playing time (measured by the game controller), the yellow card expires and the number of allowed robots is increased by one. The team may put a robot back in.

For every third card (regardless of its color) for one team, a penalty kick is awarded to the opponent team.

Usage

Yellow cards are used to punish teams that committed multiple fouls.

Yellow cards can also be given by the referee to punish fouls or unsporting behavior.

5.3.2. Red Card

Definition

A red card behaves like a yellow card, exept: It does not expire until the end of the game.

Usage

Red cards are given by the referee to punish severe fouls or unsporting behavior.

NOTE	For example, serious violent contact by the robots or disrespectful behaviour towards the referees can result in a red card.

5.3.3. Forced Forfeit

Definition

A Forced forfeit means that a team instantly loses the current game with a score of 0 to 10.

Usage

A team can be forced to forfeit if it is unable to play with at least one robot that satisfies the rules.

A team can only be forced to forfeit in agreement with members of the technical committee and the organizing committee.

5.3.4. Disqualification

Definition

A Disqualification means that a team immediately drops out of the tournament and places last. It will not be eligible to receive any trophies.

Usage

A team can be disqualified if members of this team don't follow safety guidelines, rules of the venue or commit similarly severe offenses.

A team can only be disqualified in agreement with members of the technical committee and the organizing committee.

5.4. Special Commands

5.4.1. Ball Placement

Definition

After the game was stopped, the ball must be placed on the appropriate position, depending on the event that occurred. The automatic ball placement is the preferred way to place the ball at the

designated position on the field by the robots of the teams without human interaction. If this is not possible, the referee places the ball manually.

A ball is considered placed successfully by the robots if

- no more than 30 seconds passed since the placement command
- there is no robot within 0.05 meters distance to the ball if the next command is an indirect free kick or direct free kick
- there is no robot within 0.5 meters distance to the ball if the next command is a force start
- the ball is stationary
- the ball is at a position within 0.15 meters radius from the requested position

No further commands will be issued by the game controller until the automatic placement is complete. The game will be continued by the game controller as soon as the ball is successfully placed. A failed placement will result in an indirect free kick for the opposing team. If this team failed to place the ball as well, the ball is placed by the referee and game continues with the original command.

The non-placing team must not interfere the ball placement task.

Usage

When the ball goes out of play, the following rules decide, if automatic ball placement is applied:

1. The referee has to place the ball for all kickoffs and all penalty kicks
2. For an indirect free kick or direct free kick, the team that brings the ball into play must place the ball
3. For a force start, a team is drawn by chance and must place the ball
4. The ball must be visible and must not be inside a field or goal corner or behind the goal, before the ball placement starts
5. The referee can decide to place the ball manually at any time
6. The referee can decide to disable automatic ball placement for the rest of the game. TC/OC must agree with this decision
7. When a team has failed to place the ball five times in a row, it is not allowed to place the ball for the rest of the game half. All free kicks that were a result of the ball leaving the field, are awarded to the opposing team. For all other rule violations or when both teams failed to place the ball, the ball is placed by the referee
8. If no team can place the ball, the ball is placed by the referee

NOTE	The ball may still be moving when the placement command is issued.

Ball placement is mandatory for all teams in division A. Teams in division B may decide, at any time before or during the game, not to place the ball for the rest of the game by talking to the referee, who in turn tells the game controller operator to disable ball placement for this team. In this case, the team is allowed to bring the ball into play, after the ball was placed by the opposing team. If the opposing team fails to place the ball or no team can place the ball, it is placed by the referee.

5.4.2. Shoot-Out

Definition

Both teams alternately attempt to score a goal until each team has performed 5 attempts. If both teams have the same score after those 5 attempts, each team takes another attempt in the same order as before until the score of the two teams is different.

Only one attacking robot and one keeper is allowed per team. During a shoot-out attempt, the attacking robot and the opponent keeper are the only ones allowed to move and manipulate the ball. Other robots are not allowed to interfere.

