
RoboCup Standard Platform League (NAO) Rule Book

RoboCup Technical Committee

(2013 rules, as of May 21, 2013)

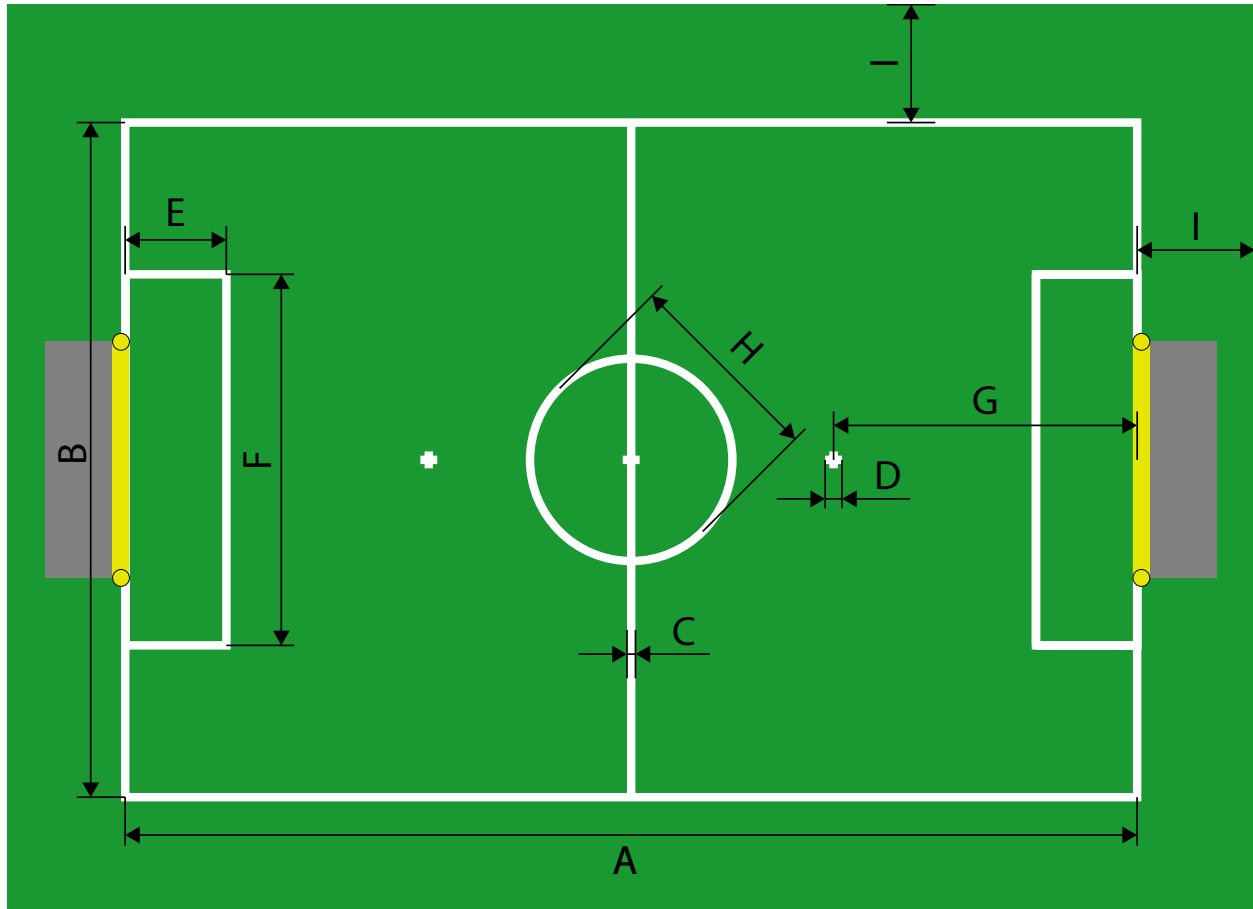
Contents

1	Setup of the Environment	1
2	Robot Players	4
3	Game Process	7
4	Forbidden Actions and Penalties	18
5	Judgement	25
6	Changes From 2012	27
7	Questions/Comments	28

1 Setup of the Environment

1.1 Field Construction

The soccer field is built on a total carpet area of length 10.4 m and width 7.4 m. The dimensions of the soccer field are shown in Figure 1. The construction and placement of the goals is depicted in Figure 2 and Figure 3.



ID	Description	Length (in mm)	ID	Description	Length (in mm)
A	Field length	9000	E	Penalty area length	600
B	Field width	6000	F	Penalty area width	2200
C	Line width	50	G	Penalty mark distance	1800
D	Penalty mark size	100	H	Center circle diameter	1500
			I	Border strip width	700

Figure 1: Schematic diagram of the soccer field (not to scale). and corresponding dimensions in mm.

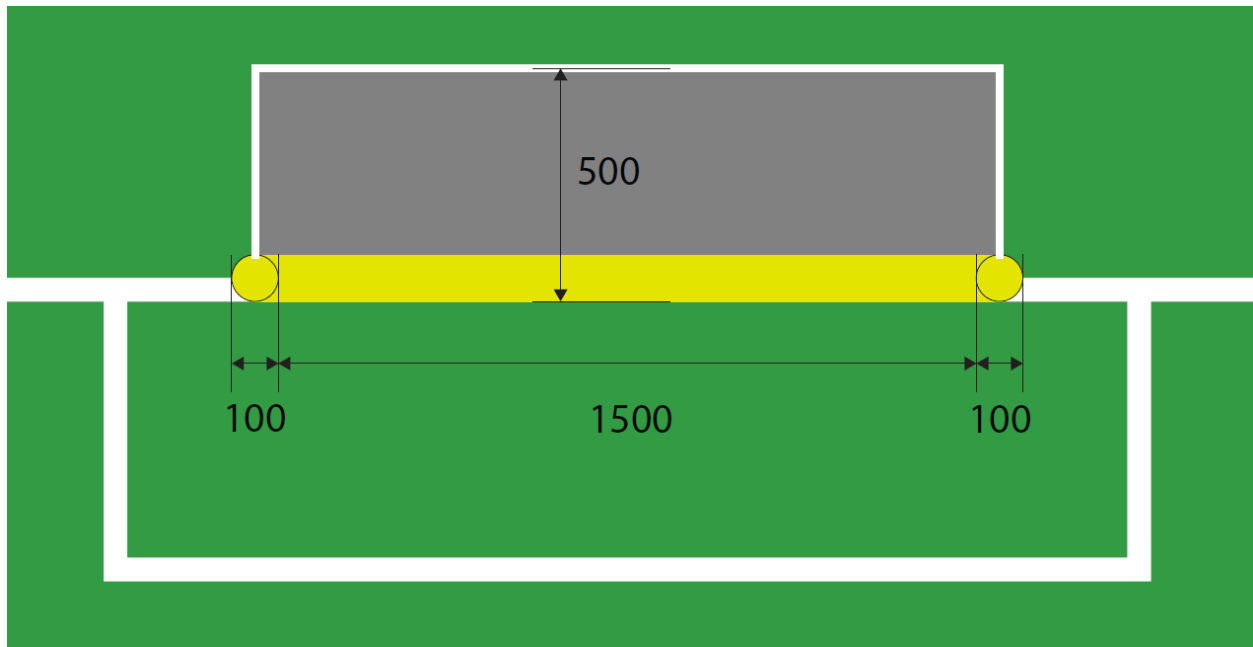
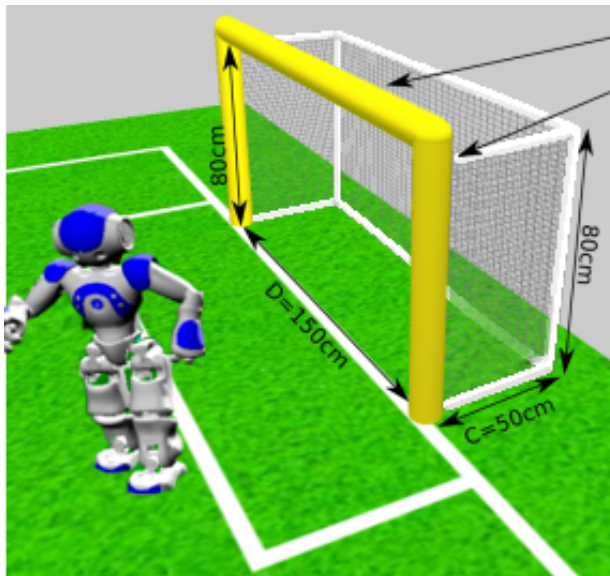


Figure 2: Dimensions of the goal (in mm), viewed from above and its placement on the field.



