



Virtual RoboCup Soccer Humanoid League Laws of the Game 2020/2021

April 1st, 2021



RoboCup Humanoid League Mailing List (for important announcements):

<https://mailman.cc.gatech.edu/mailman/listinfo/robocup-humanoid>

10 RoboCup Humanoid Forum (for rule discussion and questions):

<https://hl.forum.robocup.org>

RoboCup Humanoid League Home Pages:

<https://www.humanoid.robocup.org/>

<https://www.robocup.org/leagues/3>

15 Inspired by the Laws of the Game of the International Football Association Board,
with amendments for the RoboCup Humanoid League.

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Section I

Laws of the Game

⁴⁵ The Laws of the Game should be updated regularly to refer to the most recent FIFA document.

NOTES ON THE LAWS OF THE GAME

Modifications

Subject to the agreement of the member association concerned and provided the principles of these Laws are maintained, the Laws may be modified in their application for regional matches.

50 Any or all of the following modifications are permissible:

- size of the field of play
- size, weight and material of the ball
- width between the goalposts and height of the crossbar from the ground
- duration of the periods of play

55 • substitutions

Male and Female

References in respect of referees, assistant referees and officials have been changed from the original FIFA document to a gender neutral language. The reference to players, since they refer to robots in this context, have been kept in the male gender. However, we strongly encourage the FIFA to officially change their laws of the game to fully gender
60 neutral language in the future in respect to all participants in the game.

Official languages

RoboCup Humanoid League Technical Committee publishes the Laws of the Game in English.

Law 1 – The Field of Play

Field surface

65

Matches may be played on artificial surfaces with a height of approximately 30 mm.

The colour of artificial surfaces must be green.

Field markings

70

The field of play must be rectangular and marked with lines. These lines belong to the areas of which they are boundaries.

The two longer boundary lines are called touch lines. The two shorter lines are called goal lines.

75 The field of play is divided into two halves by a halfway line, which joins the midpoints of the two touch lines.

The centre mark is indicated at the midpoint of the halfway line. A circle with a radius of 0.75 m for KidSize and 1.5 m for AdultSize is marked around it.

Dimensions

80

The length of the touch line must be greater than the length of the goal line.

KidSize matches

Length (touch line): approximately 9 m

Width (goal line): approximately 6 m

All lines must be of the same width, which must be approximately 5 cm.

85 AdultSize matches

Length (touch line): approximately 14 m

Width (goal line): approximately 9 m

The goal area

90 Two lines are drawn at right angles to the goal line, 0.2 m from the inside of each goalpost for KidSize and 0.7 m for AdultSize. These lines extend into the field of play for a distance of 1 m and are joined by a line drawn parallel with the goal line. The area bounded by these lines and the goal line is the goal area.

The penalty area

95 Two lines are drawn at right angles to the goal line, 1.2m from the inside of each goalpost for KidSize and 0.7 m for AdultSize. These lines extend into the field of play for a distance of 2 m for KidSize and 3 m for AdultSize. They are joined by a line drawn parallel with the goal line. The area bounded by these lines and the goal line is the penalty area.

100 Within each penalty area, a penalty mark is made at 2.1m for AdultSize and 1.5m for KidSize from the midpoint between the goalposts and equidistant to them.

Goals

105 A goal must be placed on the centre of each goal line.

A goal consists of two upright posts equidistant from the corner flagposts and joined at the top by a horizontal crossbar. The goalposts and crossbar must be made of wood, metal or other approved material. They must be square, rectangular, round or elliptical in shape and must not be dangerous to players.

110 The distance between the posts is 2.6 m and the distance from the lower edge of the crossbar to the ground is 1.2 m for KidSize and 1.8m for AdultSize.

If the shape of the goalposts is square (viewed from above), the sides must be parallel or perpendicular to the goal line. The sides of the crossbar must be parallel or perpendicular to the field plane.

If the shape of the goalposts is elliptical (viewed from above), the longest axis must be perpendicular to the goal line. The longest axis of the crossbar must be parallel to the field plane.

115 If the shape of the goalposts is rectangular (viewed from above), the longest side must be perpendicular to the goal line. The longest side of the crossbar must be parallel to the field plane.

120 Both goalposts and the crossbar have the same width and depth, which is not smaller than 8 cm and do not exceed 12 cm (5 ins). The goal lines must be approximately 5 cm of width. Nets which must not be green or white may be attached to the goals and the ground behind the goal, provided that they are properly supported and do not interfere with the goalkeeper.

The goalposts and crossbars must be white.

Safety

125 Goals must be anchored securely to the ground. Portable goals may only be used if they satisfy this requirement.

The field of play

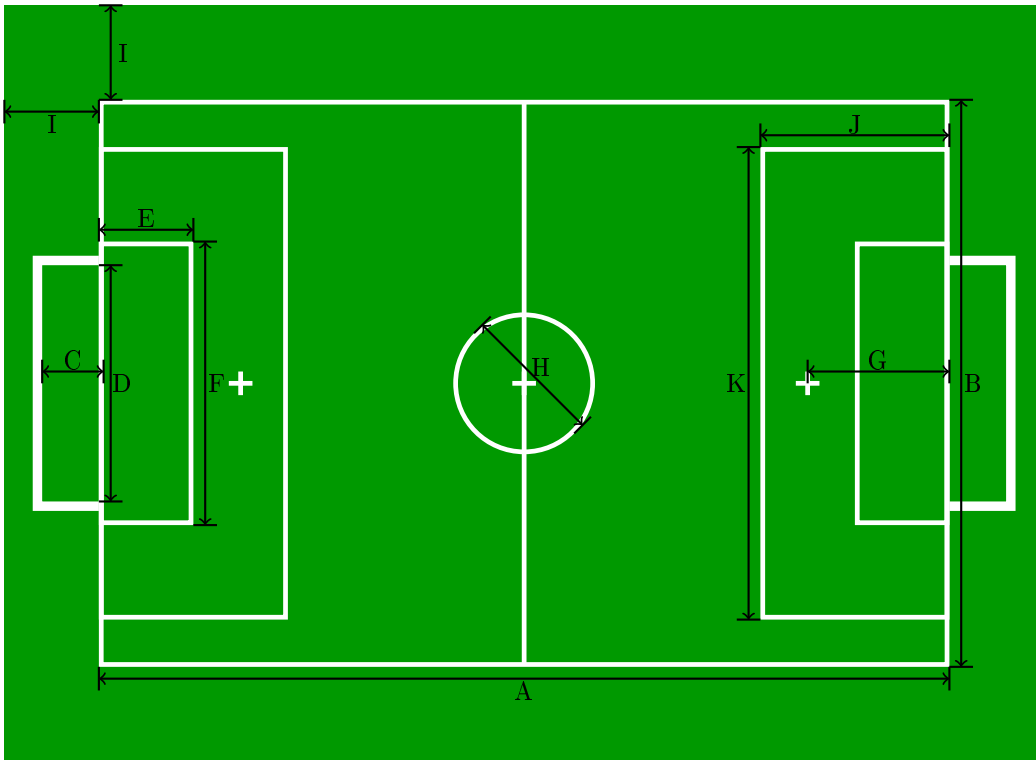


Figure 1: Humanoid robot soccer field: Kid Size (scale: 1/80)

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Light Condition

The lighting resembles that of either artificial or natural light.