The procedure of a shoot-out attempt is as follows:

1. The ball is placed by the human referee on the mid-line (not halfway line), 8 meters (division A) or 6 meters (division B) away from the opponent goal.
2. When the penalty command is issued, the defending keeper has to move to the goal line and keep touching it.
3. When the normal start command is issued, the attacker is allowed to manipulate the ball. The ball has to only move towards the opponent goal, as measured by its x coordinate in the coordinate system of SSL-Vision.
4. When the ball is in play, the defending keeper may move freely again, analogous to a penalty kick.

A goal is awarded if:

- the ball enters the goal of the defending team in less than 10 seconds, starting from when the penalty command is issued
- the defending team violates any rule

A goal is not awarded if:

- the ball crosses any field lines outside the goal
- the defending keeper touches the ball such that the ball speed vector changes direction by at least 90 degrees in 2D space
- the attacking team violates any rule

NOTE	The restrictions defined for scoring goals do not apply here. Other rules like the dribbling limitation for example do.

Robots may be substituted between shoot-out attempts. The new robot may be put in right away.

NOTE	Note that timeouts are not allowed during shoot-out.

Usage

Shoot-Out is used to determine the winner of an elimination match if both teams scored the same amount of goals in previous game stages.

6. Ball Leaves The Field

When the ball leaves the field by fully crossing the field line, the game will be stopped, the ball will be placed and the game will be restarted depending on the position of the field line crossing as well as on the team that last touched the ball.

6.1. Touch Line Crossing

Touch lines are the long field lines at both sides of the playing field.

6.1.1. Throw-In

Definition

The ball has to be placed 0.2 meters perpendicular to the touch line where the ball crossed the touch line. Its distance to the goal lines must be at least 0.2 meters.

After the ball has been placed, an indirect free kick is awarded to the opponent of the team that last touched the ball before it left the field.

Usage

A throw-in is used to restart the game after the ball left the field by crossing the touch line.

6.2. Goal Line Crossing

Goal lines are the short field lines at both ends of the playing field.

6.2.1. Goal Kick

Definition

The ball has to be placed 0.2 meters from the closest touch line and 1 meter from the goal line.

After the ball has been placed, a direct free kick is awarded to the opponent of the team that last touched the ball before it left the field.

Usage

A goal kick is used to restart the game after the ball left the field by crossing the goal line of the team that did not touch the ball last.

NOTE	In division B, the aimless kick rule might apply instead.

6.2.2. Corner Kick

Definition

The ball has to be placed 0.2 meters from the closest touch line and 0.2 meters from the goal line.

After the ball has been placed, a direct free kick is awarded to the opponent of the team that last touched the ball before it left the field.

Usage

A corner kick is used to restart the game after the ball left the field by crossing the goal line of the team that touched the ball last.

7. Scoring Goals

A goal is scored if the ball enters the goal between the goal posts, provided that no rule infringement has been committed in the play immediately preceeding this event, by the team scoring the goal.

Additionally, the goal is only valid if

- It is not shot directly from an indirect free kick
- The height of the ball did not exceed 0.15 meters after the last touch of an attacker

NOTE	During shoot-out, these additional rules do not apply.

If the goal is considered invalid, the game will be continued as if the ball crossed the goal line outside the goal.

8. Offenses

Offenses are divided into multiple categories according to the seriousness of the offense: minor offenses, fouls and unsporting behavior.

NOTE	Rule of thumb: Minor offenses are infringements of the rules committed by an attacking robot while the ball is in play. Fouls are infringements of the rules committed by a defender or while the ball is not in play or infringements that may harm the humans, the robots or the field.

8.1. Minor Offenses

Minor offenses are violations of the rules that result in a stoppage and a subsequent indirect free kick for the opposing team. The free kick will be shot from the position where the offense began happening (see the direct free kick rules for the exact ball position rules).

All minor offenses are listed below.

8.1.1. Aimless Kick (*division B only*)

A kick is aimless when after the ball touched a robot, it subsequently crossed the midline and then its opponent's goal line outside the goal without touching another robot. A kick-off kick cannot be aimless, as the ball is located at the midline and does therefore not cross it.

8.1.2. Lack Of Progress

There is a lack of progress if only one team is allowed to manipulate the ball (kick-off, direct free kick, indirect free kick, penalty kick) and does not bring the ball into play in time. The time limit is 5 seconds for free kicks in division A and 10 seconds in all other cases.

