

RoboCup Soccer Humanoid League Rules and Setup for the 2007 competition in Atlanta, USA

April 4th, 2007

Compiled by Emanuele Menegatti
(based on the 2006 version of the rules from Sven Behnke)

Please discuss 2007 rules at the mailing list
<https://lists.cc.gatech.edu/mailman/listinfo/robocup-humanoid>

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Preamble

These rules are intended to ensure that a fair competition in the RoboCup Soccer Humanoid League is possible. They want to encourage creativity and technical development.

Currently, the rules deviate in many points from the FIFA laws, but it is intended to decrease these deviations in the future, in order to work towards the long-term goal of playing with humanoid robots against human soccer teams.

Among the research challenges that are specific to the Humanoid League is maintaining the dynamic stability of the robots while they are walking, running, kicking, and performing other tasks. Another example is the coordination of perception and locomotion. The humanoid soccer robots must also be robust enough to deal with challenges from other players.

Please refer to the official FIFA rules for anything not covered by this document.

Size Classes

As it is not feasible to have humanoid robots of very different sizes play against each other, the competitions are held in two size classes: KidSize and TeenSize. See Section 4 for the definition of these classes.

1 The Field of Play

The competitions take place on a rectangular field, which contains two goals, field lines, six restart markers, and four corner poles, as shown in Fig. 1.

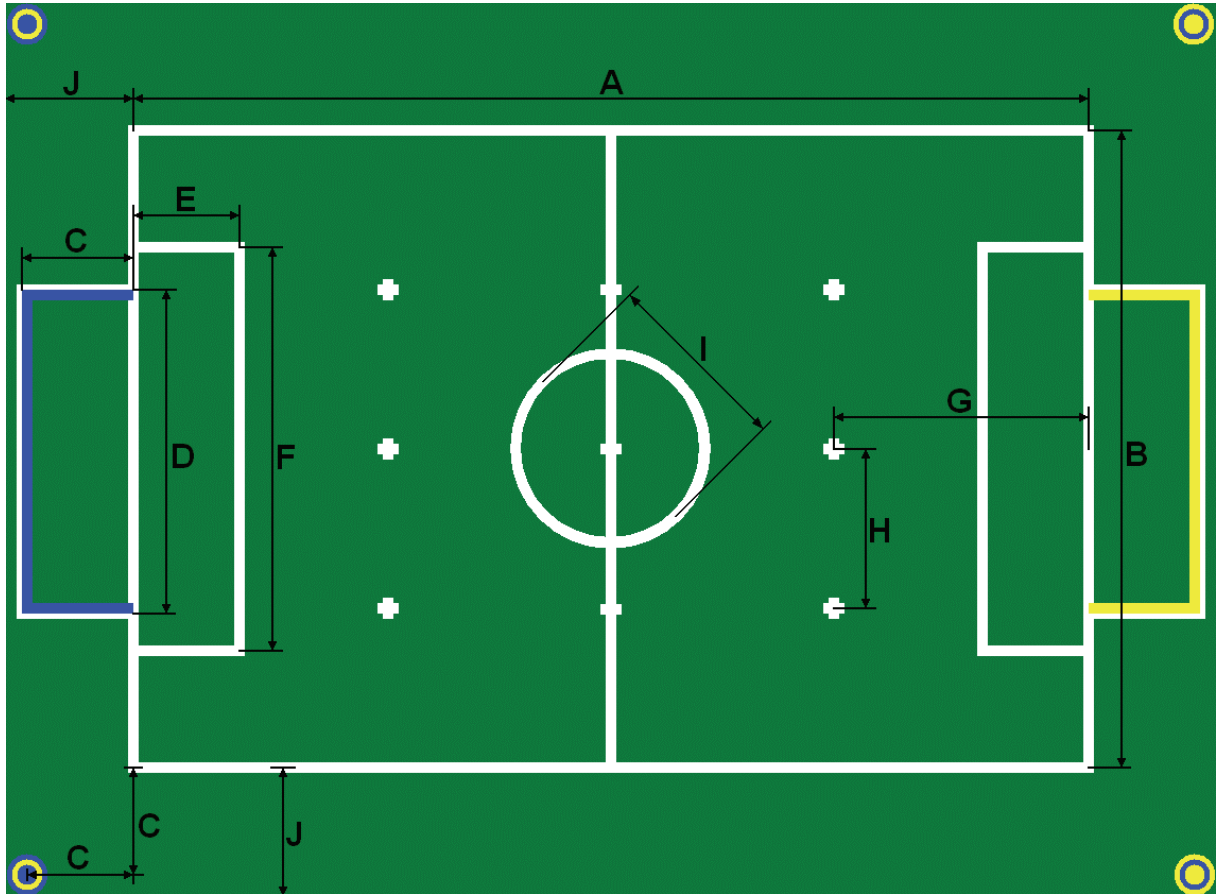


Figure 1: Soccer field.

Table 1: Soccer field sizes, in cm.

		KidSize	TeenSize
A	Field length	450	600
B	Field width	300	400
C	Goal length	50	60
D	Goal width	150	260
E	Goal area length	50	60
F	Goal area width	190	300
G	Penalty kick distance	120	180
H	Restart marker width	75	100
I	Center circle diameter	90	120
J	Border strip width (min.)	60	70

1.1 Playing Surface

The field is covered with green carpet. The white lines are 5cm wide. Line segments of 10cm length are used to mark penalty positions, restart positions, and the kick-off position. The longer outer field lines are called touch lines, whereas the shorter outer field lines are called

goal lines. The six restart positions are located half-way between the axis connecting the two goals and the touch lines, three on each side: in the middle and between the penalty positions and the touch lines. The field is surrounded by a border strip, which is also covered with green carpet. The world outside the border strip is undefined.

1.2 Goals

A goal is placed in the middle of each goal line. One of the goals is colored yellow at the three inner walls. The other goal is colored blue. The goals for the KidSize field have a horizontal goal bar at a height of 90cm. The TeenSize goals are 120cm high, but do not have a horizontal goal bar. The outer goal walls, as well as the goal posts and the goal bar are colored white.