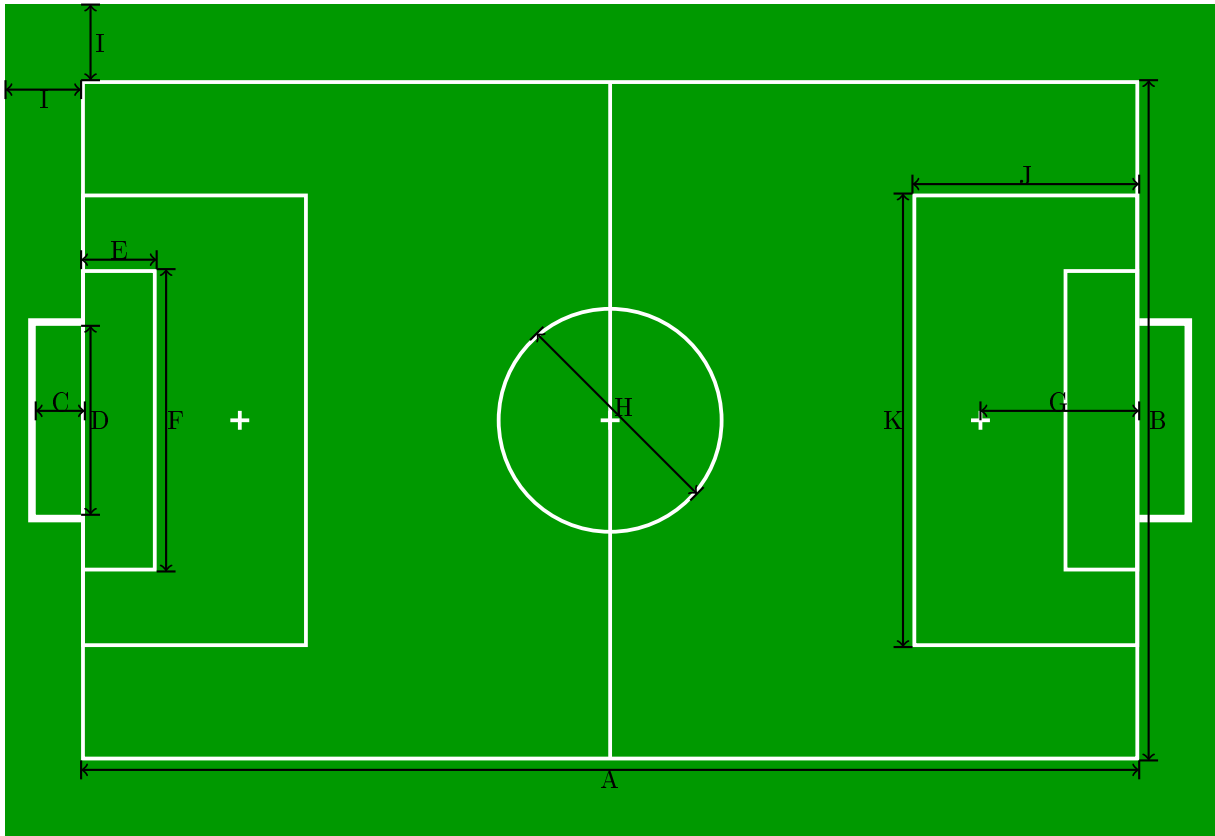


Figure 2: Humanoid robot soccer field: Adult Size (scale: 1/100)

Table 1: Approximate dimensions of the rectangular field of soccer play.

		KidSize	AdultSize
A	Field length	9 m	14 m
B	Field width	6 m	9 m
C	Goal depth	0.6 m	
D	Goal width	2.6 m	
	Goal height	1.2 m	1.8 m
E	Goal area length	1 m	
F	Goal area width	3 m	4 m
G	Penalty mark distance	1.5 m	2.1 m
H	Centre circle diameter	1.5 m	3 m
I	Border strip width (min.)	1 m	1 m
J	Penalty area length	2 m	3 m
K	Penalty area width	5 m	6 m

135 Law 2 – The Ball

Qualities and measurements

The ball is:

- 140
- spherical
 - resembles the weight, form, movement characteristics and appearance of leather or other suitable material
 - FIFA size 1 for KidSize and size 5 for AdultSize leagues.

Law 3 – The Players

Number of Players

145

A match is played by two teams, each consisting of not more than four players in KidSize and not more than two players in AdultSize, one of whom must be designated as goalkeeper. A match may not start if either team consists of less than one player. If a team does not provide any software to play with for an upcoming game, it is considered
150 a forfeit.

Number of substitutions

Official competitions

155 No substitute players may be used in the virtual competitions.

Changing the goalkeeper

Any of the other players may change places with the goalkeeper, provided that:

- 160
- the GameController is informed before the change is made
 - the change is requested during a stoppage in the match

Law 4 – The Players ('Equipment')

Safety

A player must not use equipment or wear anything that is dangerous to himself or another player (including any kind of jewellery).

The Design of the Robots

Robots participating in the Humanoid League competitions must have a human-like body plan, as shown in Fig. 3. They must consist of two legs, two arms, and one head, which are attached to a trunk.

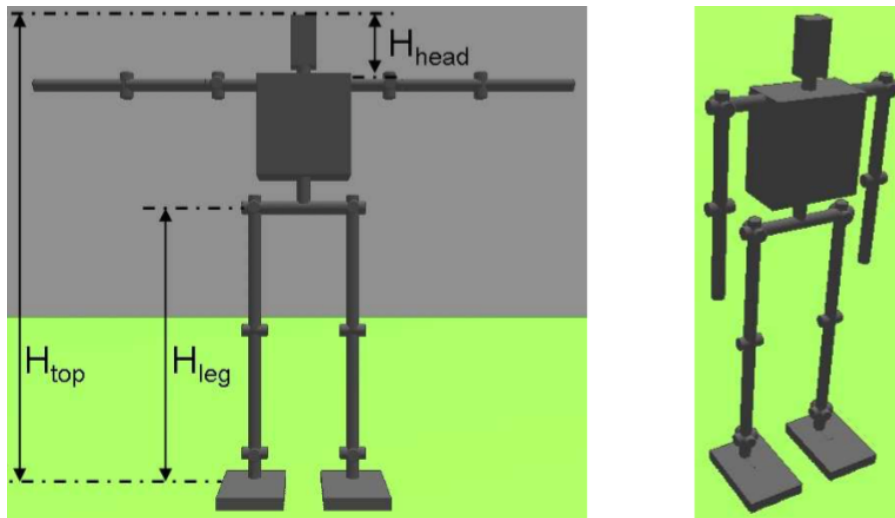


Figure 3: Example of a humanoid robot body plan (left) and standing upright pose (right)

The robots must be able to stand upright on their feet and to walk on their legs. KidSize robots need to be able to recover from a fall (get back to a standing position). The only allowed modes of locomotion are bipedal walking, running and jumping.

All actions of the robots must be kinematically equivalent to humanoid motions.

Body parts considered as feet and arms must be marked in the robot model.

Robot Height

Based on H_{top} , the following size restrictions apply:

- $40 \text{ cm} \leq H_{top} \leq 100 \text{ cm}$ to play in the KidSize class,
- $100 \text{ cm} \leq H_{top} \leq 200 \text{ cm}$ to play in the AdultSize class.