The goalposts and crossbar are made from 3 yellow cylinders with a diameter of 10 cm. The net:

- has a height of 80 cm
- is of white, grey or black color
- is properly supported, in a way to minimize interference with the goal keeper
- is attached to the field to catch the ball
- has a weave with holes smaller than the ball diameter.

Figure 3: Appearance and dimensions of the goals.

The support structure for the net shall be made with small white bars or cylinders as shown in Figure 3.

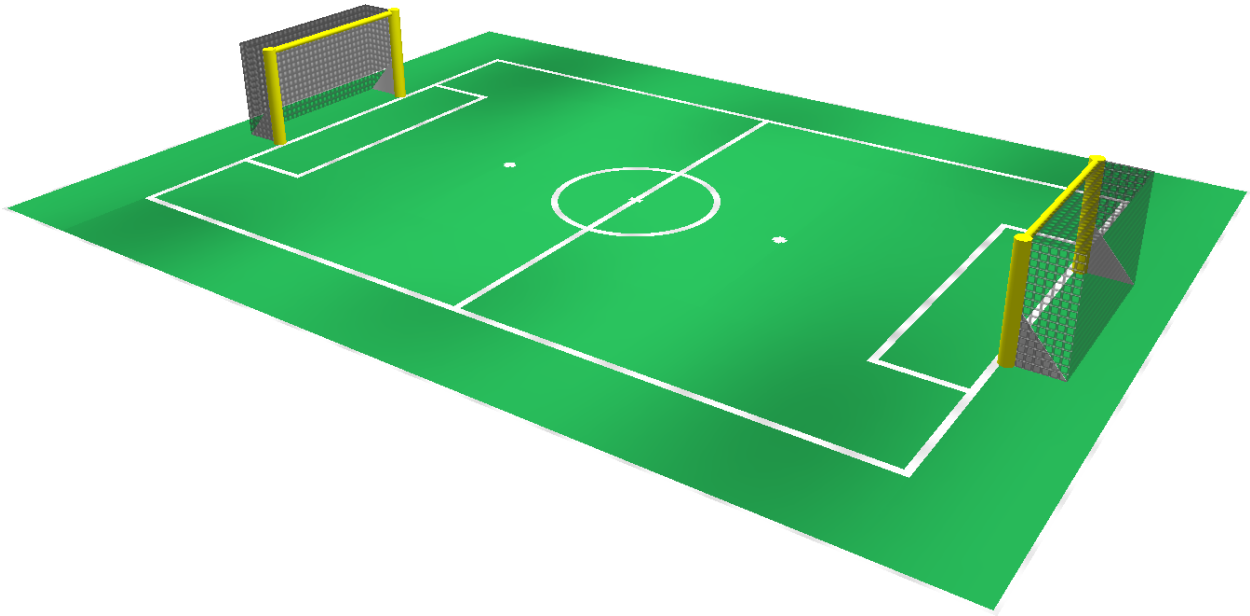


Figure 4: Field colors and layout.

1.2 Throw-in Lines

In addition to the visible lines, there are two invisible lines only relevant to the throw-in procedure (see Section 3.10), but not relevant to the construction of the field. These two throw-in lines are 400 mm away from the sidelines and run parallel to them inside the playing area. Each throw-in line is 7 m long.

The throw in lines will be marked (as dots at the end of the throw in lines and short dashes along the line) by the technical committee at the start of competition with a felt-tip pen — these lines are intended to stay invisible to robots but provide a guide to referees.

1.3 Field Colors

The colors of the soccer field are shown in Figure 4. All items on the RoboCup field are color-coded:

- The field (carpet) itself is green (color is not specified, but it should not be too dark).
- The lines on the field are white.
- Goals (cf. Figure 3). The posts and top cross bar of both goals are yellow (RAL 1018). The net is white, grey, or black. The support structure for the net is white.

1.4 Lighting Conditions

The lighting conditions depend on the actual competition site. Only ceiling lights may be used.

1.5 Venue Setup

Fields may be located close to one another. Barriers will not necessarily be constructed between adjacent fields to block the robots from seeing other fields, goals, or balls. However, barriers will be constructed to block sight between any fields that are not located at least three meters apart. Hence, for each side of a field that is adjacent to another field, either barriers will separate the fields or at least three meters will be between the carpet of adjacent fields.

1.6 Ball

The official ball will be a Mylec orange street hockey ball. They are 65 mm in diameter and weigh 55 grams. These are the *shiny* balls and are *not* gel-filled. They are no-bounce warm weather (60 to 75 degrees Fahrenheit) hockey balls. These balls are available at a few locations:

- http://www.amazon.com/Mylec-Weather-Bounce-Hockey-Orange/dp/B002LBDA30/ref=sr_1_18?ie=UTF8&s=sporting-goods&qid=1259775748&sr=8-18
- <http://www.puckshop.com/mylec-orange-warm-weather-ball.html>

2 Robot Players

A match is played by two teams, each consisting of not more than **5** players. At most one may be designated as *goalkeeper*, the others are all *field players*.

2.1 Hardware

All teams must use NAO humanoid robots manufactured by Aldebaran Robotics. Absolutely no modifications or additions to the robot hardware are allowed. No additional hardware is permitted including off-board sensing or processing systems. Additional sensors besides those originally installed on the robots are likewise not allowed. The only exceptions are:

-
- Attaching the jersey numbers provided by the league to the robots.
 - Adding black and white sponsor or team logos to the upper legs of the robots (cf. Figure 6). These logos must be at least 50% white by area.
 - Adding small black and white stickers to the torso of the robots stating the name of the robot, the name of the team, or similar information. These stickers must be at least 50% white by area.
 - Setting the passive wrist joints to a fixed position either with glue or a transparent or white duct tape.
 - Protecting the fingers with transparent or white duct tape.
 - Use of alternate memory sticks in replacement of the Aldebaran supplied memory sticks.

A computer will be provided by the event organizers for the purpose of sending GameController messages to the robots.

2.2 Goal Keeper

The goal keeper is the only player that is allowed to enter the penalty area of its own team. The goal keeper is allowed to touch the ball with its arms/hands only while it is within its own penalty area. It always has the jersey number “1”.

2.3 Field Players

The field players are not allowed to enter their own penalty area. The four field players robots have the jersey numbers “2”, “3”, “4” and “5”.

2.4 Team Markers

Robots will use colored jersey shirts as team markers. The official jersey shirt colors are cyan and magenta (referred to as blue and red throughout this document). Each jersey shirt will have a player number(1-5) printed on it in white text. The official jersey shirts will be available for purchase by each team — details regarding purchase of official jersey shirts will be sent via email to all teams. Teams must purchase the official jersey shirts as specified in this email — teams are not allowed to use jersey shirts that they design themselves or that are manufactured by a different supplier. An example of how the team markers are worn is shown in Figure 5.