1.3 Corner Poles

The four corners of the field are marked with one corner pole each. The corner poles have a diameter of 20cm. They consist of three segments of 30cm height, placed above each other. The lowest and the highest segments are colored in the same color as the goal belonging to the same goal line. The middle segment is colored in the color of the opposite goal.

1.4 Lighting

The field is illuminated homogenously by artificial white light sources placed at a height greater than 2.5m above the field. The brightness of the lighting is between 600lux and 1200lux. The brightness within the field does not vary more than 300lux.

1.5 People area

Around the field of play (Figure 1) a field zone is defined on site in which only the referee (Section 5), the assistant referees (Section 6) and the two robot handlers are allowed to stay during a game. All other people (including other team members, organizational staff, representatives of the press and the media etc.) must stay outside the field zone.

2 The Ball

Each size class uses its own ball:

1. KidSize: Orange plastic ball (8.4cm diameter, 26g),
2. TeenSize: Orange beach handball, size 2 (18.0cm diameter, 294g).

3 The Number of Players

A match is played by two teams, each consisting of not more than two players, one of whom may be designated as goalkeeper. A match may not start if either team consists of less than one player.

3.1 Incapable players

Players not capable of play, e.g. players not able to walk on two legs, players not able to stand, or players with obvious malfunctions 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. The referee may ask the team leader of a player suspected to be incapable of play to demonstrate playing ability at any time.

3.2 Substitutions

Up to two players per game can be substituted by other players of the same team. The referee must be informed prior to the substitution. A substitute only enters the field after the player being replaced left the field and after receiving a signal from the referee. Any of the other players may change places with the goalkeeper, provided that the referee is informed before the change is made and that the change is made during a stoppage of the match. Exchanging a field player with a goalie does not count as substitution.

3.3 Temporal Absence

Servicing robots on the playing field is not permitted. A robot may be taken out of the field for service, after receiving permission from the referee. Taking out a robot for service does not count as a substitution. A serviced robot may not come into play again before 60s elapsed after it was taken out. It has to enter the field at the position of a touch line closest to the position where it was taken out. It has to face the center of the field when entering.

4 The Design of the Robots

Robots participating in the Humanoid League competitions must have a human-like body plan, as shown in Fig. 2. They must consist of two legs, two arms, and one head, which are attached to a trunk. The robots must be able to stand upright on their feet and to walk on their legs. The only allowed modes of locomotion are bipedal walking and running. -

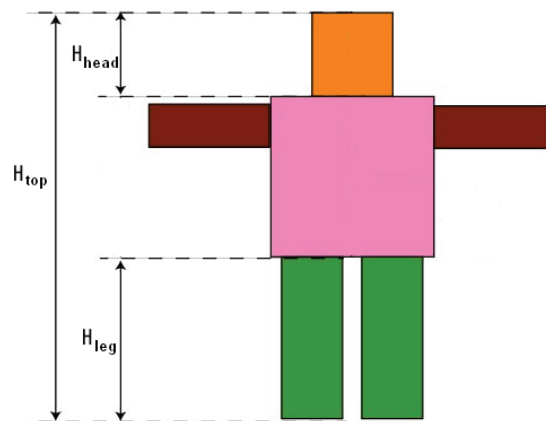


Figure 2: Humanoid robot body plan.

4.1 Robot Height

4.1.1: The height H of a robot is determined as follows:

$$H = \min(H_{top}, 2.2 \cdot H_{com}),$$

where H_{top} denotes the height of the robot when standing upright and H_{com} denotes the height of the robot's center of mass, measured in upright posture.

4.1.2: Based on H , the following size restrictions apply:

- $30\text{cm} \leq H \leq 60\text{cm}$ to play in the KidSize class,
- $80\text{cm} \leq H \leq 160\text{cm}$ to play in the TeenSize class.

A robot larger than 160cm may be allowed to play in the TeenSize class, provided that:

- $H < 180\text{cm}$ and
- the robot fits at all times into a vertical cylinder of diameter 130cm.

4.2 Size Restrictions

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

1. Each foot must fit into a rectangle of area $H^2/24$.
2. Considering the rectangle enclosing the convex hull of the foot, the ratio between the longest side of the rectangle and the shortest one, shall not exceed 2.5
3. The robot must fit into a cylinder of diameter $0.55 \cdot H$.
4. If the arms are maximally stretched in horizontal direction, their extension must be less than $1.2 \cdot H$.
5. The robot does not possess a configuration where it is extended longer than $1.5 \cdot H$.
6. The length of the legs H_{leg} , including the feet, satisfies $0.35 \cdot H \leq H_{\text{leg}} \leq 0.7 \cdot H$.
7. The height of the head H_{head} , including the neck, satisfies $0.05 \cdot H \leq H_{\text{head}} \leq 0.25 \cdot H$.

4.3 Sensors

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

1. Any active sensor (emitting light, sound, or electromagnetic waves into the environment in order to measure reflections) is not allowed.
2. External sensors, such as cameras and microphones, may not be placed in the legs or arms of the robots. They should be placed in the robot's head.
3. Touch sensors, force sensors, and temperature sensors may be placed at any position on the robot.
4. Sensors inside the robot may measure all quantities of interest, including (but not limited to) voltages, currents, forces, movements, accelerations, and rotational speeds. They can be at any position inside the robot.

4.4 Communication and Control

4.4.1: 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.

4.4.2: Robots may communicate only via the wireless network provided by the organizers. The total bandwidth of the robots belonging to one team may not exceed 1MBaud. The robots must not rely on availability or quality of the wireless network. They must be able to play if the network is not available or of low quality.

4.4.3: Robots of a team may communicate with each other at any time during a game. They may receive start and stop signals from an off-the field computer. This computer is only allowed to listen to the wireless communication while the ball is in play. It may be used to send game-control signals (e.g. kick-off, penalty, free kick, ...) to the robots during game stoppages.