H_{top} is defined as the height of the robot when standing upright (with fully extended knees, cf. Fig. 3 right) and H_{COM} denotes the height of the robot's centre of mass, measured in upright posture. H_{top} is measured with the head of the robot oriented in such a way that it is tilted to either its maximum upwards tilt angle or the horizon line, whichever is lower.

Weight Restrictions

The robot's Body-Mass Index (BMI) is defined as follows: $BMI = \frac{M}{H_{top}^2}$, where M is the mass of the robot in kg and H_{top} its height in meters. The following restriction applies:

- $5 \leq \text{BMI} \leq 30$

Size Restrictions

195

All robots participating in the Humanoid League must comply with the following restrictions:

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- Each foot must fit into a rectangle of area $\frac{1}{32}(2.2 \cdot H_{COM})^2$. A foot is defined as the minimum encapsulating rectangle covering all mechanical parts below the ankle joint. The encapsulating rectangle should be in a plane parallel to the bottom contact surface of the foot.

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- The ratio between the longest and the shortest side of the encapsulating rectangle should be between 1.2 and 3.5
- The robot must fit into a cylinder of diameter $0.55 \cdot H_{top}$.
- The robot does not possess a configuration where it is extended longer than $1.5 \cdot H_{top}$.
- The length of the legs H_{leg} , including the feet, satisfies $0.35 \cdot H_{top} \leq H_{leg} \leq 0.7 \cdot H_{top}$.

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- The height of the head H_{head} , including the neck, satisfies $0.1 \cdot H_{top} \leq H_{head} \leq 0.3 \cdot H_{top}$. H_{head} is defined as the vertical distance from the axis of the first arm joint at the shoulder to the top of the head.
- The leg length is measured while the robot is standing up straight. The length is measured from the first rotating joint where its axis lies in the plane parallel to the standing ground to the tip of the foot.
- The minimum length of the arm, measured from the first joint, is $H_{top} - H_{leg} - H_{head}$.

Sensors

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Teams participating in the Humanoid League competitions are encouraged to equip their robots with sensors that have an equivalent in human senses. These sensors must be placed at a position roughly equivalent to the location of the human's biological sensors. In particular,

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- No active external sensors may be used during the game.
- External sensors, such as cameras and up to two microphones, may not be placed in the legs or arms or the torso of the robots. They must be placed in the robot's head and above any neck joint.
- The number of cameras is limited to a stereo vision setup (i.e., max. 2 cameras with a large overlap) only. Monocular vision is also allowed.

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- The field of view of the robots is limited at any time to 180 degrees. This means that the maximum angle between any two points in the union of the field of view of all cameras mounted on the robot must be less than 180 degrees. Also the pan-tilt motion of the head and the cameras mounted on the robot's head is restricted to be more human like not only with respect to the field of view but also to the range of motion of the neck joints. Therefore, the mechanism to pan the camera is limited to 270 degree pan, which means ± 135 degrees from the position looking straight ahead. The mechanism to tilt the camera is limited to ± 90 degrees (measured from the horizontal line). Furthermore, if positioned at the centre mark the robot may not be able to see more than two goal posts in any tilt angle and in any standing or walking posture of the robot.

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- Touch sensors, force sensors, and temperature sensors may be placed at any position on the robot.
- Sensors inside the robot may measure all quantities representing the local state of the system, including (but not limited to) voltages, currents, forces, movements, accelerations, and rotational speeds. They can be at any position inside the robot. Measurements from earth magnetic field sensors may not be used in the software and - in case of doubt - the code must be made available to members of the Technical Committee for inspection.

235 **Communication and Control**

Robots participating in the Humanoid League competitions must act autonomously while a competition is running. No external power supply, teleoperation, remote control, or remote brain of any kind is allowed.

240 Robots may communicate only via the network provided by the organizers, which must support the referee box. The total bandwidth of the virtual robot instances belonging to one team may not exceed 1 Mbit/s. Teams will not be able to monitor the robot communication and receive debug messages during an ongoing simulation.

Robots in play may communicate with each other at any time during a game. Any kind of transmission from an external computer to the playing robots is prohibited.

245 Sending any direct or indirect transmission from an external computer to the robots is not possible during a simulated game.

Teams may not use any type of communication with robots in play or with robots serving their 30 seconds penalty time that contains information which reduces the need for autonomy in detecting the current game state of the robots, including the position of the ball, the location where the robot re-enters the field, the orientation of the robots own or opponents goal, and the position of team members or opponents. In case of doubt that a team violates this rule, 250 the code must be made available to members of the Technical Committee for inspection.

During the game an official game controller/referee box will be used. It uses UDP to broadcast information to the robots like elapsed time, current score, game state (ready, set, playing, finished) and the robot-specific penalized state. The source code is open. Teams have to be able to use the referee box in order to respect the rules.

255 The source code of the game controller/referee box is available from <https://github.com/RoboCup-Humanoid-TC/GameController>, see also <https://www.robocuphumanoid.org>.

Colours

260

- Robots must be mostly black or of dark grey colour (i.e. RAL 7011 Iron Grey or darker) and non reflective. Robots may also be coloured in aluminium-like silver, grey or white but then their feet must be coloured black. Any colour used for the field (green, white) or colours similar to the opponent team's team markers must be avoided. Arms, legs and bodies of the robot must be of solid shape appearance.
- The robots must be marked with team markers. These markers are coloured red for one team and blue for the other team. The total visible area of all team markers (up to 20) on the robot's arms, legs and chest combined must be at least $0.06 \cdot H_{top}^2$. The visible area of the one to five largest team markers on each side (left, right, front and back) must be at least $0.015 \cdot H_{top}^2$. The color teams play in is randomly assigned and announced in the game plan.
- The robots of each team must be uniquely identifiable. They must be marked with numbers or names. The goal keeper robot must be marked uniquely that it can be easily distinguished from the other robots of a team by the referees.
- The two teams must wear colours that distinguish them from each other

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Infringements and sanctions

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The equipment of the players is checked by the Technical Committee prior to the tournament.

In the event of any infringement of this Law:

- The Technical Committee notifies the team in advance of the tournament about the violations and allows them 280 to correct the equipment of the players.

- In case no valid robot model has been provided prior to the tournament, the team is excluded from participation.

Decisions of the International F.A. Board

285 Decision 1

Players must not reveal undergarments showing slogans or advertising. The basic compulsory equipment must not have any political, religious or personal statements. A player removing his jersey or shirt to reveal slogans or advertising will be sanctioned by the competition organiser. The team of a player whose basic compulsory equipment has political, religious or personal slogans or statements will be sanctioned by the competition organiser or by RoboCup Federation

290 Humanoid League .

Law 5 – The Referee

The authority of the referee

295 Each match is controlled by a autonomous referee who has full authority to enforce the Laws of the Game in connection with the match to which they have been appointed. Decisions will be made to the best of the referees ability according to the Laws of the Game and the spirit of the game and will be based on the programming of the referee who has the discretion to take appropriate action within the framework of the Laws of the Game. The games are overseen by the Technical Committee of the league, who ensures that the players and simulated environment is according to the laws of the game, and who may sanction unsportive behavior by teams.