2.5 Communications

The robots should play without human control. Communication is only allowed among robots on the field and between the robots and the GameController.

2.5.1 Acoustic Communications

There are no restrictions on communication between the robots using a microphone or a speaker.

2.5.2 Wireless Communications

The only wireless hardware allowed to be used by the teams are the wireless network cards built into the NAOs, and the access points provided by the event organizers. All other wireless hardware must be deactivated. A team may be disqualified if one of the team members violates this rule. The MAC-addresses of all NAOs participating in the competition will be registered. Only these MAC-addresses can be reached through the access points provided by the event organizers. In addition, the access points will be secured by different SSIDs and WEP keys.

Each team will get a range of IP addresses that can be used both for their robots and their computers. The IP addresses, channels, SSIDs, and WEP keys of the fields will be announced at the competition site.

Teams can use a bandwidth of up to 500 Kbps of the wireless. This includes any data transferred, namely the actual payload and any protocol overhead created, e. g., by TCP, UDP, or the GameController.

Any form of wireless robot-to-robot communication is allowed, as long as it uses the access points provided by the event organizers (using the so-called ad-hoc mode is prohibited), it does not conflict with TCP/IP or UDP, and the maximum bandwidth allowed for each team is not exceeded.

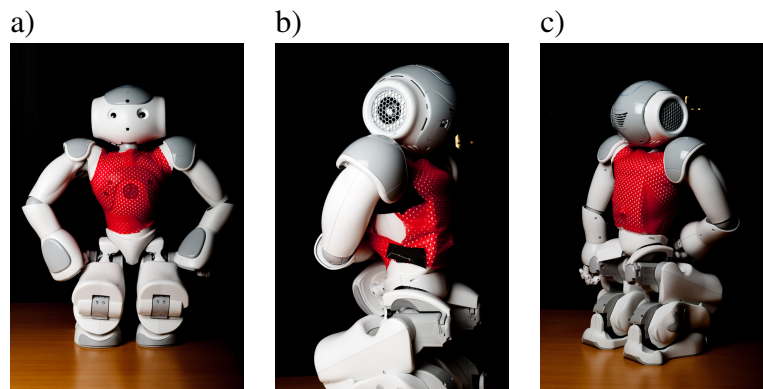


Figure 5: Preliminary version of team markers. a) Front view. b) Side view. c) Back view.

Each team will be assigned a range of IP-addresses that can be used for direct robot-to-robot communication. Each team will also be allocated a limited range of UDP ports on which broadcast will be permitted.

The GameController will use UDP to connect to the robots. The source distribution of the GameController provides the header file *RoboCupGameControlData.h* that defines all messages sent by the GameController to the robots. They correspond to the *robot states* described in Section 3.2.

The use of remote processing/sensing is prohibited.

3 Game Process

3.1 Structure of the Game

A game consists of three parts, i. e. the first half, a half-time break, and the second half. Each half is 10 minutes counted from the initial kick-off. The clock stops during stoppages of play¹ (such as ready and set state after goals). The extra time over ten minutes total is referred to as “lost time”. The half-time break is also ten minutes — during this time both teams may change robots, change programs, or do anything else that can be done within the time allotted. In round robin pool play, a game can finish in a draw as no penalty shoot-out will follow. In the intermediate round, quarter finals, semi finals, or 3rd place, or final a game that ends in a draw will be followed by a penalty shoot-out (see Section 3.9).

The teams will change the goal defended and color of the team markers during the half-time break.

¹This may not be the case until the quarter finals.



Figure 6: Example Sponsor/Team Logo placement.

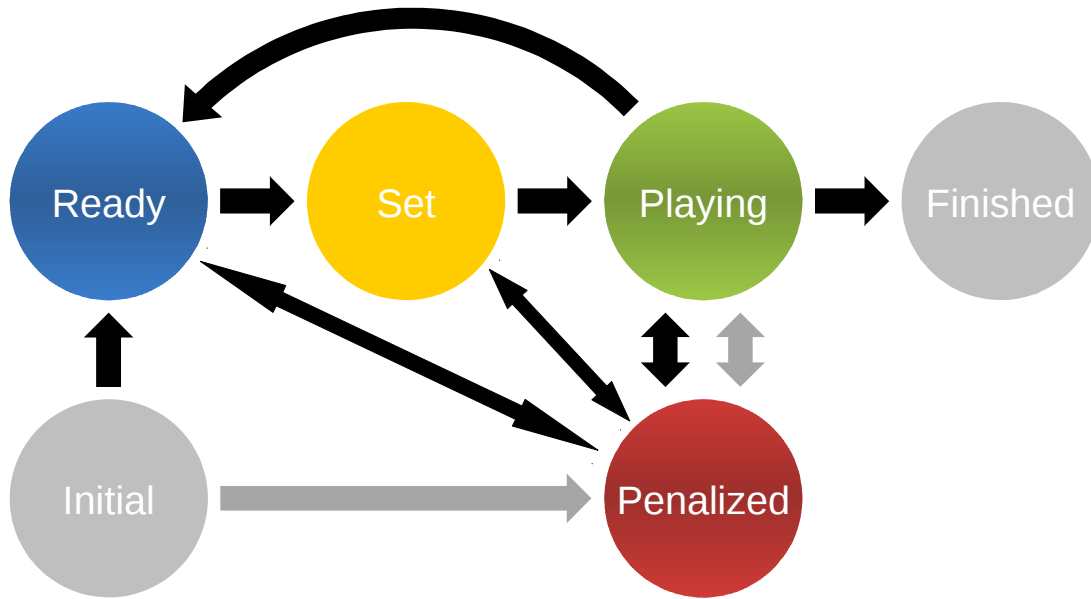


Figure 7: Robot states. Button interface transitions are shown in gray. GameController transitions are shown in black. However, any transition possible can actually be sent by the GameController.

3.2 Robot States

Robots can be in six different states (cf. Figure 7). If the wireless is available, these states will be set by the GameController. Teams must implement code to receive and correctly respond to wireless GameController packets, and also give indication of the game state, team color, and the kickoff state. *If a robot does not respond to either the game controller or the button press interface, then it is not included in the game, and the game starts without the offending robot.*

Initial. After booting, the robots are in their *initial* state. In this state, the button interface for manually setting the team color and whether the team has kick-off is active. The robots are not allowed moving in any fashion besides initially standing up. Pressing the left foot bump sensor will switch the team color. Shortly pressing the chest button will switch the robot to the *penalized* state.

Ready. In this state, the robots walk to their legal kick-off positions (cf. Section 3.6). They remain in this state, until the head referee decides that there is no significant progress anymore (after a maximum of 45 seconds). This state is not available if only the button interface is implemented.

Robots may be disentangled by the referees at the start of the Ready state. After that, the “Player Pushing” rules are applied, but the penalty is manual placement by the assistant referees (cf. Section 3.6), not the penalty described in Section 4.9. Consequently those pushings do not go into the permanent removal count.

Set. In this state, the robots stop and wait for kick-off (cf. Section 3.6). If they are not at legal positions, they will be placed manually by the assistant referees to the positions shown in Figure 8. They are allowed to move their heads before the game (re)starts but they are not allowed to move their legs or locomote in any fashion. This state is not available if only the button interface is implemented. Robots that do not listen to the GameController will be placed manually. Until the game is (re)started, they are in the *penalized* state.

Playing. In the *playing* state, the robots are playing soccer. Shortly pressing the chest button will switch the robot to the *penalized* state.

Penalized. A robot is in this state when it has been penalized. It is not allowed to move in any fashion, i. e. also the head has to stop turning. Shortly pressing the chest button will switch the robot back to the *playing* state.

Finished. This state is reached when a half is finished. This state is not available if only the button interface is implemented.