4.4.4: No humans are allowed on the field while the ball is in play. Robot handlers must receive permission from the referee prior to entering the field. Each team may designate only one person as robot handler. The robot handler of a team may not touch a robot of another team in order to avoid any (unintentional or intentional) damage to that robot.

4.5 Colors and Markers

4.5.1: Robots participating in the Humanoid League competitions must be mostly black. Less than 10% of the total body surface may have a higher reflectance, e.g. gray or white. Less than 1% of the total body surface may be colored. Any color used for the field (green, yellow, blue) or the ball (orange) should be avoided.

4.5.2: The robots must be marked with team markers, attached to the trunk. These markers are colored magenta for one team and cyan for the other team. At least 8cm×8cm (KidSize) /

16cm×16cm (TeenSize) of the team markers should be visible from any side. If both teams cannot agree, which team color to use, a coin will be flipped 15 minutes prior to the game to assign the team colors.

4.5.3: The robots of a team must be uniquely identifiable. They should be marked with numbers or names.

4.6 Safety

4.6.1: Robots participating in the Humanoid League competitions must not pose any danger to humans, other robots, or the field of play. Anyone is allowed to take every action necessary to prevent urgent harm.

4.6.2: The robots should be constructed in a way that offenses described in Section 12 are avoided. Robots violating above safety requirements will be excluded by the referee from the ongoing game. They may be excluded by the league organization committee from the remainder of the tournament.

4.7 Robustness

Robots participating in the Humanoid League competitions must be constructed in a robust way. They must maintain structural integrity during contact with the field, the ball, or other players. Their sensing systems must be able to tolerate significant levels of noise and disturbance caused by other players, the referees, robot handlers, and the audience.

5 The Referee

5.1: Each match is controlled by a referee who has full authority to enforce these rules in connection with the match to which he has been appointed.

5.2: The Referee ensures that the field and the ball are in proper condition. He ensures that the robot players meet the requirements of Section 4.

5.3: The referee acts as timekeeper and keeps a record of the match. He stops, suspends or terminates the match, at his discretion, for any infringements of the rules or because of outside interference of any kind.

5.4: The referee allows play to continue when the team against which an offense has been committed will benefit from such an advantage and penalizes the original offense if the anticipated advantage does not ensue at that time.

5.5: He punishes the more serious offense when a player commits more than one offense at the same time and takes disciplinary action against players guilty of cautionable and sending-off offenses. He is not obliged to take this action immediately but must do so when the ball next goes out of play.

5.6: The referee takes action against team officials who fail to conduct themselves in a responsible manner and may, at his discretion, expel them from the field of play and its immediate surrounds. He ensures that no unauthorized persons enter the field of play.

5.7: The referee acts on the advice of assistant referees regarding incidents which he has not seen. Some referee duties, like time keeping and keeping a record of the match, may be delegated to one of the assistant referees.

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

6 The Assistant Referees

6.1: One or more assistant referees are appointed for a match whose duties, subject to the decision of the referee, are to indicate when the whole of the ball has passed out of the field of play, which side is entitled to a corner kick, goal kick or throw-in, and when misconduct or any other incident has occurred out of the view of the referee.

6.2: The assistant referees might be assigned additional duties, such as time keeping and keeping a record of the match.

6.3: The assistant referees also assist the referee to control the match in accordance with these rules.

6.4: In the event of undue interference or improper conduct, the referee will relieve an assistant referee of his duties and make a report to the league organizing committee.

7 The Duration of the Match

7.1 Periods

7.1.1: The match lasts two equal periods of 10 minutes. Players are entitled to an interval at half-time. The half-time interval must not exceed 5 minutes.

7.1.2: Allowance is made in either period for all time lost through, e.g. substitution(s), timeouts, and wasting time. The allowance for time lost is at the discretion of the referee.

7.1.3: 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. If during regular playing time none of the two teams in a knock-out match was able to kick the ball to reach their respective opponent's goal the extra time is skipped and the game immediately continues by the five alternating penalty kick trials(cf. Section 14).

7.2 Timeouts

A team may extend a stoppage of the game by taking a timeout. During a timeout robots may be serviced. Each team may take at most one timeout per period. If a team is not ready to resume the game when the referee wants to start the game, it has to take a timeout. If there is no timeout left, the referee will start the game anyway. A timeout ends automatically after 120s. A timeout also ends when the team signals its end to the referee.

8 The Start and Restart of Play

8.1 Preliminaries

8.1.1: Access to the field is given to both teams at least 15 minutes prior to the scheduled kick-off time. A coin is tossed and the team which wins the toss decides which goal it will attack in the first half of the match. The other team takes the kick-off to start the match. The team which wins the toss takes the kick-off to start the second half of the match. In the second half of the match the teams change ends and attack the opposite goals.

8.1.2: If both teams cannot agree on the color of their team markers, a coin is tossed and the markers are exchanged at halftime.

8.1.3: A match must start at the scheduled time. In exceptional situations only, the referee may re-adjust the time for starting the game in accordance with both team leaders. All robots of a team are started (and stopped) by receiving a signal through wireless communication

from outside the field. In exceptional cases, starting and stopping robots manually may be allowed by the referee.

8.2 Kick-off

8.2.1: 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. After a team scores a goal, the kick-off is taken by the other team.

8.2.2: A goal may not be scored directly from the kick-off. A goal may not be scored directly from the kick-off. Either the ball must move 20cm from the kick-off point or must be touched by another player before being kicked towards the goal.
If the ball is kicked directly towards the goal the kick-off is awarded to the opposing team.

8.2.3: The procedure for kick-off is as follows:

- All players are in their own half of the field.
- The opponents of the team taking the kick-off are outside the center circle until the ball is in play.
- The ball is stationary on the center mark.
- The referee gives a signal.
- The ball is in play when it is touched or 10 seconds elapsed after the signal.