Powers and duties

The autonomous Referee:

- 305 • enforces the Laws of the Game
- controls the match
- acts as timekeeper and keeps a record of the match
- stops, suspends or abandons the match, at their discretion, for any infringements of the Laws
- punishes the more serious offence when a player commits more than one offence at the same time
- 310 • takes disciplinary action against players guilty of cautionable and sending-off offences. They are not obliged to take this action immediately but must do so when the ball next goes out of play
- indicates the restart of the match after it has been stopped
- provides the appropriate authorities with a match report, which includes information on any disciplinary action taken against players and/or team officials and any other incidents that occurred before, during or after the match
- 315 • indicates when the whole of the ball leaves the field of play
- indicates which team is entitled to a corner kick, goal kick or throw-in
- indicates whether, at penalty kicks, the goalkeeper moves off the goal line before the ball is kicked and if the ball crosses the line
- 320 • communicates its decisions directly to the GameController.

The Technical Committee:

- ensures that any ball used meets the requirements of Law 2
- ensures that the players' equipment meets the requirements of Law 4
- stops, suspends or abandons the match because of outside interference of any kind
- 325 • takes action against team officials who fail to conduct themselves in a responsible manner and may, at their discretion, expel them from the field of play and its immediate surrounds

Decisions of the referee

330 The decisions of the referee regarding facts connected with play, including whether or not a goal is scored and the result of the match, are final.

Decisions of the International F.A. Board

335 Decision 1

A virtual referee (or where applicable, the Technical Committee) is not held liable for:
any kind of injury suffered by a player, official or spectator
any damage to property of any kind
any other loss suffered by any individual, club, company, association or other body, which is due or which may be due
340 to any decision that they may take under the terms of the Laws of the Game or in respect of the normal procedures required to hold, play and control a match.

Such decisions may include:

- a decision that the condition of the field of play or its surrounds or that the weather conditions are such as to allow or not to allow a match to take place
- 345 • a decision to abandon a match for whatever reason
- a decision as to the suitability of the field equipment and ball used during a match
- a decision to allow or not to allow a player to wear certain apparel or equipment
- any other decision that they may take in accordance with the Laws of the Game or in conformity with their
350 duties under the terms of FIFA, confederation, member association or league rules or regulations under which the match is played

suspended: Law 6 – The Assistant Referees

Law 7 – The Duration of the Match

Periods of play

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The match lasts two equal periods of 10 minutes. Any agreement to alter the duration of the periods of play must be approved by the Technical Committee, must be made before the start of play and must comply with competition rules.

360

Teams are given a 2 minute time period between the robot models being spawned and the start of the match. The start of the match is defined as the game state changing to READY for the first half time. At the beginning of the second half time, each half time in the extended period and the beginning of the penalty shootout, the referee will wait at least 15 seconds between spawning the robot models and transitioning to an active game state. Once the end of the match was declared by the referee and communicated by the GameController, teams receive a 2 minute time period to finish writing logs and properly shut down their program before the process will be terminated.

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Half-time interval

There is no half-time interval between the two periods of play.

Abandoned match

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An abandoned match is replayed unless the competition rules provide otherwise.

Law 8 – The Start and Restart of Play

A kick-off starts both halves of a match, both halves of extra time and restarts play after a goal has been scored.
375 Free kicks (direct or indirect), penalty kicks, throw-ins goal kicks and corner kicks are other restarts (see law 13-17).

If an infringement occurs when the ball is not in play this does not change how play is restarted.

Definition of kick-off

380 A kick-off is a way of starting or restarting play:

- at the start of the match
- after a goal has been scored
- at the start of the second half of the match
- at the start of each period of extra time, where applicable

385 A goal may not be scored directly from the kick-off by the team taking the kick-off. Either the ball must move entirely outside the centre circle or must be touched by another player before being kicked into the goal. If the ball is kicked directly into the goal a goal-kick is awarded to the opposing team.

Procedure

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Before a kick-off at the start of the match or extra time

- the referee decides randomly which team attacks which goal
- the referee decides randomly which teams has kick-off in the first half of the match.
- the team that was not given kick-off in the first half of the match takes the kick-off to start the second half of
395 the match.
- in the second half of the match, the teams change ends and attack the opposite goals.

Kick-off

- after a team scores a goal, the kick-off is taken by the other team.
- all players must be in their own half of the field of play
- 400 • the opponents of the team taking the kick-off are outside the center circle until it is in play
- the ball must be stationary on the centre mark
- the referee gives a signal
- the ball is in play when it is kicked and moves at least 5 cm or 10 seconds after the referee gave the signal

Infringements and sanctions

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In the event of any other infringement of the kick-off procedure:

- the kick-off is retaken

Definition of dropped ball

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A dropped ball is a method of restarting play when, while the ball is still in play, the ball has moved less than 5 centimeters in the last 2 minutes of play.

Procedure

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The game is continued at the centre mark. A goal can be scored directly from a dropped ball. The procedure for dropped ball is the same as for kick-off, except that the players of both teams must be outside the centre circle. The ball is in play immediately after the referee gives the signal. If a player moves too close to the ball before the referee gives the signal, a kick-off is awarded to the opponent team.

Infringements and sanctions

The ball is dropped again:

- 425 • if it is touched by a player before it makes contact with the ground
- if the ball leaves the field of play after it makes contact with the ground, without a player touching it

Law 9 – The Ball In and Out of Play

Ball out of play

4.30

The ball is out of play when:

- it has wholly crossed the goal line or touch line whether on the ground or in the air
- play has been stopped by the referee

Ball in play

4.35

The ball is in play at all other times, including when:

- it rebounds off a match official, goalpost, crossbar or corner flagpost and remains in the field of play

Law 10 – The Method of Scoring

440 Goal scored

A goal is scored when the whole of the ball passes over the goal line, between the goalposts and under the crossbar, provided that no infringement of the Laws of the Game has been committed previously by the team scoring the goal.

445 If the kicking robot is removed from the game due to a removal penalty before the ball passes the goal line, the goal does not count. The restart of the play will be a goal kick for the opponents team. If another robot of a team is removed from the game before the ball passes the goal line and it is not the kicker, the goal counts.

Winning team

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The team scoring the greater number of goals during a match is the winner. If both teams score an equal number of goals, or if no goals are scored, the match is drawn.

Competition rules

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When competition rules require there to be a winning team after a match or home-and-away tie, the only permitted procedures for determining the winning team are those approved by the International F.A. Board, namely:

- away goals rule
- extra time
- 460 • kicks from the penalty mark
- extended kicks from the penalty mark

(suspended: Law 11 – Offside)

Law 12 – Fouls and Misconduct

465 Direct and indirect free kicks and penalty kicks can only be awarded for offences and infringements committed when the ball is in play.

Direct free kick

470 A direct free kick is awarded to the opposing team if a player commits a foul according to the decision diagram presented in Fig. 4, with the values listed in Table 2.

Table 2: Decision values for the foul detection

Name	Notation	value	unit
Pushing time	T_p	1	s
Pushing period	T_{pt}	2	s
Vicinity distance	D_v	2	m
Distance threshold	D_t	0.1	m
Speed threshold	s_t	0.2	m/s
Direction threshold	θ_t	30	deg

A free kick is not awarded if one of the following exceptions occurs:

- A player that had an offence committed against himself can not simultaneously be called for a free kick offence himself.