There is also a lack of progress if the ball is inside a team's defense area for 10 seconds, since the keeper is the only robot that is allowed to manipulate the ball.

NOTE	If both teams are allowed to manipulate the ball, and thus no team is at fault, the referee may stop the game and issue a force start command.

NOTE	If both teams are clearly unable to bring the ball into play without violating the rules, the referee may issue a force start command instead of an indirect free kick for the other team.

8.1.3. Double Touch

When the ball is brought into play following a kick-off, direct free kick, indirect free kick or penalty kick, the kicker is not allowed to touch the ball until it has been touched by another robot or the game has been stopped.

The ball must have moved at least 0.05 meters to be considered as in play.

NOTE	It is understood that the ball may be bumped by the robot multiple times over a short distance while the kick is being taken. This is why a distance of 0.05 meters is used to decide whether a robot violates this rule or not. Remaining in contact with the ball for more than 0.05 meters also counts as double touch, even though technically the robot only touched the ball once.

8.1.4. Attacker In Defense Area

A robot must not touch the ball while being partially or fully inside the opponent defense area.

NOTE	When the ball is not in play, the more strict rule Attacker Too Close To Defense Area applies instead.

8.1.5. Attacker Touches Keeper

A robot must not touch the opponent keeper inside the opponent defense area.

NOTE	When the ball is not in play, the more strict rule Attacker Too Close To Defense Area applies instead.

8.1.6. Dribbling

A robot must not dribble the ball further than 1 meter, measured linearly from the ball location

where the dribbling started. A robot begins dribbling when it makes contact with the ball and stops dribbling when there is an observable separation between the ball and the robot.

NOTE	Dribblers can still be used to dribble large distances with the ball as long as the robot periodically loses possession, such as kicking the ball ahead of it as human soccer players often do.

8.1.7. Ball Speed

A robot must not shoot the ball faster than 6.5 meters per second in 3D space.

8.2. Fouls

Fouls are violations of the rules that result in a direct free kick for the opposing team. The free kick will be shot from the position where the offense began happening (see the direct free kick rules for the exact ball position rules). If the foul happened while the ball is not in play, no free kick is given.

Every third foul of the same team results in a yellow card.

In case of severe fouls, the referee can also issue a yellow card or a red card.

All fouls are listed below.

8.2.1. Attacker Too Close To Defense Area

During stop, direct free kicks and indirect free kicks, before the ball has entered play, all robots have to keep at least 0.2 meters distance to the opponent defense area.

There is a grace period of 2 seconds for the robots to move away from the opponent defense area.

8.2.2. Ball Placement Interference

During ball placement, all robots of the non-placing team have to keep at least 0.5 meters distance to the line between the ball and the placement position (the forbidden area forms a stadium shape).

If a robot of the non-placing team is too close to the line between the ball and the placement position for more than 2 seconds, it commits a foul. In this case, the placement procedure is restarted.

NOTE	This rule does not cover all cases of ball placement interference. The referee is encouraged to call fouls if the non-placing team is obviously interfering with the ball placement.

8.2.3. Crashing

At the moment of collision of two robots of different teams, the difference of the speed vectors of both robots is taken and projected onto the line that is defined by the position of both robots. If the length of this projection is greater than 1.5 meters per second, the faster robot committed a foul. If

the absolute robot speed difference is less than 0.3 meters per second, both conduct a foul but the game will not be stopped.

8.2.4. Pushing

A robot pushes an opponent robot if both robots keep contact to the ball or to each other while both robots travel towards the opponent robot for more than 0.2 meters or until the opponent enters its defense area.

8.2.5. Ball Holding

Robots must not surround the ball to prevent access by others.

8.2.6. Tipping Over Or Dropping Parts

A robot must not tip over, break or drop parts on the field that pose a potential threat to other robots.

A robot violating this rule has to be substituted.

NOTE	Metal parts (screws for example) as well as larger parts generally pose a potential threat, very small non-metal parts (for example rubber subwheel rings) don't.