8.2.4: Robots being able to autonomously reposition themselves can take any position on the field that is consistent with above requirements. Robots not able to autonomously reposition themselves, e.g. robots being carried or joysticked around by human team members, have to start from the game restart points or behind the game restart points. If all robots of the team executing the kick-off cannot autonomously reposition themselves, then one robot may be placed into the center circle.

8.2.5: If one or both of the teams in a match have permission to use a manual startup procedure, the referee gives a sequence of two signals with an interval of 10 seconds. Robot players without remote start capability may be started on the field after the first signal. They may not move before the second signal was given by the referee. All human team members must leave the field of play immediately after the first signal and before the second signal.

8.3 Dropped Ball

8.3.1: A dropped ball is a way of restarting the match after a temporary stoppage which becomes necessary, while the ball is in play, for any reason not mentioned elsewhere in the rules. In particular, the referee may call a game-stuck situation if there is no progress of the game for 60s.

8.3.2: The game is continued at the center 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 robots of both teams must be outside the center circle (or at or behind restart positions if positioned manually). The ball is in play immediately after the referee gives the signal.

8.3.3: If a player moves too close to the ball before the referee gives the signal, a kick-off is awarded to the opponent team.

9 The Ball In and Out of Play

9.1: 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 or when play has been stopped by the referee.

9.2: The ball is in play at all other times, including when it rebounds from a goalpost, crossbar, corner pole, or human and remains in the field of play.

10 The Method of Scoring

10.1: 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 rules has been committed previously by the team scoring the goal. For the TeenSize class, where the crossbar is missing, the referee judges if the ball would have passed the goal line below the virtual crossbar.

10.2: 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.

10.3: For knock-out matches ending in a draw after regular time, extra time, penalty kicks, and scoring times will be used to determine the winner of a match.

10.4: An abandoned match is replayed unless the league organization committee decides otherwise. If a team chooses to forfeit a match, the result will be 10:0 against the team that forfeited. Teams may choose to forfeit games at any stage prior to the end of the game.

11 Offside

The offside rule is not applied.

12 Fouls and Misconduct

12.1 Ball Manipulation

Manipulation of the ball by robot players is guided by the following principles:

1. Players may exert force onto the ball only by direct physical contact with one of their body parts, excluding their hands, arms, and shoulders.
2. The ball may be kicked with the whole foot. Kicking devices which differ from the human body are not allowed.
3. Contact with the ball must be instantaneous. Actively touching the ball for more than 1s is considered ball holding. Inside the goal area, the goal keeper may hold the ball for not more than 5s. Physical contact may be exerted repeatedly by the same player, if the ball is free to move between contacts for the majority of the time.
4. It will also be considered ball holding, if the ball cannot be removed from a robot by other players for more than 1s. More than half of the ball's volume must be outside the convex hull of the robot, 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 robot of a team is in the vicinity of the ball, the convex hull is taken around all the robots of a team, which prevent removal of the ball.

12.2 Physical Contact

Contact between robot players is guided by the following principles:

1. Physical contact between players of different teams should be minimized.
2. If physical contact is unavoidable, the faster moving robot should make efforts to minimize the impact. The goal keeper enjoys special protection inside its goal area. The attacking player always has to avoid contact with the goalie.
3. Extended physical contact should be avoided. Both robots should make efforts to terminate contact, if the contact time exceeds 1s.
4. If entangled robots fail to untangle themselves, the referee might ask designated robot handlers of both teams to untangle the robots. Untangling must not make significant changes to robot positions or heading directions.

12.3 Attack and Defense

12.3.1: Not more than one robot of each team should be inside the goal or the goal area at any time. If more than one robot of the defending team is inside its goal or goal area for more than 10s, this will be considered illegal defense. If more than one robot of the attacking team is inside the opponent's goal or goal area for more than 10s, this will be considered illegal attack.

12.3.2: The referee may delay the call of illegal defense or illegal attack if the robots make serious attempts to leave the goal area or if they are hindered from leaving the goal area by robots of the opponent team.

12.4 Indirect Free Kick

12.4.1: An indirect free kick is awarded to the opposing team if a player commits any of the following offenses in a manner considered by the referee to be careless, reckless or using excessive force: kicking, tripping, jumping at, charging, striking, and pushing an opponent.

12.4.2: An indirect free kick is also awarded to the opposing team if a player commits any of the following offenses:

1. tackles an opponent to gain possession of the ball, making contact with the opponent before touching the ball,
2. holds an opponent,
3. holds the ball,
4. handles the ball deliberately (except for the goalkeeper within his own goal area),
5. makes an opponent fall.

12.4.3: An indirect free kick is awarded to the opposing team if a goalkeeper, inside his own goal area, commits any of the following offenses:

1. takes more than four steps while controlling the ball with his hands, before releasing it from his possession,
2. touches the ball again with his hands after it has been released from his possession and has not touched any other player,
3. touches the ball with his hands after it has been deliberately kicked to him by a teammate,
4. wastes time,
5. blocks more than half of its goal line for more than 15s or for the majority of the time.

12.4.4: An indirect free kick is also awarded to the opposing team if a player, in the opinion of the referee:

1. plays in a dangerous manner,
2. impedes the progress of an opponent,
3. prevents the goalkeeper from releasing the ball from his hands,
4. performs illegal defense,
5. performs illegal attack,
6. commits any other offense, not previously mentioned in Section 12, for which play is stopped to caution or dismiss a player.

12.4.5: An indirect free kick is taken from where the offense occurred when this position is outside the goal area. Otherwise, the free kick is taken from the closest restart position.

12.4.6: An indirect free kick is awarded to the opposing team, if a human member of a team, in the opinion of the referee, commits any of the following offenses:

1. interfering with the game on the field, e.g. through touching the ball while removing a robot,

2. interfering with the game remotely through wireless communication, e.g. by remotely joysticking a robot, or sending commands to robots that convey information about the position of objects on the field or activate particular patterns of actions on the robots,
3. behaving otherwise in an unsportsmanlike manner.

In this case, the indirect free kick will be started from the penalty mark position in the half of the opponent of the awarded team.