A direct free kick is also awarded to the opposing team if a player commits the following offence:

- 475
- holds the ball for more than 1 second in a way that the ball cannot be removed from the player (a goal keeper may hold the ball up to 6 seconds on the ground or 10 seconds lifted up with one or both hands, a player performing a throw-in may lift the ball up with one or both hands for up to 10 seconds). More than half of the ball's volume must be outside the convex hull of the player, projected to the ground, for the ball to be considered removable. If the ball enters the convex hull repeatedly, it must be removable in between for the majority of the time. If more than one player of a team is in the vicinity of the ball¹, the convex hull is taken 480 around all the player of a team, which prevent removal of the ball.

If an offense did not happen within a radius of approx. 1 m around the current ball position, the direct free kick is replaced by a removal penalty.

485 A removal penalty is also applied to any player touching the ball with part of its arm, except for the goalkeeper in its own penalty area or a player performing a throw-in.

A direct free kick is taken from the place where the offence occurred (see Law 13 – Position of free kick).

Penalty kick

490 A penalty kick as defined by Law 14 is awarded if any of the above offences is committed by a player inside his own penalty area, irrespective of the position of the ball, provided it is in play.

Indirect free kick

495 An indirect free kick is awarded to the opposing team if a goalkeeper, inside his own penalty area, commits any of the following four offences:

¹defined as less than 0.75m in KidSize and 1.5m in AdultSize.

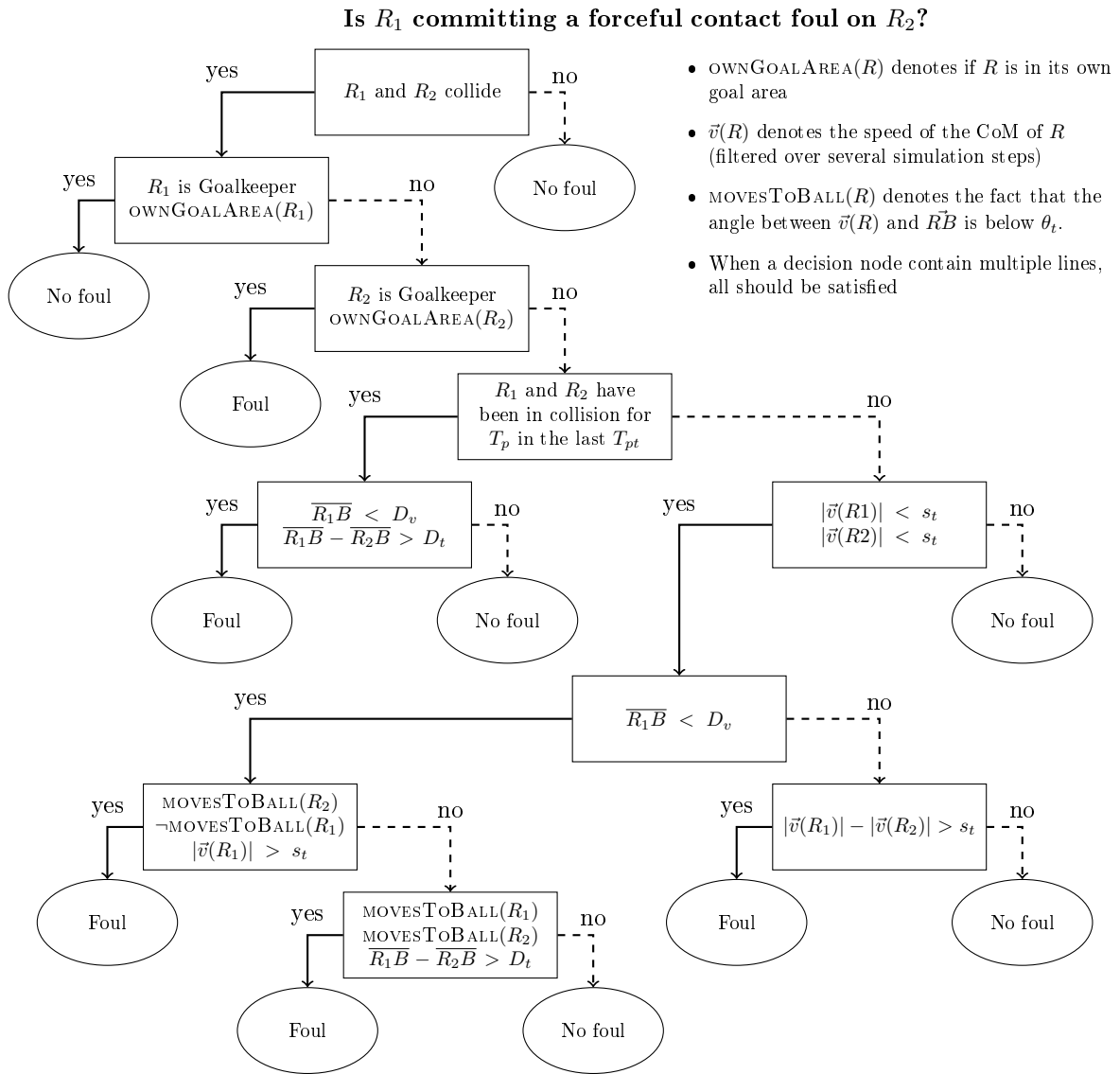


Figure 4: Is robot R_1 committing a forceful contact foul on R_2 ? This decision diagram is applied on every couple of robots from opposing teams.

- controls the ball with his hands for more than ten seconds before releasing it from his possession
- touches the ball again with his hands after he has released it from his possession and before it has touched another player
- 500 • touches the ball with his hands after it has been kicked to him by a team-mate
- touches the ball with his hands after he has received it directly from a throw-in taken by a team-mate

If an offense did not happen within a radius of approx. 1 m around the current ball position, the indirect free kick is replaced by a removal penalty.

The indirect free kick is taken from the place where the offence occurred (see Law 13 – Position of free kick).

505 Disciplinary sanctions

The yellow card is used to communicate that a player has been cautioned.

The Technical Committee may use yellow cards to communicate that a team has been cautioned.

510 The red card is used to communicate that a player has been sent off.
The Technical Committee may use red cards to communicate that a team has been excluded from the tournament.

Only a player and a team may be shown the red or yellow card.

The referee has the authority to take disciplinary sanctions from the moment the game is started until the game was declared finished by the referee.

515 The Technical Committee has the authority to take disciplinary sanctions against a team at any point during the tournament and in particular after a simulated game has been played and before the result was certified by the Technical Committee.

520 A player who or a team that commits a cautionable or sending-off offence, either on or off the field of play, whether directed towards an opponent, a team-mate, the referee, or any other person, is disciplined according to the nature of the offence committed.

Cautionable offences

A player is cautioned by the referee and shown the yellow card if he commits any of the following offences:

- 525 • entering or re-entering the field of play without the referee's permission
- receiving a second official warning from the referee

Sending-off offences

530 A player is sent off if he commits any of the following offences:

- receiving a second caution in the same match

A team is shown the red card and excluded from the tournament if it commits one of the following offences:

- using offensive, insulting or abusive language and/or gestures
- receiving a second caution in the same tournament

535 **Law 13 – Free Kicks**

Types of free kick

Free kicks are either direct or indirect.