The team color should be displayed during the whole game on the LED of the left foot (blue/red). Teams that support the GameController can visualize whether the robot's team has kick-off on the LED of the right foot (off/white) in the states *initial*, *ready* and *set*. The current game state should be displayed on the LED in the torso. The colors corresponding to the game states are:

- Initial: Off
- Ready: Blue
- Set: Yellow
- Playing: Green
- Penalized: Red
- Finished: Off

3.3 Goal

A goal is achieved when the entire ball (not only the center of the ball) goes over the goal-side edge of the goal line, i. e. the ball is completely inside the goal area². The restart after the goal shall adopt the same rules as the kick-off.

Note that a goal can never be awarded where the last contact of the ball with a robot was by the arm or hand (even if unintentional – see also Section 4.10) of an attacking robot. Should the ball enter the goal area where the last contact is accidental contact with the arm or hand of an attacking robot, the goal shall not count and a goal kick is awarded, that is, it shall count as if the ball is out by the attacking team (see Section 3.10).

²The goal line is part of the field.

3.4 Applying Penalties

See Section 4.2.

3.5 Initial Kick-off

The first kick-off at the start of each half time is the initial kick-off. Before the initial kick-off, i.e. before the start of each half, all robots must be in the initial state and must be placed on the sidelines in their own half of the field. It is up to the team as to which sideline(s) and where exactly on the sidelines the robots are placed. Once the robots receive the *ready* signal from the GameController, they are to proceed as described in Section 3.6.

3.6 Kick-off

For kick-off, the robots listening to the wireless GameController run through three states: *ready*, *set*, and *playing*. Robots not listening to the GameController are simply penalized and manually placed for kick-off³.

In the ready state, the robots should walk to their legal kick-off positions. These positions are always located inside their own side of the field. No player is allowed to touch the halfway line. The field players of the attacking team can walk to any position within their own half (including inside the center circle), except for inside the penalty area. The field players of the defending team can walk to any position within their own half, except for inside the center circle and the penalty area. The feet of both goal keepers must be *inside* the penalty area.

If robots collide during the autonomous placement, the “Player Pushing” rules are applied, but the penalty is manual placement by the assistant referees, not the penalty described in Section 4.9. Consequently those pushings do not go into the permanent removal count.

The robots have a maximum of 45 seconds to reach their positions. If all the robots have reached legal positions and have stopped, or if 45 seconds have passed, the robots will be switched into the *set* state, in which they must stop walking. Each robot that is not at a legal position at this point in time will be placed manually by the assistant referees to the positions as shown in Figure 8. Robots that are legally positioned will not be moved by the assistant referees unless a manual position is requested by the team leader. *In the case where the team leader requests manual placement, all robots on that team are manually positioned.*

There are extra restrictions on the legal positions of manually positioned robots. The kicking-off robot is placed on the center circle, right in front of the penalty mark. Its feet touch the line, but

³Note that robots being manually placed because they are not listening to the GameController must still be placed in the restricted set of legal positions for manually placed robots. It is to a team’s advantage to have their robots listen to the GameController.

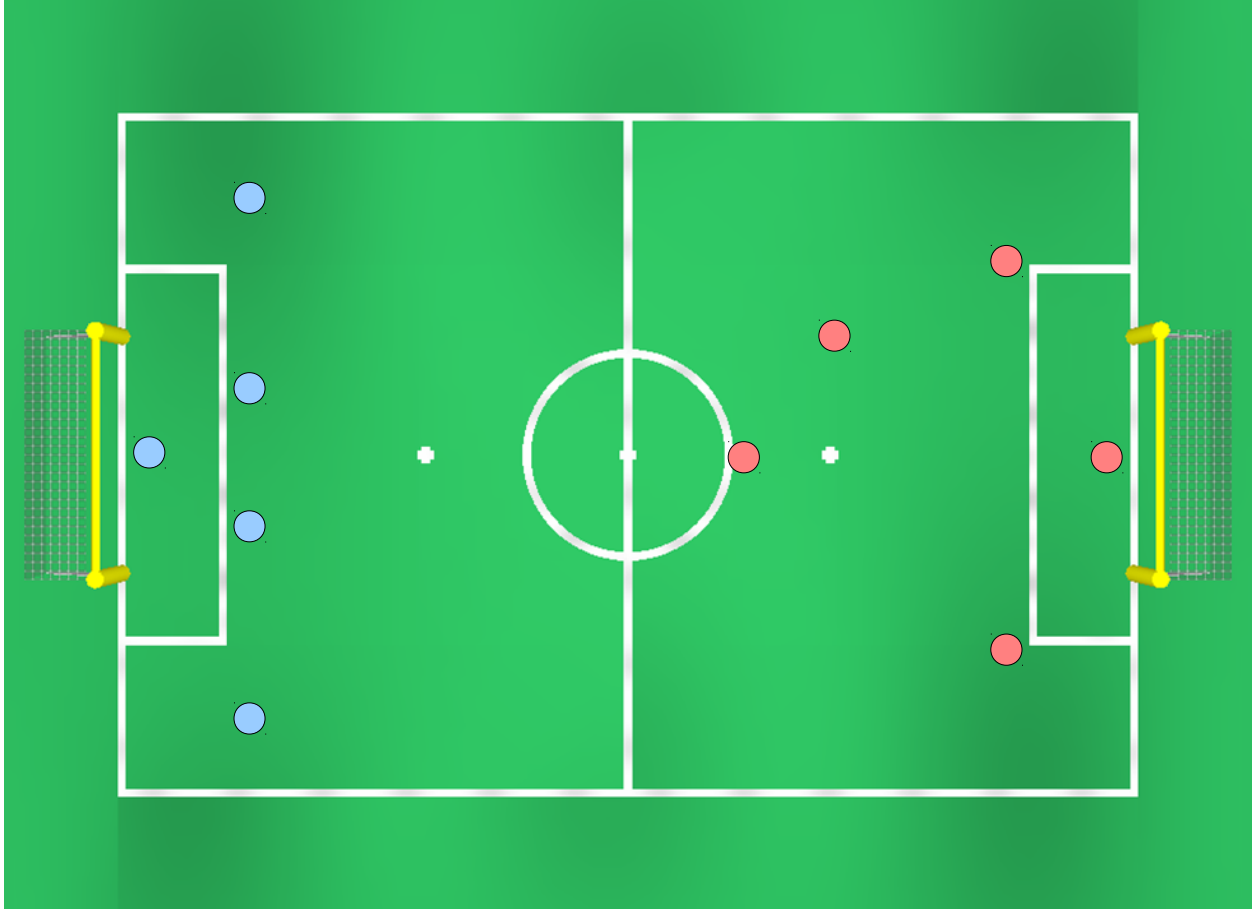


Figure 8: Manual setup for kick-off.

they are not inside the center circle. One of the other field players of the attacking team is placed in front of one of the goal posts on the height of the penalty mark (i.e. the virtual intersection point of the goal post and the penalty mark) and the other two are placed on the corners of the penalty box without having their feet touching the corners. Two field players of the defending team are placed halfway between the corners of their own penalty box and the sidelines. The other two field players of the defending team are placed immediately in front of their own penalty box, halfway between the center of the penalty box and the goal post. The goal keepers for each team are placed at the center of the penalty box, with their feet immediately in front of the end-line.

As autonomously placed robots are allowed to be much closer to the ball, successful autonomous placement results in a significant advantage over manual placement.

Just before the *set* state is called, the ball is placed on the center point of the center circle by one of the referees. If it is moved by one of the robots before set is called it is replaced by one of the referees.