12.5 Yellow and Red Cards

12.5.1: A player is cautioned and shown the yellow card if he commits any of the following offenses:

1. is guilty of unsporting behavior,
2. persistently infringes the rules,
3. delays the restart of play,
4. fails to respect the required distance when play is restarted with a free kick.

12.5.2: A player is sent off the field and shown the red card if he commits any of the following offenses:

1. is guilty of serious foul play,
2. is guilty of violent conduct,
3. receives a second caution in the same match.

13 The Free Kicks

13.1: All free kicks are indirect. The ball must be stationary when the kick is taken. The kicker may not score directly from an indirect free kick. The ball must move at least 20cm from the position where the kick was taken or must be touched by another player before being kicked towards the goal. If an indirect free kick is kicked directly into the opponents' goal, a goal kick is awarded to the opponent team.

13.2: All players of the team not taking the free kick must be at a distance greater than 60cm (for KidSize) or 90cm (for TeenSize) from the ball. If, when a free kick is taken, an opponent is closer to the ball than the required distance, the kick is retaken.

13.3: The ball is in play when it is touched, or 10 seconds after the referee has given the signal.

14 The Penalty Kick

14.1: A goal may be scored directly from a penalty kick.

14.2: The player taking the penalty kick is placed at a distance of at least $1.5 \cdot H$ from the penalty mark.

14.3: The defending goalkeeper is placed in upright position on the middle of his goal line, facing the kicker. It must remain upright between the goalposts until the ball has been touched by the kicker.

14.4: No other players are allowed on the field.

14.5: When both players are ready, the ball is placed randomly within 20cm (KidSize) or 30cm (TeenSize) of the penalty mark.

14.6: After the referee gives the start signal, the striker has 60s to kick the ball once or multiple times. After this time, the trial ends if the movement of the ball obviously does not result in a goal. Otherwise, the trial is extended until the ball stops.

14.7: The striker is not allowed to touch the ball during this extension. The striker is also not allowed to touch the ball after the ball has been touched by the goalie.

14.8: The goalie is not allowed to move forward or to fall until the ball is touched by the striking robot.

14.9: Both robots are not allowed to touch or cross the line around the goal area.

14.10: If the goalie robot violates the rules in any way, the referee will let the trial continue. If the striker robot scores a goal, then the goal counts. If the striker does not score a goal, the trial is retaken. If the goalie violates the rules after causing two restarts, a technical goal is awarded to the striker.

14.11: If the striker violates the rules in any way, the referee will let the trial continue. If the striker robot is unable to score a goal, the trial ends. If the striker scored, the trial is retaken without counting the goal. If the striker violates the rules after causing two restarts, the trial will end with 'no goal'.

14.12: Both teams conduct five alternating trials.

- If after the first five trials none of the teams was able to kick the ball to the goal line then the winner is determined by flipping a coin.
- If there is still a draw in knock-out games, the alternating trials continue up to five more times, until one team leads after an equal number of trials.
- If there is still a draw in knock-out games, the alternating trials continue up to five more times without goalies, until either one striker is able to score and the other striker fails to score or both strikers score. In the latter case, the goal is awarded to the striker that needed the shortest time for scoring.
- If there is still a draw in knock-out games, the winner is determined by flipping a coin.

15 The Throw-In

A throw-in is necessary if the ball leaves the field of play, by fully crossing a touch line or a goal line (outside the goal posts or above the cross bar) either on the ground or in the air. Without stopping play, one of the assistant referees places the ball at one of the three restart points that are on the same side, where the ball left the field.

- The ball is placed at the restart point closest to a goal, if a player of the team defending this goal was touched last by the ball before it went out on the same half of the field.
- The ball is placed at the restart point on the middle line in all other cases.

If a robot obstructs the restart point, the ball is placed at the next empty spot found by moving from the restart position towards the closer touch line.

16 The Goal Kick

The goal kick is performed without stopping play according to the throw-in procedure.

17 The Corner Kick

The corner kick is performed without stopping play according to the throw-in procedure.

18 The Footrace

The footrace in the TeenSize is done as a 1 vs. 1 competition between two teams. It takes place on a TeenSize field. Access to the field is given to both teams at least 10 minutes prior to the scheduled starting time.

A footrace match consists of five runs. A run goes from one touch line to the other touch line. Both teams place their robot in front on the border strip, outside the field, in front of the

touch line. The robots must be in an upright standing posture. One team uses the yellow side of the field and the other team uses the blue side. Different robots might be used for multiple runs.

After the referee gives the start signal, both robots walk as fast as possible across their half of the field towards the opposite touch line. Robot handlers are not allowed to enter the field, unless the referee asks them to remove a robot.

If a robot touches the start line before the referee gave the start signal, the start is invalid. This robot receives a warning and the start is retaken. The warnings of a team accumulate within a match. Every third warning results in the technical winning of a run for the other team.

The robot which first crosses the goal line wins the run. Both feet must be outside the field on the border strip again. If a robot falls, it must get up by itself to continue the run.

If a robot leaves its half of the field, its run terminates at the position where it left the field. If 60s after the start signal no robot crossed the goal line, the referee decides which robot advanced more towards the goal line. This robot wins the run. If the referee cannot determine which of the robots advanced more the run ends in a draw. Both teams must place their robot in front of the start line within 60s after the end of a run.

The team which wins most of the runs wins the footrace match. If both teams win an equal number of runs, the match ends in a draw. To decide knock-out matches, the runs are continued until one team wins a run.

19 The Technical Challenge

It is not allowed to use robots which are specialized for a specific technical challenge. Only the robots used for the soccer games are allowed to participate in the technical challenges. No hardware modifications on the robots are allowed for the Technical Challenges (i.e., a robot cannot be modified from the configuration it had in the soccer games).

Each humanoid size class uses its field for the technical challenges. The team scheduled for the technical challenge must have access to the field five minutes prior to the scheduled starting time. The referee will give the start signal at the scheduled time.