540 **The direct free kick**

Ball enters the goal:

- if a direct free kick is kicked directly into the opponents' goal, a goal is awarded
- 545 • if a direct free kick is kicked directly into the team's own goal, a corner kick is awarded to the opposing team

The indirect free kick

Ball enters the goal

550 A goal can be scored only if the ball is either kicked and moves at least 5 cm or has been touched by another player before being kicked into the goal :

- if an indirect free kick is kicked directly into the opponents' goal, a goal kick is awarded
- if an indirect free kick is kicked directly into the team's own goal, a corner kick is awarded to the opposing team

555 **Procedure**

All free kicks are taken from the place where the offence occurred, except:

- indirect free kicks to the attacking team for an offence inside the opponents' goal area are taken from the nearest point on the goal area line which runs parallel to the goal line

The ball:

- must be stationary
- is in play when it is kicked and moves at least 5 cm except for a free kick to the defending team in their penalty area where the ball is in play when it is kicked directly out of the penalty area. In both cases the ball is also considered in play 10 seconds after the referee gave the signal.

Until the ball is in play all opponents must remain:

- at least 0.75m for KidSize and 1.5m for AdultSize from the ball until it is in play, unless they are on their own goal line between the goalposts
- outside the penalty area for free kicks inside the opponents' penalty area

570 The referee announces 'Free-Kick' blue or red and communicates "Direct / Indirect Free Kick" Blue/Red to the GameController. The referee places the ball depending on the call and announces "Free Kick Ready" and communicates "Prepare Direct / Indirect Free Kick" Blue/Red to the GameController. The player taking the free kick has up to 30 seconds to position themselves for the free kick. Any player from the team taking the free kick may announce that the player is ready to take the free kick at any point.

575 Players are guaranteed at least 15 seconds to move away from the ball. They may take up to 30 seconds if the team taking the free kick has not announced their robot is ready to take the kick off. Any opponent robot still illegally positioned is considered as an incapable player and must be removed from the field for 30 seconds removal penalty. The referee may decide to execute the free kick before 15 seconds have passed if the team taking the free kick have

announced their robot is ready and if no opponent is illegally positioned. Once the free kick can be executed, the referee communicates "Execute Direct / Indirect Free Kick" Blue/Red to the GameController.

Infringements and sanctions

If, when a free kick is taken, an opponent is closer to the ball than the required distance:

- the opponent receives a 30 second removal penalty

If, when a free kick is taken by the defending team from inside its own penalty area, the ball is not kicked directly out of the penalty area:

- the kick is retaken once if the goal keeper managed to reach the ball within the time frame. Otherwise, the ball is in play again.

If a free kick was awarded to team A and any player of team A touches the ball before the referee announced the execution of the free kick:

- The ball is in play.
- The player touching the ball received a warning. For the second warning, the player received a yellow card. For the fourth warning, the player receives a second yellow card.

If a free kick was awarded to team A and any player of team B touches the ball before the referee announced the execution of the free kick:

- The free kick is retaken.
- The player touching the ball received a warning. For the second warning, the player received a yellow card. For the fourth warning, the player receives a second yellow card.

600 **Law 14 – The Penalty Kick**

A penalty kick is awarded against a team that commits one of the offences for which a direct free kick is awarded, inside its own penalty area and while the ball is in play.

A goal may be scored directly from a penalty kick.

Position of the ball and the players

605

The ball:

- must be placed on the penalty mark.

The defending goalkeeper:

- 610
- must remain on his goal line, between the goalposts until the ball has been kicked

The players other than the kicker must be:

- inside the field of play
- behind the penalty mark
- at least 0.75m for KidSize and 1.5m for AdultSize from the penalty mark

615 **Procedure**

If a penalty kick is taken during the normal course of play the same procedure as in regular direct free kicks is applied.

During penalty shoot-out:

- 620
- After the players have taken positions in accordance with this law, the referee signals for the penalty kick to be taken
 - The player taking the penalty kick must kick the ball forward
 - The ball is in play when it is kicked and moves forward for at least 5 cm

625 The trial ends after 60 seconds. It may be extended until the ball comes to a complete stop if the ball is still moving at the time the 60 seconds are over. The trial also ends if the ball stops being entirely inside the goal area or leaves the field.

Infringements and sanctions

630 The same infringements and sanctions as in regular direct free kicks are applied.

If the player taking the penalty kick does not kick the ball forward:

- The referee allows the penalty kick to be retaken once. If the ball is moved backwards again, the ball is considered in play and the penalty kick continues.

Law 15 – The Throw-In

635 A throw-in is a method of restarting play.

A throw-in is awarded to the opponents of the player who last touched the ball when the whole of the ball crosses the touch line, either on the ground or in the air.

A goal cannot be scored directly from a throw-in:

- if the ball enters the opponents' goal - a goal kick is awarded
- 640 • if the ball enters the thrower's goal - a corner kick is awarded

Procedure

645 If the ball leaves the field it will be replaced on the field by the referee . If the whole of the ball passes over a touch line the ball is placed on the touch line directly at the point at which the ball left the field.

Balls are deemed to be out based on the team that last touched the ball, irrespective of who actually kicked the ball.

After placing the ball, the same procedure and rules of executing an indirect free kick apply. Robots are also allowed to perform the throw-in with their hands, in this case:

- has part of each foot either on the touch line or on the ground outside the touch line
- 650 • holds the ball with at least one hand
- releases the ball within 10 seconds

Law 16 – The Goal Kick

A goal kick is a method of restarting play.

655 A goal kick is awarded when the whole of the ball passes over the goal line, either on the ground or in the air, having last touched a player of the attacking team, and a goal is not scored in accordance with Law 10.

A goal may be scored directly from a goal kick, but only against the opposing team. If the ball directly enters the kicker's goal a corner kick is awarded to the opponents if the ball left the penalty area.

Procedure

660

If the ball leaves the field it will be replaced on the field by the referee. If the whole of the ball passes over the goal line the ball is placed on the touch line at the intersection with the centre line on the side of the field the ball went out.

Balls are deemed to be out based on the team that last touched the ball, irrespective of who actually kicked the ball.

665 After placing the ball, the same procedure and rules of executing a direct free kick apply.

Law 17 – The Corner Kick

A corner kick is a method of restarting play.

A corner kick is awarded when the whole of the ball passes over the goal line, either on the ground or in the air, having last touched a player of the defending team, and a goal is not scored in accordance with Law 10.

- 670 A goal may be scored directly from a corner kick, but only against the opposing team; if the ball directly enters the kicker's goal a corner kick is awarded to the opponents.

Procedure

- 675 If the ball leaves the field it will be replaced on the field by the referee. If the whole of the ball passes over the goal line the ball is placed on the corner on the side of the field the ball went out.

Balls are deemed to be out based on the team that last touched the ball, irrespective of who actually kicked the ball.

After placing the ball, the same procedure and rules of executing a direct free kick apply.

PROCEDURES TO DETERMINE THE WINNER OF A MATCH OR HOME-AND-AWAY

680 Away goals, extra time, kicks from the penalty mark and extended kicks from the penalty mark are the four methods approved for determining the winning team where competition rules require there to be a winning team after a match has been drawn.

Away goals

685 Competition rules may provide that where teams play each other home and away, if the aggregate score is equal after the second match, any goals scored at the ground of the opposing team will count double.

Extra time

Competition rules may provide for two further equal periods, not exceeding 5 minutes each, to be played. The conditions of Law 8 will apply.