After the head referee has signaled the kick-off, the robot's state is switched to *playing* (again either by the GameController or manually), in which they can actually play soccer. The defensive

team must stay outside of the center circle until the ball is in play. The ball is in play once it is touched by the attacking team or once *10 seconds* have elapsed in the playing state. If a defensive player enters the center circle before the ball is in play the “Illegal Defender” penalty is applied (cf. Section 4.13).

Note that a goal can never be scored directly from a shot from the kick-off. See Section 4.5 for details.

If the assistant referees have misconfigured the robots (e. g. they set the wrong team color), the kick-off is repeated. In this case, goals scored with at least one misconfigured robot on the field are not counted. The time that was played with a wrong configuration is counted as “lost time”, i. e. the half should be lengthened by it. Note that the assistant referees are only responsible for setting team color on kick-off. Robots replaced after a request for pickup are the responsibility of the team, and should be handed to the referees or assistants in the ‘penalized’ state.

The current GameController requires robots to know both their team number and their robot number within the team. It is each team’s responsibility to make sure this is correctly configured. It is recommended that the robot indicates its number within the team on bootup so that this can be easily checked at the start of the game.

3.7 Free Kick

None.

3.8 Penalty Kick

A penalty kick is carried out with one attacking robot and one opposing goal keeper. Other robots should be powered off and stay outside of the field. Teams are allowed to switch to specially designed software for a penalty kick. Standard penalty kicks are taken against the opponent goal. For a penalty shootout, see Section 3.9.

The ball is placed on the penalty spot, at the end of the field closest to the goal being defended. The attacking robot is positioned 1 meter behind the penalty spot, facing the ball. This spot is denoted with a small dot made with a felt-tip pen. The goal keeper is placed with its feet on the goal line and in the center of the goal.

Neither robot shall move their legs before the penalty kick starts. Movements of the robot’s head and arms are allowed as long as the robot does not locomote. Technically, the robots are in the *set* state when waiting for the penalty kick to start. If robots are not listening to the GameController, they are in the *penalized* state instead. The robots are started by switching to the *playing* state.

The attacking robot is only allowed to contact the ball once. The time limit for the kicker is 1 minute after the penalty kick starts. The ball must be in the goal within this time limit in order to count as a goal.

Hence, a penalty shot is over after the first contact by the attacking robot, either in favor of the attacker if a goal has been scored, or in favor of the defending team if the goal keeper successfully blocked or if the ball just did not reach the goal line.

All the rules such as “Ball Holding”, “Pushing” and others are also applied during the penalty kick. The only exception is the “Illegal Defender” rule, i. e. the penalty shooter is allowed to enter its own penalty area. A goal keeper will not be penalized for inactivity during a penalty kick (including penalty shoot out), provided its stiffness is on. Other penalties are applied as usual.

Teams will keep their team colors⁴. The attacking robot will be indicated by the GameController using the kick-off flag, i.e. the kick-off team is the attacking one.

3.9 Penalty Kick Shoot-out

A penalty kick shoot-out is used to determine the outcome of a tied game when an outcome is required (for example, during quarter finals, semi finals, third place or final). There will be a five minute break between the end of the game and the start of the penalty kicks. In the intermediate round, the penalty kick shoot-out will consist of three penalty shots per team; in the quarterfinals and later, it will consist of five penalty shots per team. All penalty shots are taken against the same goal⁵. At the conclusion of these shots the team that has scored the most goals will be declared the winner. Note that a winner can be declared before the conclusion of the penalty shoot-out if a team can no longer win, for example, a team requires 3 goals to win but only has 2 attempts remaining. If the two teams still remain tied then a sudden death shoot-out will follow until a definite winner is found.

The procedure for each attempt is the same as for the normal penalty kick described in Section 3.8. For the first five attempts, the standard time limit of 1 minute is applied. If after five penalty kicks by each team there is no result (that is, each team has scored the same number of goals), then the decision will be made by the following sudden death shoot-out procedure.

3.9.1 Sudden Death Shoot-Out

The time limit for sudden death penalty shots is two minutes.

These attempts will be timed (that is, for a goal scored, how long did it take to score the goal) and measured (that is, if a goal is not scored, what is the shortest distance between the ball and the goal

⁴This makes the progress of the penalty shoot-out easier to follow for the audience.

⁵Which goal to take for the shoot-out is decided in accordance with the teams, or otherwise by a coin toss.

line segment between the goal posts, achieved at any time during the penalty shot) by the referee. After these attempts, the game decision will be made as follows:

1. If only one team scores a goal, that team wins.
2. If both teams score a goal, then if one team is timed to have scored at least 2 seconds faster than the other team, the faster team wins. Otherwise, the sudden death shoot-out is repeated.
3. If neither team scores a goal, then if one team is measured to have moved the ball more than 50 mm closer to the goal than the other team, the closer team wins. Otherwise, the sudden death shoot-out is repeated.
4. If neither team has touched the ball during the shoot-out, the referee will toss a coin to decide the game.

3.10 Throw-in

A ball is considered to have left the field when there is no part of the ball over the outside of the boundary line (i. e. the line itself is in). If the ball leaves the field it will be replaced on the field by an assistant referee. There is *no* stoppage in play.

If the ball goes over a sideline then the assistant referee will replace the ball back on the field on the throw-in line on the same side of the field as the ball went out of play.

The ball will be replaced on the throw-in line at the farthest back of these two locations: a) one meter back from the point it went out or b) one meter back from the location of the kicking robot. We define ‘back’ as being towards the goal of the team that last touched the ball. Note that if the one meter placement would cause the ball to be placed off the end of the throw-in line, then it should be placed at the end of the throw in line, and not beyond.

If the ball goes over an end-line then the assistant referee will replace the ball back on the field according to the following rules:

- If the ball was last touched by the defensive team then the ball is replaced on the closest endpoint of the throw-in line.
- If the ball was touched by the offensive team, the ball is replaced on the throw-in line at the farthest back of these two locations: a) one meter back from the location of the kicking robot, or b) at the halfway line.

Balls are deemed to be out based on the team that last touched the ball, irrespective of who actually kicked the ball. In these examples, “yellow half of the field” refers to the half the yellow team is defending.

Example 1. The red goalie kicks the ball out the end of the field to the right of the goal. The ball is placed on the endpoint of the throw-in line to the right of the goal.

Example 2. A blue robot on the yellow half of the field kicks the ball out the end of the field to the right of the goal the red team is defending. The ball is placed on the intersection of the right throw-in line and the halfway line.

Example 3. A blue robot on the blue half of the field kicks the ball out the end of the field to the right of the goal the red team is defending. The ball is placed on one meter behind the robot on the right throw-in line.

Example 4. A blue robot at midfield kicks the ball over the left sideline 2 meters into the yellow half of the field. The ball is replaced on the left throw-in line 1 meter into the blue half of the field (one meter behind the robot).

Example 5. A blue robot at midfield kicks the ball over the left sideline 2 meters into the blue half of the field (towards its own goal). The ball is replaced on the left throw-in line 3 meters into the blue half of the field.

Example 6. A blue robot kicks the ball but the ball touches a red robot at midfield before leaving the field near the centre line. The ball is regarded as out by red and therefore is replaced on the throw-in line 1 meter closer to the goal the red team is defending.

3.11 Game Stuck

In the event of no substantial change in the game state for 15 seconds, this is considered a game stuck. This includes if a robot is at the ball circling it for 15 seconds without kicking the ball. The main referee has two options how to solve the game stuck and to reestablish the chance of progress in the game. The intention of the game stuck rule is to achieve progress with as little intervention as possible, i. e. the *Local Game Stuck* rule will be preferred, but only if there is a chance that its application will result in progress in the game.

3.11.1 Local Game Stuck

The nearest robot to the ball will get the standard removal penalty according to Section 4.3.