This year's challenge consists of three parts. Each of the parts can be attempted multiple times, in any order. The team might terminate a trial at any time, in order to reattempt the same part or switch to another part of the challenge. A trial terminates automatically when 25 minutes elapsed after the referee gave the start signal. This concludes the technical challenge for the team.

The time is taken for each of the trials, if completed successfully. The minimum time is used for scoring each part of the challenge. The team with the minimal time receives 10 points. The second fastest team receives 7 points. The third fastest team receives 5 points. All other teams who successfully managed this part of the challenge receive 3 points. Intermediate scoring applies as detailed in the following sections. The intermediate scoring rules in the technical challenge do only apply to the best three teams if there are no three teams which can pass the respective challenge completely.

19.1 Part A: Obstacle Avoidance

Six black obstacles (cylinders of diameter 20 cm and height 90 cm) are put in the half of the field in front of the yellow goal, as defending players. The obstacles are put at arbitrary positions by the referees, just before the start of each trial, when the robot is already waiting at the starting position and are rearranged at each trial. The distance between the obstacles is at least 50 cm for KidSize and at least 100 cm for TeenSize. No obstacles are placed in the center circle. The robot is placed at the center mark. The robot should reach the goal, enter in it, by crossing at least once the line between two obstacles and by avoiding touching all obstacles.

The trial ends without success, if the robot bumps on any obstacle or if the robot leaves the field. If the robot touches an obstacle a minus is given.

The trial ends with success, if the robot touches the goal line. The teams are ranked by the time needed to complete the task and the number of minus.

Poles are only re-arranged once the robot has actually made an effort to navigate around the poles and a minimum of 60 sec. must have elapsed.

19.2 Part B: Dribbling Around Poles

Fig. 4 shows the setup for Part B of the technical challenge. Two cyan poles are placed at the penalty kick marks. One magenta pole is placed at the center mark. The poles have a diameter of 20cm and a height of 90cm.

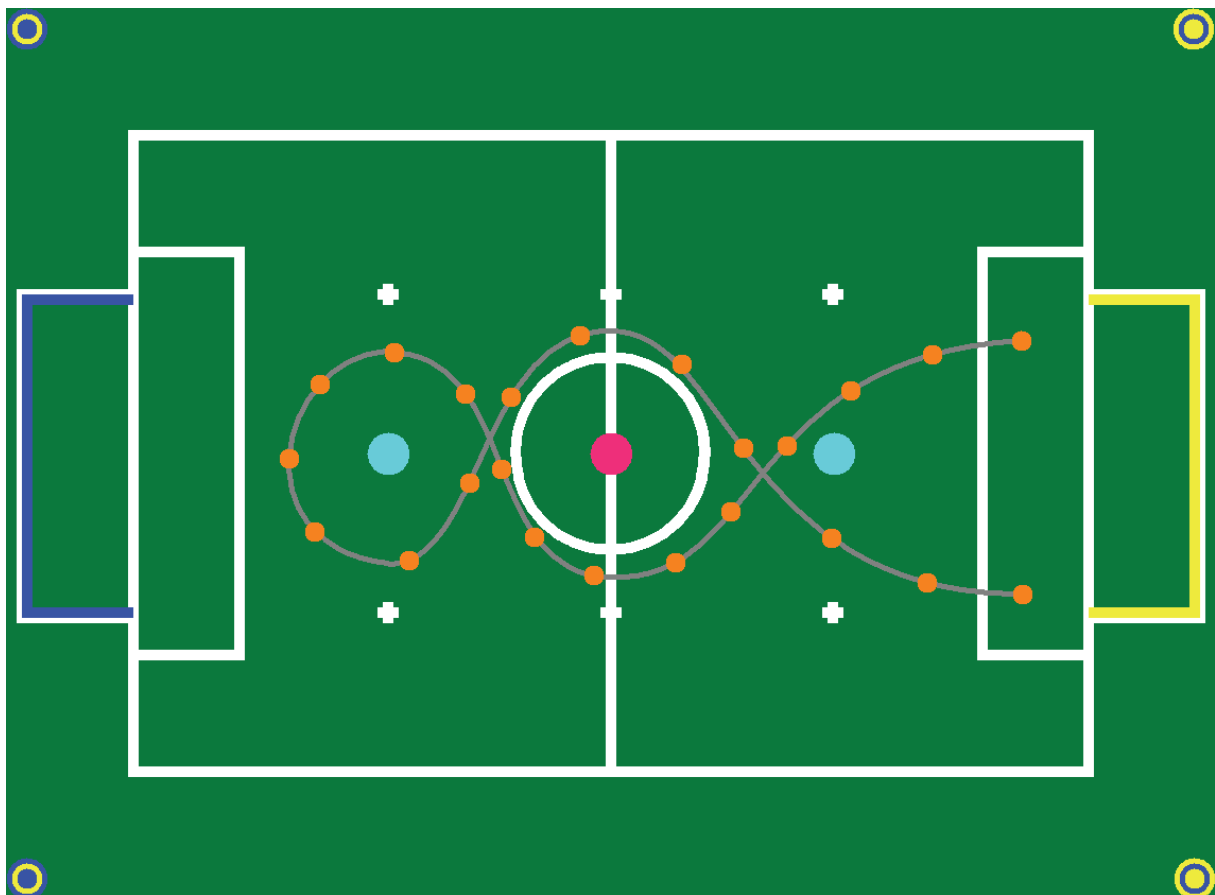


Figure 4: Field with poles and example ball trajectory.

- The ball and the robot start in one of the goal areas.
- The task is to dribble the ball around the poles as indicated by the example trajectory.
- The trial starts when the ball leaves the goal area.
- The trial ends without success if the ball leaves the field or if the ball crosses the line between two poles too early. The trial also ends without success if the robot collides with a pole.
- The ball must cross four times the line between a magenta pole and a cyan pole, in the indicated order.
- The trial ends successfully if the ball reenters the goal area from where the robot started.