Kicks from the penalty mark

690 Procedure

- The referee randomly chooses the goal at which the kicks will be taken
- The referee randomly chooses a team to perform the first penalty kick
- 695 • The referee keeps a record of the kicks being taken
- Subject to the conditions explained below, both teams take five kicks
- The kicks are taken alternately by the teams
- At the beginning of every kick, the kicker and the goalkeeper are spawned at a position specified by their team according to Law 14.
- 700 • If, before both teams have taken five kicks, one has scored more goals than the other could score, even if it were to complete its five kicks, no more kicks are taken
- Unless otherwise stated, the relevant Laws of the Game and International F.A. Board Decisions apply when kicks from the penalty mark are being taken

Extended kicks from the penalty mark

705 Procedure

- All penalty shoots are taken on an empty goal.
- The player performing the penalty kick may enter the goal area.
- 710 • The team wins which...
 1. ... kicked the ball into the goal / scores more often. If this is a tie:
 2. ... kicked the ball into the goal area more often. If this is a tie:
 3. ... touched the ball in a larger number of the performed trials. If this is a tie:
 4. ... in sum needed less time to score the goals. If this is a tie:
 - 715 5. ... in sum needed less time to kick the ball into the goal area. If this is a tie:
 6. ... in sum needed less time to touch the ball
- If this is a tie a coin is flipped by the Technical Committee

Interpretation of the Laws of the Game and Guidelines for Referees

⁷²⁰ Please see the respective FIFA documents.

(e.g. pp. 60 of http://resources.fifa.com/mm/document/footballdevelopment/refereeing/02/36/01/11/lawsofthegameweben_neutral.pdf)

Section II

Virtual RoboCup Humanoid League Competition Rules

Setup and Inspections

Teams who do not want their robot model to be shared publicly should provide a non-disclosure agreement to the Technical Committee. This agreement will have to be signed by every team requesting access to the robot model, for reviewing or inspection.

The virtual competitions in the Humanoid League are preceded by a setup and inspection period. Teams need to submit a first draft of a file containing their robot model two months before the tournament. During the following two weeks, every robot will be inspected by the league organizing committee for compliance with the design rules detailed in Law 4. Teams will then receive feedback and are granted a period of two weeks to change the robot model to be compliant with the laws of the game. A final file containing the robot model needs to be submitted at latest four weeks before the competition. A re-inspection becomes necessary after any change that could affect the compliance to the design rules. Changes to the robot model made less than four weeks before the tournament need to be submitted by e-mail to the Organizing Committee. The e-mail needs to contain the new file containing the robot model as well as a summary of the changes made and a justification for performing the changes. A re-inspection might be requested by any team leader and is guaranteed to be evaluated if submitted up to 12 hour prior to a game.

Competitions

The competitions consist of:

1. Regular tournament for KidSize (4 vs. 4),
2. Regular tournament for AdultSize (2 vs. 2),

If at least 16 full teams participate in a league, the teams are separated in two different divisions for the regular tournament:

- The best N full teams are qualified for the first round robin of division A ².
- The other full teams are qualified for the first round robin of division B.

The qualification for division A and division B as well as the seeding for the round robin groups is determined prior to the first game of the main tournament. It may be based on an initial round of games, penalty shoot-outs, results from the previous RoboCup competition, or another similarly appropriate method determined by the Organizing Committee. The method of seeding needs to be announced at least one month prior to the start of the tournament. Both divisions play separate round robins. The lowest ranked teams per group in division A will have a playoff with the highest ranked teams per group in division B. The winners of the playoff games are qualified for the second round robin of division A, the losers will play the second round robin in division B.

Thereafter, division A and division B proceed independently of each other and each will normally consist of a round robin stage, followed by a number of knockout matches.

In case there is less than 16 full teams, there is only one division with a first round robin and a number of knock-out games.

All teams of a group play once against each other. The round robin games may end in a draw. In this case, both teams receive one point. Otherwise, the winning team receives three points and the not winning team receives zero points.

After games of a round robin have been played, the teams of a group are ranked based on (in decreasing priority):

1. the number of earned points,
2. the goal-difference,
3. the absolute number of goals,

² N is either 8 or 12 depending on the number of full teams and has to be announced before the beginning of the tournament.

- 770 4. the result of a direct match,
5. an extended penalty shoot-out between the teams ,
6. the drawing of a lot.

At least two teams of every group will enter the next round robin or the playoffs.

775 In the knock-out games of a tournament two further equal periods of 5 minutes each are played if the game is not decided after the regular playing time.

The game plan needs to be announced prior to the start of the tournament.

Forfeits

780 A team that forfeits is disqualified from the competition. Forfeiting is defined as refusing to make a good faith effort to participate in a scheduled game³.

- If a team chooses to forfeit a match in the round robin games the other team plays on an empty goal.
- If a team chooses to forfeit in a knock-out game before the quarter final, the other team continues in the competition.
- 785 • If a team chooses to forfeit in the quarter finals, it will be replaced by the runner up team in the round robin group that included the forfeiting team.
- If a team chooses to forfeit in the semi finals or the game for 3rd and 4th place, it will be replaced by the team that lost to the forfeiting team in the quarter finals.
- 790 • A team forfeiting the final match should announce its decision at least 30 minutes before the start of the 3rd vs 4th final. The league organization committee may impose a one year disqualification of the team and its members in case of avoidable delayed announcements.
- If a team chooses to forfeit the final after the game for 3rd and 4th place began, it will be replaced by the 3rd place winner, and the 4th place winner will be 3rd place. No new 4th place will be selected.
- 795 • If a team chooses to forfeit the final before the game for 3rd and 4th place, it will be replaced by the team that lost to the forfeiting team in the previous semi-finals. The team that lost to the forfeiting team in the previous semi-finals (i.e. the one initially being qualified for the game for 3rd and 4th place) will be replaced for the game for 3rd and 4th place by the team that lost to it in the respective quarter final.

Gameplay

800 A time period of 15 seconds is granted to teams between the start of the half time or penalty shoot-out and the beginning of the kick-off procedure.

Kick-off procedure

- The referee gives the signal "READY" that all robots have to reach their own half of the field.
- 805 • After 45 seconds the referee gives the signal "SET". The referee calls robots illegally positioned to be removed. The robot playing the goal keeper has to be announced before the beginning of the game. Illegally positioned players do not suffer a removal penalty and are allowed to enter the field as soon as the game starts.
- The opponents of the team taking the kick-off are outside the centre circle until the ball is in play.
- The ball is placed stationary on the centre mark after the "SET" signal was given.

³If the software is currently not running properly, a version should be submitted anyway as an indication that the team is willing to participate.

- 810 • The referee gives the signal "PLAY" 5 seconds after the "SET" signal was given .
- The ball is in play when it is kicked and moves at least 5 cm or 10 seconds elapsed after the signal.

Robots can take any position on the field that is consistent with the above requirements.

For initial kick-off (to initially start or restart after a half-time interval), robots can be placed anywhere on the touch lines or goal lines on the respective team's own side outside of the goal, to autonomously enter the field from there. 815 In case an illegal start position is chosen for a robot, it is considered illegally positioned and removed from the field. It is allowed to enter the field as soon as the game starts. For other kick-off situations and for dropped ball robots need to position themselves from the the position they were when the game was stopped.

Robots with autonomous positioning ability are given 45 seconds for re-positioning after a goal has been scored by one of the teams before the "SET" signal for kick-off is given by the referee.