3.11.2 Global Game Stuck

The referee stops the game and restarts the game from the kick-off formation. The kick-off will be awarded to the team defending the side of the field the ball is on when the game stuck is called. A global game stuck can only be called if at least one robot has touched the ball since the previous kick-off.

3.12 Request for Pick-up

Either team may request that one of their players be picked up only for hardware dysfunction and software crashes at any point in the game (called “Request for Pick-up”). Basically every change (hardware or software) is allowed during a request for pick-up. In particular, it is permitted to change batteries, fix mechanical problems, reboot the robots, and change configuration files. It is discouraged to change the robot’s control program, **but not forbidden**. It is also allowed to replace a broken robot by a substitute robot.

Any strategic “Request for Pick-up” is not allowed, i.e. gaining an advantage by removing the robot from the game. In general, a “Request for Pick-up” for a robot which is currently in the game is only allowed for obvious hardware failures. In this case, the head referee will indicate when the robot is no longer affecting play and can be removed from the field by an assistant referee. A “Request for Pick-up” for a robot which is currently out of the game, e.g. penalized, can be granted immediately.

To prevent mistakes and confusion during games, only team leaders should make a “Request for Pick-up”, and only one designated person per team shall accept the robot from the referee, and hand it back after fixing the problem. The returning robot will be replaced after a minimum of 30 seconds after it was taken off the field following the normal replacement procedure used after the standard removal penalty (see Section 4.3).

If a robot has been rebooted and the wireless is not working, it is the responsibility of the team members (not the assistant referees) to configure its team color correctly. The robot should be returned to the assistant referees in the *penalized* state so that the assistant referees cannot accidentally change the robot’s team color.

3.13 Request for Timeout

At any stoppage of play (after a goal, stuck game, before half, etc.) either team may call a timeout. Each team can call a **maximum of 1 timeout per game** with a total time totaling no more than **5 minutes**. During this time, both teams may change robots, change programs, or anything else that can be done within the time allotted. The timeout ends when the team that called the timeout says they are finished, at which time they must be ready to play. The other team must be ready to

play at the time the timeout runs out, or **2 minutes** after a prematurely called end of the timeout, whichever is earlier. If the other team is not ready to play in time, it has to call a timeout of its own.

The clock stops during timeouts, even during the preliminaries.

After the completion of the timeout, the game resumes with a kick off for the team which did not call the timeout.

If a team is not ready to play at the assigned time for a game, the referee will call the timeout for that team. After the expiration of such a timeout, if the team is still not ready to play then the referee shall start the game with only one team on the field. The team that wasn't ready can return its robots to the field as per the rules for "Request for Pick-up". If both teams are not ready, the referee will call timeouts for both teams. This "double timeout" expires after 10 minutes.

3.14 Winner and Rankings

The team which scored more goals than the other is the winner of the match. If the two teams scored the same number of goals, the game will be a draw. The draw will follow the same system defined in Section 3.1. Total (and final) standings will be decided on points as follows (the points will be given based on the result of each game):

Win = 3 pts

Draw = 1 pt

Lose = 0 pts

If a team's obtained points is the same as another team's after the preliminary round is complete, the following evaluations will be applied in order to qualify the finalists.

1. The points obtained
2. The difference between goals for and goals against per game
3. The average goals for per game
4. Game result between the teams directly

3.15 Rules for Forfeiting

If a team chooses to forfeit a match then the opposing team will play the match against an empty field. However, any own goals will not be scored. Hence, after an opponent forfeits, the team playing against an empty field cannot lose (but they can draw). Teams may choose to forfeit a game at any stage. However, once a forfeit is announced, they may not reverse this decision.

4 Forbidden Actions and Penalties

The following actions are forbidden. In general, when a penalty applies, the robot shall be replaced, not the ball. For penalties that are timed, the penalty time is considered to be over whenever the game time stops (for goals, half-time, and game stuck).

4.1 Locomotion Type

Robots should clearly demonstrate bipedal walking similar to human walking. Other types of locomotion involving other parts than feet (crawling etc.) are strictly forbidden. It is duty of the head referee to decide whether a robot's locomotion is appropriate.

4.2 Penalty procedure

When a robot commits a foul, the head referee shall call out the infraction committed, the jersey color of the robot, and the jersey number of the robot. Each robot will be labeled with a jersey number before the game. The penalty for the infraction will be applied immediately by an assistant referee. The assistant referees should perform the actual movement of the robots for the penalty so that the head referee can continue focusing on the game. The operator of the GameController will send the appropriate signal to the robots indicating the infraction committed.

4.3 Standard Removal Penalty

Unless otherwise stated, all infractions in this league result in the removal of the infringing robot from the field of play for 30 seconds, after which it will be returned to the field of play. This process is called the standard removal penalty, and a detailed description of the process follows.

When the head referee indicates a foul has been committed that results in the standard removal penalty, the assistant referee closest to the robot will remove the robot immediately from the field of play. The robot should be removed in such a way as to minimize the movement of the other robots and the ball. If the ball is inadvertently moved when removing the robot, the ball should be replaced to the position it was in when the robot was removed.

The operator of the GameController will send the appropriate signal to the robot indicating the infraction committed. If the wireless is not working and the penalty is timed, the assistant referee handling the robot will reset the robot into the *penalized* state for the duration of the penalty. This may not be done if the penalty is not timed, i. e. it is a 0 seconds penalty. After a penalty is signaled to the robot, it is not allowed to move in any fashion, such as being in the *initial* state. The removed robot will be placed outside of the field facing away from the field of play.



Figure 9: For robots coming back from a standard removal penalty, re-entry points lie in their own half, on the sideline on the side away from the ball.

The GameController will keep track of the time of the penalty. The operator of the GameController will signal the assistant referees when the penalty is over, so that one of them can put the robot back on the field. The assistant referee will then place the robot on the field in the half of the field which this robot's team is defending. The robot should be placed close to the position, where the penalty point projects on the sideline. The robot should be pointed towards the opposite sideline. The robot should be placed on the side of the field furthest from the ball. If there is another robot already in this position, the robot should be replaced at a nearby location along the sideline facing towards the opposite sideline. If there are no practical locations nearby, a location along one of the sidelines should be found that is away from the ball (the robot should be set down facing the opposite sideline). This is illustrated in Figure 9. When finding a nearby location, locations away from the ball should be preferred, but they **must** still be in the robot's on half, so that the symmetry of the field can be resolved by the robot's localization system.

When the robot is on the field again, the operator of the GameController will send the *playing* signal to it. If the wireless is not working, the assistant referee who placed the robot back on the field has to bring it into the *playing* state again.

4.4 Manual Interaction by Team Members

Manual interaction with the robots, either directly or via some communications mechanism, is not permitted. Team members can only touch one of their robots when an assistant referee hands it over to them after a "Request for Pick-up".

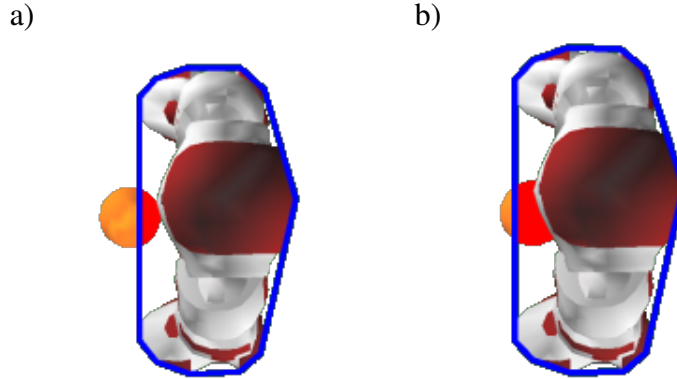


Figure 10: Examples for “Ball Holding”. The orange circle is the ball, the blue polygon visualizes the convex hull of the robot’s projection onto the ground and the red area shows the occupied portion of the ball. Situations a) is legal, whereas b) violates the rule.