Intermediate scoring for dribbling:

- ball crossing the line between 1st cyan and magenta --- 0 point

- ball crossing the line between 2nd cyan and magenta--- 2 points
- ball crossing the line opposite site ---4 points
- ball crossing the line between 3rd cyan and magenta ---6 points
- ball crossing the line between 1st cyan and magenta ---8 points
- goal ---10 points

19.3 Part C: Passing

A KidSize field is marked with two additional white lines, which are parallel to the middle line and tangential to the center circle, as shown in Fig. 5. The ball is placed at a penalty kick mark. One robot is placed inside each goal area.

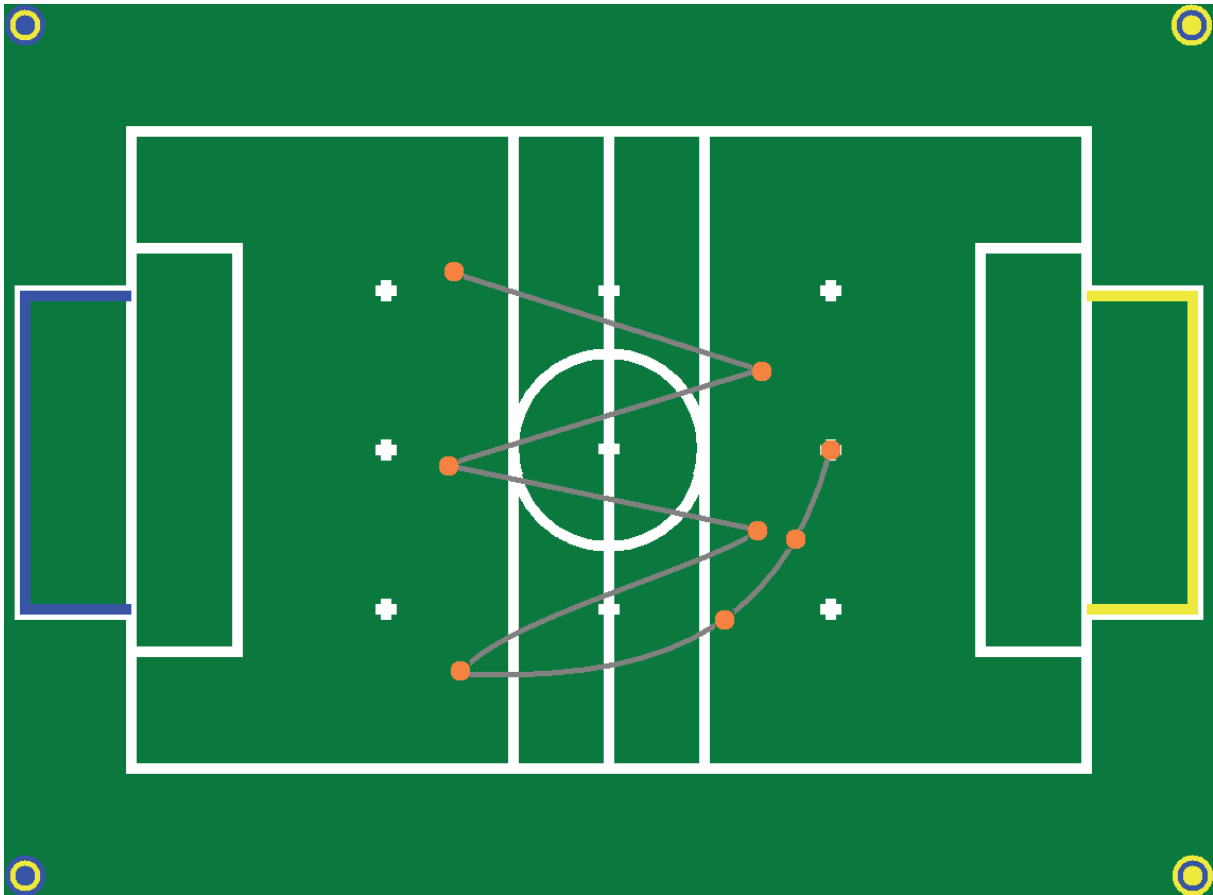


Figure 5: Passing challenge with example trajectory.

- The task is to pass the ball between the robots back and forth.
- The trial starts when the first robot leaves its goal area.
- The trial ends without success if the ball leaves the field or stops inside the middle area. The trial also ends without success if one of the robots leaves the field or enters the middle area.
- The ball has to cross the middle area five times, as indicated by the example trajectory.
- The trial ends successfully if the receiving robot touches the ball after the fifth crossing.

Intermediate scoring for passing (between robot A and B (A: first kicking))

- 1st touch of the ball to robot B --- 0 point
- 2nd touch of the ball to robot A --- 4 points
- 3rd touch of the ball to robot B --- 6 points
- 4th touch of the ball to robot A --- 8 points
- 5th touch of the ball to robot B --- 10 points

20 The Competitions and Trophies

20.1 Setup and Inspections

The competitions in the Humanoid League are preceded by a setup and inspection period of at least 24h. During this time, every robot will be inspected by the league organizing committee for compliance with the design rules detailed in Section 4. All robots will be photographed during the inspection. A reinspection becomes necessary after any change that could affect the compliance to the design rules. A reinspection might be requested by any team leader up to 10 minutes prior to a game.

20.2 Referee Duty

Each team must name at least one person who is familiar with the rules and who might be assigned for referee duties by the league organizing committee.

20.3 Competitions

20.3.1: The competitions consist of:

1. Soccer Games for KidSize
2. Penalty Kick for TeenSize,

The technical Challenges consist of:

1. obstacle avoidance (KidSize & TeenSize)
2. pole dribbling (KidSize & TeenSize)
- 3a. passing (KidSize)
- 3b. footrace (TeenSize)

20.3.2: Both, Penalty Kick (TeenSize) and Soccer Games (KidSize) are organized in one or more round robins and playoffs. For the first round robin, the teams are assigned to groups at random. 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.