820 Free-kick procedure

1. The referee announces the offence and the free kick (e.g 'Pushing Red - Direct Free-Kick Blue')
2. The referee communicates "Direct / Indirect Free Kick" Blue/Red to the GameController.
3. The referee places the ball depending on the call and announces "Free Kick Ready". Until the referee announced the free kick to be ready robots may move their head to track the ball but must otherwise remain stationary. 825 Robots which are significantly moving during this phase are removed from the field.
4. The referee communicates "Prepare Direct / Indirect Free Kick" Blue/Red to the GameController. The player taking the free kick has up to 30 seconds to position themselves for the free kick. Any player of the team taking the free kick may announce that the player is ready to take the free kick at any point. Opponent robots must move to a position at least 0.75 m for KidSize and 1.5m for AdultSize away from the ball. They are guaranteed 830 at least 15 seconds to move away from the ball. They may take up to 30 seconds if the team taking the free kick has not announced their robot is ready to take the kick off.
5. The referee may decide to execute the free kick any time between 15 and 30 seconds have passed depending on the call of the team taking the free kick and the position of the opponent robots. The referee may also allow the free kick to be executed before 15 seconds have passed if the team taking the free kick have announced 835 their robot is ready and if no opponent is illegally positioned.
6. Any opponent robot still illegally positioned is considered as an incapable player and must be removed from the field for 30 seconds removal penalty.
7. When the referee decides to execute the free kick and all opponent robots are legally positioned or have been removed from the field, the referee sends "Execute Direct / Indirect Free Kick" Blue/Red to the GameController. 840 The team that was awarded the free-kick can kick now.
8. The ball is in play after it has been kicked and moves at least 5 cm or after 10 seconds.

The distance between the ball and the player of the opponent team is measured between the point on the convex hull of the robot and the point on the outside of the ball which are most close together.

Incapable Players

845 Players not capable of play (e.g. players not walking on two legs, players not able to stand) are not permitted to participate in the game. They must be removed from the field. It is up to the referee to judge whether a player is capable of play. A field player that is not able to get back into a standing or walking posture from a fall within 20 seconds receives a 30 seconds removal penalty. If the ball is within a radius of 0.5 m around the goal keeper inside the goal area, the goal keeper has to show active attempts to move the ball out of this radius by walking towards 850 the ball or moving the ball. If no attempt is shown for 20 seconds, the goal keeper is considered to be an inactive player and receives a 30 seconds removal penalty.

A player that stays outside of the artificial turf for 20 seconds is considered as an incapable player and receives a 30 seconds removal penalty.

Removal Penalty

- 855 • Time penalties of 30 seconds for players are called by the referee.

- 860
 • A field player or goal keeper suffering a time penalty will be automatically removed from the field and is only allowed to re-enter the field from the team's own half of the field close to the penalty mark as indicated by the referee. The referee chooses the touch line further away from the ball if there is still an empty spot available. The first spot for a penalized robot on the touch line is on the same height of the penalty mark. Every consecutive spot is 60 cm (KidSize) or 100 cm (AdultSize) away from the previous position, either towards the team's own goal line or towards the center line. A valid position must be at least 30 cm (KidSize) or 50 cm (AdultSize) away from the goal line and center line. A position is considered as being taken if a robot from any team is within a radius of 30 cm (KidSize) or 50 cm (AdultSize) of the penalty position. The referee always positions the robot on the penalty spot closest to the penalty mark. If two positions are available that are equally close, the referee chooses the position that is further away from the ball. When placed, the robot joints are reset to their initial position and their velocities is set to 0.
- 865
 • After the robot has been placed at the position indicated by the referee and with both feet entirely outside the field of play the 30 seconds penalty start counting .
- 870
 • The GameController will:
 - Penalize the robot as soon as the referee calls the penalty.
 - Marks the penalty time counting down as soon as the robot is placed on the penalty position outside the field
- The penalty is automatically removed after 30 seconds of penalty have expired.

Timeout and Restart by Technical Committee

875
 Two members of the Technical Committee that are not directly involved with any of the team currently playing the game can decide to pause or restart the simulation in case of severe technical difficulties with the simulator, the network, the computer instances or any other equipment involved in running the simulated games. A timeout can be taken multiple times throughout a game if necessary. The Technical Committee must publish a written report of the amount and reasons for any timeout taken or restart of the game.

880 Disciplinary sanctions against robots

Yellow and red cards given to robots only accumulate for the current game and are cleared again after the end of each game. Warnings against teams will be noted by the Technical Committee after each game. They are recorded and accumulated for the whole tournament.

Disciplinary sanctions against teams

885
 A team is cautioned by the technical committee and may be shown a yellow card if it commits any of the following offences:

- unsporting behaviour, in particular by deliberately and repeatedly using limitations of the automated referee to their advantage
- dissent by word or action
- 890
 • persistent infringement of the Laws of the Game
- delaying the restart of play

Result publication

895
 In case the simulation can be performed and rendered in real time, a video of the simulated game will be streamed simultaneously to the match being played. In case the simulator does not allow for real-time games and rendering, the video will be streamed after the match was performed and the rendering was completed. Teams will get access to log files of the game and their robot software immediately after the video of the match has ended.

Software changes

Teams can update their software during the tournament. The software they intend to use for the next round of games needs to be submitted at latest 2 hours before the video stream of their next game is scheduled.

900 Trophies

A trophy is awarded to the winner of the soccer tournament in each of the individual size classes . In case of less than 3 teams participating in a size class no trophies will be given in this class.

905 A trophy is awarded to the teams second and third in the KidSize 4-4 soccer game and the AdultSize 2-2 soccer game. In case of less than 5 teams participating in a size class the team ranked third will be awarded a certificate instead of a trophy. In case of less than 4 teams participating in a size class the team ranked second will also be awarded a certificate instead of a trophy. The final number of trophies awarded will be decided by the RoboCup Federation based on the number of actually participating teams.

910 **Conflict Resolution**

It is the responsibility of the team leader to inspect the other team's robots six hours in advance of a game. Any concern regarding the rule compliance of any of the robots, including the amount, size and colour of the team markers, must be brought to the attention of the Technical Committee six hours in advance of the game.

Every result of a game needs to be certified by at least two members of the Technical Committee not directly involved in any of the teams playing in that game. Doubts concerning a serious violation of any rule during a specific game must be brought up to a member of the Technical Committee and investigated before digitally signing the result. By signing the result, a team agrees that the result came off in a fair game. Concerns must be brought to the attention of the Technical Committee within half an hour of the completion of the video stream. If a team brings up an official concern to the Technical Committee, a meeting of the Technical Committee must be called as soon as possible. If the team of a member of the Technical Committee is directly involved in the game in question, the respective member is excluded from the meeting. At least three members of the Technical Committee need to be part of the meeting and the decision process. If less than three members of the Technical Committee are available, members of the Organizing committee or, if necessary, Trustees or members of committees from other leagues have to be called into the meeting. Members of these meetings may request to inspect the robot model and software of any team involved in the issue. In addition, they will receive access to the rendered video of the simulation and any log file produced by the simulator, GameController and automated referee. If serious violations of rules or recurrent unsportive behavior are detected, the committee may, among others, decide to invalidate the result of the game in question or take disciplinary actions against a team as defined in Law 5, depending on the severity of the rule violation. The decision of the committee meeting need to be announced to the whole league. If teams receive a warning or yellow card for unsportive behavior and are requested to make changes to their code for the next game, they need to receive a period of at least four hours to make the requested change. If their next game was scheduled earlier than this, the game needs to be postponed.

935 **Acknowledgements**

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