4.5 Kick-off Shot

A “kick-off shot” can never score a goal. A “kick-off shot” is a shot taken by the team kicking off after a kick-off before the entire ball has left the center circle, including the boundary line. If a kick-off shot enters the goal (either directly or via contact with an opposing robot), no goal will be scored and a kick-off will be awarded to the defending team (as per Section 3.6). The main referee’s decision in this case is final and can not be changed afterwards by video proof.

4.6 Ball Holding

The goalie is allowed to hold the ball for up to 5 seconds as long as it has one foot inside in its own penalty area. In all other cases, robots are allowed to hold the ball for up to 3 seconds. Holding the ball for longer than this is “Ball Holding” and is not allowed.

A robot which does not leave enough open space around the ball will be penalized as “Ball Holding” if that situation continues more than 3 seconds. The occupation of the ball is judged using the convex hull of the projection of the robot’s body onto the ground. “Enough open space” means that at least the half of the ball is not covered by the convex hull. It is not important whether the robot actually touches the ball.

Intentional continual holding is prohibited even if each individual holding time does not continue for up to the time limit. In general robots should release the ball for approximately as long as they were holding it to reset the clock. Without a sufficient release, the continual holding is regarded as a continuous hold from the very beginning and the holding rule is strictly applied. The violation of this rule will result in the standard removal penalty (see Section 4.3 for details). The ball should be removed from the possession of the robot and placed where the foul occurred. If the robot that held the ball has moved the ball before the robot can be removed, the ball shall be replaced where the foul occurred.

Example. A robot holds the ball and before the referees can remove the robot, it shoots the ball into the goal. The goal will not be counted and the ball will be replaced where the robot held the ball.

4.7 Fallen or Inactive Robots

If a robot falls during the game, it should start executing a getup action within 5 seconds. If it does not commence a get up action within 5 seconds, it will be removed as per the standard removal penalty. A robot which is unable to autonomously stand up within 20 seconds after a fall will be removed and subject to the standard penalty. The goal keeper, inside its own penalty area, is the only robot permitted to ‘dive’ (that is deliberately fall in a way that might cause its torso, arms or hands) to intercept the ball. In all other cases, the robot should be programmed to attempt to remain upright – that is, supported by its feet.

A robot that has ceased activity for 10 seconds or has turned off will be removed by the referees and is subject to the standard removal penalty. A robot is active if it performs at least one of the following:

1. The robot walks in any direction, or turns.
2. The robot searches for the ball, or is looking at the ball.

Note: The intention of this rule is not to penalize robots simply for being stationary – provided they are not ‘asleep’ and have not ‘crashed’.

4.8 Player Stance

Robots are not allowed to stay in a stance that is wider than the width of the robot’s shoulders for more than 5 seconds. The robot is allowed to go into a wide stance as long as it comes back to a normal stance within 5 seconds. Staying in a wide stance for longer than 5 seconds will result in the standard penalty. If the robot has fallen down, it must start getting up within 5 seconds.

4.9 Player Pushing

Pushing is a forceful contact with another robot, i.e., enough to destabilize it, and is not allowed. In the following, the cases when pushing occurs as well as exceptions are specified in more detail.

The standard removal penalty will apply for pushing. The 4th time a team is called for pushing in a half, the offending robot will be removed for the remainder of the half. Subsequently for that half, a robot from the team will be removed for every 2 pushing offenses (i.e., the 6th time, 8th time, etc). Note that this can result in all five of a team's robots being removed for the remainder of the half if they are called for pushing twelve times in a half. Pushing offenses during the ready state are not counted as part of this removal count (cf. Section 3.6).

If the ball moves significantly as the result of pushing, then it should be replaced to where it was at the time of the infringement.

4.9.1 Exceptions to the Pushing Rules

The following define situations where pushing does not apply:

1. Pushing may occur **only** between players of different teams.
2. A stationary robot cannot be penalized for pushing, including a robot that is kicking, provided that the ball was close enough where a kick could have succeeded at the start of the kick motion.
3. The goal keeper cannot be penalized for pushing while looking at or chasing the ball in it's own penalty area.
4. Front to front contact between robots with the ball between them does not constitute pushing.
5. Any robot proceeding to the ball whose side (i.e., arm, shoulder etc.) makes contact with another robot cannot be called for pushing. Even if the second robot is not proceeding to the ball.

4.9.2 Contact between standing/walking Robots

The following forms of contact are considered pushing contacts except for the conditions in Section 4.9.1:

1. Any form of contact that has enough force to knock a robot over.
2. Walking into another robot for 3 seconds, even if the 'force to push' is minimal.

4.9.3 Contact with a Fallen Robot

While doing a getup movement the following pushing contacts might occur:

1. If, during the getup, another robot moves towards the fallen robot and makes contact with the fallen robot who is attempting a getup, then the upright robot will be penalized if none of the exceptions of Section 4.9.1 apply.
2. If the ‘getting up robot’ makes forceful contact with another robot (enough to destabilize it) where the standing robot is not moving towards the fallen robot, then the fallen robot will be called for pushing. (Basically saying if the opposing robot has ‘cleared’ the area of the fallen robot, however the getup routine causes the contact, then the getting up robot should be penalized.)

4.9.4 Contact Between More Than 2 Robots

Pushing should be called the in the same way when multiple robots are in contact. The robot that is pushing will be called for a penalty regardless of how many robots of either team are in the area. This is to ensure that the team that is pushing is called for the penalty. If any of the exceptions apply to a robot in the group, that robot cannot be called for pushing.

4.10 Playing with Arms/Hands

A field player or a goal keeper outside its own penalty box that intentionally touches the ball with its arms/hands in a manipulative manner (i.e. to stop the ball, to kick the ball etc.) will be subject to the standard removal penalty. In this case, the ball is to be replaced at the point where it contacted the arms/hands of the offending robot.

4.11 Damage to the Field

A robot that damages the field will be removed from the field for the remainder of the game. Similarly, a robot that poses a threat to spectator safety will also be removed from the field for the remainder of the game.

4.12 Leaving the Field

A robot that intends to leave the 7.4 m \times 10.4 m carpeted area will be subject to the standard removal penalty (see Section 4.3). This penalty can already be called after a robot leaves the 6 m \times 9 m playing field if the robot appears to be “lost”.

In addition, a robot that walks into the goal net for more than 5 seconds will also be subject to the standard removal penalty.

4.13 Illegal Defender

Only the goalie can be within its team’s penalty area. Having both legs inside the penalty area (i. e. at least touching the line) is the definition of being in the penalty area and that situation is not allowed for defending field players. When other defending robots enter the area, they will be subject to the standard removal penalty (see Section 4.3). This is called the “Illegal Defender Rule”. This rule will be applied even if the goalie is outside of the penalty area, but not if an operational defender is pushed into the penalty area by an opponent.

If an illegal defender kicks an own goal, the goal is scored for the opponent. If there is any doubt about whether a goal should count (e.g. the illegal defender infraction is called, but the robot scores the own goal immediately afterwards, before it is removed) then the decision shall be against the infringing robot.

4.14 Jamming

During the match any robot shall never jam the communication and the sensor systems of the opponents:

Wireless communication. Teams can use a bandwidth of up to 500 Kbps of the wireless. This includes any data transferred, namely the actual payload and any protocol overhead created, e. g., by TCP or UDP. If a team uses more bandwidth over a couple of seconds in a game, it will be disqualified for that game. Except for the wireless cards and the access points provided by the organizers of the competition, nobody close to the field is allowed using 2.4 GHz radio equipment (including cellular phones and/or Bluetooth devices).