20.3.3: 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,
4. the result of a direct match,
5. the time needed to score a penalty kick into an empty goal (up to five alternating attempts to score, until at least one team scored),
6. the drawing of a lot.

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

20.3.5: The game plan needs to be announced prior to the random assignment of teams to groups.

20.4 Best Humanoid

20.4.1: The teams of both size classes are ranked in separate lists to determine the overall best humanoid.

20.4.2: The ranking is based on the aggregated number of points earned in the individual competitions.

20.4.3: The points earned in the technical challenge are used directly.

20.4.4: For the Penalty Kick competitions (TeenSize) and the Soccer Games (KidSize) or Footrace (TeenSize), the winner receives 30 points. The second best team receives 21 points. The third best team receives 15 points.

20.4.5: As KidSize and TeenSize robots do not compete directly, a jury decides the overall best humanoid robot, 2nd best humanoid robot, 3rd best humanoid robot. The jury consists of the team leaders of all teams, except for the teams ranked first and second in the KidSize and TeenSize lists. The jury decides by majority vote. In case of a draw, the president of the RoboCup federation decides the vote.

- The teams ranked first in the KidSize and TeenSize lists are candidates for the Best Humanoid. The jury decides from the general picture of the performance according to the criteria:
 - A. Robustness
 - B. Walking ability
 - C. Ball handling
 - D. Soccer skillsfor the robot that is the Best Humanoid.
- Of each, TeenSize and KidSize, the best robot that was not chosen to be the best humanoid robot is candidate for the 2nd best humanoid robot. Criteria are same as for the best humanoid.
- If the best and the second best humanoid robot are chosen from the KidSize class then the best humanoid robot from the TeenSize list is the third best humanoid robot. If the best and the second best robot are chosen from the TeenSize class then the third best humanoid is the best robot from the KidSize list. Otherwise, the third best humanoid robot is chosen between the 2nd best robots from the KidSize and TeenSize lists according to the same criteria as before.

20.5 Trophies

20.5.1: A trophy is awarded to the winner of each of the individual competitions.

20.5.2: A trophy is awarded to the teams second and third in the KidSize 2-2 soccer game competition.

20.5.3: The Louis Vuitton Humanoid Cup is awarded to the team ranked first in the Best Humanoid list.

20.5.4: Certificates are awarded to the teams second and third in each of the individual competitions.

Appendix A

The trend in rule evolution for the next years

In this section the Technical Committee wants to make explicit the trends to be followed in the rules in the next year in order to improve the scientific level of the robots developed by the RoboCup teams.

- The minimum height of TeenSize robots will be increased year after year.

This is to foster the teams to develop taller robots and to apply more advanced technologies with respect to KidSize robots that are intrinsically more stable.

- The foot size of all robots will be decreased

This is to foster the development of more advanced walking algorithms. By reducing the size of the foot the intrinsic stability of the humanoid robot is reduced and active walking are encouraged. (e.g. from $H^2/24$ in following years in steps of $H^2/26$, $H^2/28$ to finally reach human-like proportions).

- Human like sensors

Next year the new formulation of rule “4.3 Sensors” will be more strict, i.e.

Teams participating in the Humanoid League competitions are encouraged to equip their robots with sensors that have an equivalent in humans. These sensors **MUST** be placed at a position roughly equivalent to the human senses. In particular,

5. Any active sensor (emitting light, sound, or electromagnetic waves into the environment in order to measure reflections) is not allowed.
6. External sensors, such as cameras and microphones **MUST** be placed in the robot's head.
7. Touch sensors, force sensors, and temperature sensors may be placed at any position on the robot.
8. Sensors inside the robot may measure all quantities of interest, including (but not limited to) voltages, currents, forces, movements, accelerations, and rotational speeds. They can be at any position inside the robot.

- The field of view of vision will be restricted from 2008

This is to encourage the development of active vision strategies in which the robot has to control its body parts to actively seek for object of interest and to develop short-term and long-term memory strategies to reconstruct a global view of the field of play.

The maximum allowed angle of the field of view in a camera is 180° . The cameras and joints moving the cameras must be arranged in a way that at no time the robot is able either to have a larger field of view than 180° or to see a ball directly behind it. Omnivision cameras can be used if the field of view is restricted mechanically (e.g., by a covering tape) to 180°

- The number of players in KidSize soccer games will be increased

This is to encourage team play and cooperation among humanoid robots. In 2008, 3 on 3 games shall be introduced and in the following years the number of player should be increased further.

- Field Layout

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- ✖ Size of KidSize field may increase with the number of players.
- ✖ The distance of the PK point to the goal in KidSize may increase, as already in 2006 the best teams could kick so strongly that no goal keeper could catch the ball unless by chance.
- ✖ Instead of the massive goals more natural goal shapes may be introduced.

Game Controller (aka: Referee Box)

- Standard game controlling/refereeing software may be introduced for 3-3 games. Demonstrations are called for during RoboCup 2007 in Atlanta.

- Robot colors:

Other colors than black for the robots may be allowed like silver or grey.

Acknowledgements

These rules evolved from previous versions of the RoboCup Humanoid League rules. The 2006 version of the rules was edited by Sven Behnke, who did a terrific job improving this rule document. The 2005 version was edited by Norbert Michael Mayer. Other input came from the FIFA laws of the game and the rules of the RoboCup MiddleSize and Four-legged leagues.

The rules were discussed within the technical and organizing committees of the league and also on the Humanoid list. Among others, Minoru Asada, Jacky Baltes, Hans-Dieter Burkhard, Davide Faconti, Rodrigo Guerra, Bernhard Hengst, Hiroshi Ishiguro, Damien Kee, Yue Pik Kong, Pasan Kulvanit, Norbert Michael Mayer, Emanuele Menegatti, Chew Chee Meng, Masaki Ogino, Maziar Palhang, Thomas Röfer, Philippe Schober, Naoki Shibatani, Oskar von Stryk, Ashfaqur Ur-Rahman, Gerald Weratschnig, Shuzo Yumoto, and Changjiu Zhou contributed to the discussion.