8.2.7. Robot Stop Speed

A robot must not move faster than 1.5 meters per second during stop.

There is a grace period of 2 seconds for the robots to slow down.

NOTE	This rule does not apply to ball placement.
NOTE	Since the stop command is used for manual ball placement and robot substitution, the intention of the robot speed limit is to avoid robots harming the people on the field.

8.2.8. Defender Too Close To Ball

A robot's distance to the ball must be at least 0.5 meters during an opponent kick-off, direct free kick or indirect free kick. The game is resumed with the same command that was issued before the foul.

NOTE	During stop, there is no automatic sanction for being too close to the ball. The referee may still punish a team for unsporting behavior by issuing a yellow card if it does not respect the required distance. See stop for further explanation.

8.2.9. Multiple Defenders

NOTE	This rule does not use the standard sanctions defined for fouls.

If a robot touches the ball while being partially inside its own defense area, the game is stopped, the robot receives a yellow card and the opponent team resumes the game with a direct free kick. The foul counter is not increased.

If a robot touches the ball while being entirely inside its own defense area, the game is stopped and a penalty kick is awarded to the other team. The foul counter is not increased.

8.3. Unsporting Behavior

Unsporting behavior can lead to yellow cards, red cards, penalty kicks, a forced forfeit or a disqualification. The human referee chooses an appropriate sanction, depending on the severity of the offense.

NOTE	If the referee is not sure which sanction to choose, he may confer with members of the technical committee or the organizing committee.

Some examples of unsporting behavior are listed below.

8.3.1. Damaging Other Robots

It is not allowed to damage or modify robots of other teams.

8.3.2. Damaging The Field Or The Ball

It is not allowed to damage or modify the field or the ball.

8.3.3. Showing Lack Of Respect

A team member must show appropriate respect to everyone involved in the game. Infringements of this rule include but are not limited to:

- insulting the opponent, the referee or other persons holding an impartial role
- annoying the referee or other persons holding an impartial role
- not obeying the orders of the referee

8.4. Simultaneous Offenses

If the game is stopped and a team is allowed to resume the game, minor offenses and fouls of this team's opponent don't affect the method and position of the resumption of the game, except if the resulting method is a penalty kick.

If a team exploits this rule, the referee may punish this team for unsporting behavior by issuing a yellow card.

NOTE	This rule is in place to prevent teams from purposely committing offenses in order to relocate the opponent free kick to a more favorable position.

8.5. Advantage Rule

In certain situations, stopping the game because of a foul may have a disadvantage to the opposing team. As these situations are not easy to detect automatically, the opposing team is asked if it likes to continue the game. In this case, the game is not stopped and no direct kick is awarded at any time. The foul counter is still incremented and any resulting cards are given when the game is stopped.

Fouls that are considered

- Crashing, if not both teams committed the foul
- Pushing

NOTE	If the team is not connected to the game controller or does not reply within 0.2 seconds, the decision of the team defaults to stopping the game.

9. Robot Substitution

Robots can be substituted for any reason. There is no limit on the number of substitutions.

Robots are substituted by the robot handler of the respective team. No other team member is allowed to take robots out or put robots in.

A robot substitution consists of two actions, taking a robot out and putting a robot in. If the robot to be taken out is closer than 1 meter to the intersection of the halfway line with one of the touch lines, another robot can be put in right away. Otherwise, the robot handler has to wait until the next stoppage of the game (after the ball placement has been completed).

If the robot to be taken out is the keeper, the robot handler tells the referee the id of the robot that takes over the keeper role. This information is forwarded to the game controller operator.

9.1. Taking A Robot Out

1. The robot handler informs the referee that he intends to take a robot out.
2. The referee forwards this request to the game controller operator, so that he can pause the automatic referee.
3. After the next ball placement (manual or automatic), the halt command is issued and the robot handler is allowed to take the robot out.

9.2. Putting A Robot In

1. The robot handler informs the referee that he intends to put a robot in.

2. The referee forwards this request to the game controller operator, so that he can pause the automatic referee.
3. After the next ball placement (manual or automatic), the halt command is issued and the robot handler is allowed to put the robot in.