Acoustic communication. If acoustic communication is used by both teams, they shall negotiate before the match how they can reduce interference. If only one team uses acoustic communication, the robots of the other team shall avoid producing any sound. In addition, both the teams and the audience shall avoid intentionally confusing the robots by producing similar sounds to those used for communication.

Visual perception. To avoid confusing other robots, the robots are not allowed to switch LEDs to orange. In general, the use of flashlights is not allowed during the games.

5 Judgement

The referees are the only persons that are allowed inside the playing area.

5.1 Head Referee

The head referee signals game starts, restarts, when a goal was scored, the case of *game stuck*, and penalties by a single whistle. In general, the head referee first whistles and then announces the reason for the whistle. The only exception is the case of the kick-off, in which the reason for the whistle is obvious. The whistle defines the point in time at which the decision is made. If the head referee has to announce many decisions in short sequence, he may skip whistling. For penalties, he announces the infraction committed, the team color, and the jersey number of the robot, e. g. “illegal defender, blue number 3”. In case of a goal scored, local or global game stuck, this is also announced verbally. By two whistles, the head referee terminates the first half; by three whistles he terminates the second half, i. e. the whole game. The head referee is also responsible for keeping the time of each half, i. e., he or she stops the clock after a goal or game stuck, and continues it at the kick-off⁶. The head referee may choose to delegate this task to the GameController, it should be noted that the ultimate responsibility for correct time keeping still remains with the head referee.

In the penalty kick shoot-out, the head referee keeps the time.

Any decision of the head referee is valid. There is no discussion about decisions during the game, neither between the assistant referees and the head referee, nor between the audience or the teams and the head referee.

5.2 Assistant Referees

The two assistant referees handle the robots. They start them if the wireless is not working, they move them manually to legal kick-off positions, they take them out when the robots are penalized, and they put them in again. If a team requests to pick up a robot, an assistant referee will pick it up and give it to one of the team members once the head referee approves. An assistant referee will also put the robot back on the field. In addition, the assistant referees can indicate violations against the rules committed by robots to the head referee, so that the head referee can decide whether to penalize a certain robot or not. Assistant referees should only enter the field to execute a decision made by the main referee. They should not prevent robots from falling during the game.

⁶The clock may not be stopped during the preliminaries.

5.3 Operator of the GameController

The operator of the GameController sits at a PC outside the playing area. He or she will signal any change in the game state to the robots via the wireless as they are announced by the head referee. He or she will also inform the assistant referees when a timed penalty is over and a robot has to be placed back on the field. The operator may also be responsible for time keeping if the head referee has delegated this task.

5.4 Selection of the Referees

At least in the preliminaries, the games will be refereed by members of teams from a different Round-Robin group. Each team has to referee a number of these games. For each of the games, it can either provide the head referee and the operator of the GameController, or the two assistant referees. These persons must have good knowledge of the rules as applied in the tournament, and the operator of the GameController must be experienced in using that software. The persons should be selected among the more senior members of a team, and preferably have prior experience with games in the RoboCup Standard Platform league.

Referees for playoff games will need to be certified (i. e. deemed fit to referee) by at least half the teams in the playoffs. Unless they have no eligible referees, each team in the playoffs shall supply at least one referee for the playoffs. For a particular game, each of the teams playing shall be able to veto one and only one eligible referee with no reason required.

5.5 Referees During the Match

The head referee and the assistant referees should wear clothing and socks *of black or dark blue color* (blue jeans are acceptable) and avoid reserved colors for the ball, the goals, and player markings in their clothing. They may enter the field in particular situations, e. g., to remove a robot when applying a penalty. They should avoid interfering with the robots as much as possible.

5.6 Penalty for Failing to Referee when Assigned

A schedule will be released regarding the games for which each team is required to provide two referees. These referees should report to the field on which the game they are to referee is to be played at least five minutes before the game is scheduled to start.

Each time a team fails to provide two referees for a game in which they are scheduled to provide referees, it will be noted by the organizing committee. Failing to provide referees when assigned is a serious offence that will not only cost you automatic qualification if your team reaches the

Quarter Finals, but will also severely effect your team’s chances of being accepted the following year.

A team may swap refereeing duties with another team, but the team listed on the referee schedule will be held accountable if referees fail to appear for a game they are scheduled to referee.

The requirement to referee may be an extreme hardship for extremely small teams. If a team believes providing two referees for games will be an extreme hardship, they must send an email explaining their situation to the Organizing Committee and Technical Committee at least two weeks before the first set up day of the competition. The Organizing and Technical Committees will then consider the request and attempt to find an acceptable solution.

5.7 A Remark on Artificial Landmarks

The head referee may decide at any point before or during a game to relocate any objects around the field, or direct persons to another position around the field.

The intent of using same-colored goals is to remove artificial landmarks. Robots should be able to localize with the SPL field and its “normal” surroundings. Introducing new team-specific artificial landmarks is against the spirit and intention of the league’s progress. The application of this rule needs to be well considered and should be reserved for situations which seem constructed by one team or another, but will ultimately be the head referee’s decision alone.

6 Changes From 2012

This is a brief list of rule changes from 2012 to 2013.

- Increased the size of the field to $6\text{ m} \times 9\text{ m}$, and the center circle diameter to 1.5 m (cf. Section 1.1).
- Use the same goals construction as the humanoid kid-size league (cf. Section 1.1)
- Fields may be located close to one another, with no barriers or boundaries between them. There will be at least three meters of space between fields if there is not a boundary (cf. Section 1.5).
- Increased the number of players to **5** (cf. Section 2).
- Robots will use cyan and magenta jersey shirts as team markers (cf. Section 2.4).
- Updated legal kick-off positions, as well as manual positions (cf. Section 3.6). In particular, any number of the field players of the attacking team may position themselves inside the center circle before kick-off.

-
- On kick-off, the defensive team must stay outside of the center circle until the ball is in play (cf. Section 3.6). The ball is in play once it is touched by the attacking team or once 10 seconds have elapsed in the playing state. The “Illegal Defender” rule is applied if a player of the defensive team enters the center circle before the ball is in play (cf. Section 3.6).
 - The attacker is allowed only one contact with the ball on penalty kicks. The attacker’s starting position on penalty kicks was also updated for the larger field (cf. Section 3.8).
 - Clarified that *any* changes on the robot (hardware and software) may be made during a request for pick-up (cf. Section 3.12).
 - If a timeout is ended prematurely, the opponent team has up to 2 minutes time to be ready to play (cf. Section 3.13).
 - Forfeits no longer result in a 10:0 score. When an opponent forfeits, the other team must play out the game against an open field. Any own goals scored by this team will not count, however (cf. Section 3.15).
 - All five of a team’s robots can be removed for the remainder of a half if they are called for pushing twelve times in that half (cf. Section 4.9).
 - Simplified the pushing rules. In particular:
 - A ball that moves significantly as the result of pushing should always be replaced to where it was at the time of the infringement (cf. Section 4.9).
 - Removed an old rule: referees will not put upright a robot fallen after pushing, i.e., a robot has to get up on its own (cf. Section 4.9).
 - Robots are allowed to push robots on their own team (cf. Section 4.9.1).
 - Pushing while walking front-to-back is not treated separately anymore (cf. Section 4.9.2).
 - There is no special treatment if more than two robots are involved in pushing (cf. Section 4.9.4).
 - A penalty kick is no longer awarded when an opponent’s robot presents a threat to spectator safety. Instead, this robot is removed for the remainder of the game (cf. Section 4.11).
 - Failing to provide referees when assigned will not only cost you automatic qualification if your team reaches the Quarter Finals, but will also severely effect your team’s chances of being accepted the following year (cf. Section 5.6).

7 Questions/Comments

Questions or comments on these rules should be mailed to rc-spl-tc@lists.robocup.org.