
Sony Four Legged Robot Football League Rule Book

RoboCup Technical Committee

(As of May 20, 2004)

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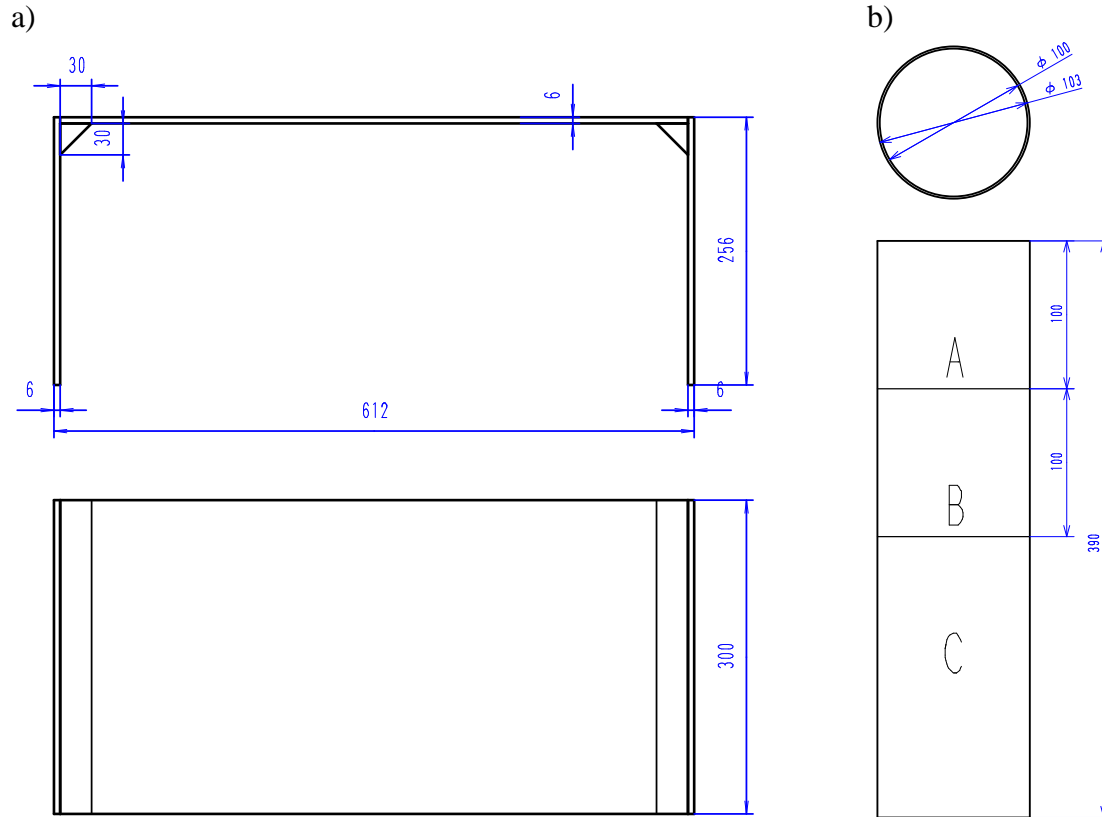


Figure 2: Top and side views of the goals and the beacons. a) Goal. b) Beacon.

middle of the white stripe on the other side, i. e. its outer diameter is 325 mm and its inner diameter is 275 mm.

1.3 Field Colors

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

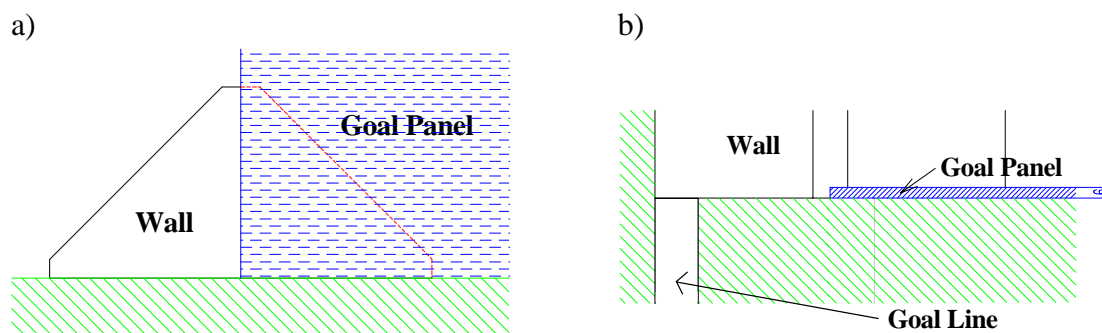


Figure 3: The connection between field wall and goal. a) Side view. b) Top view.

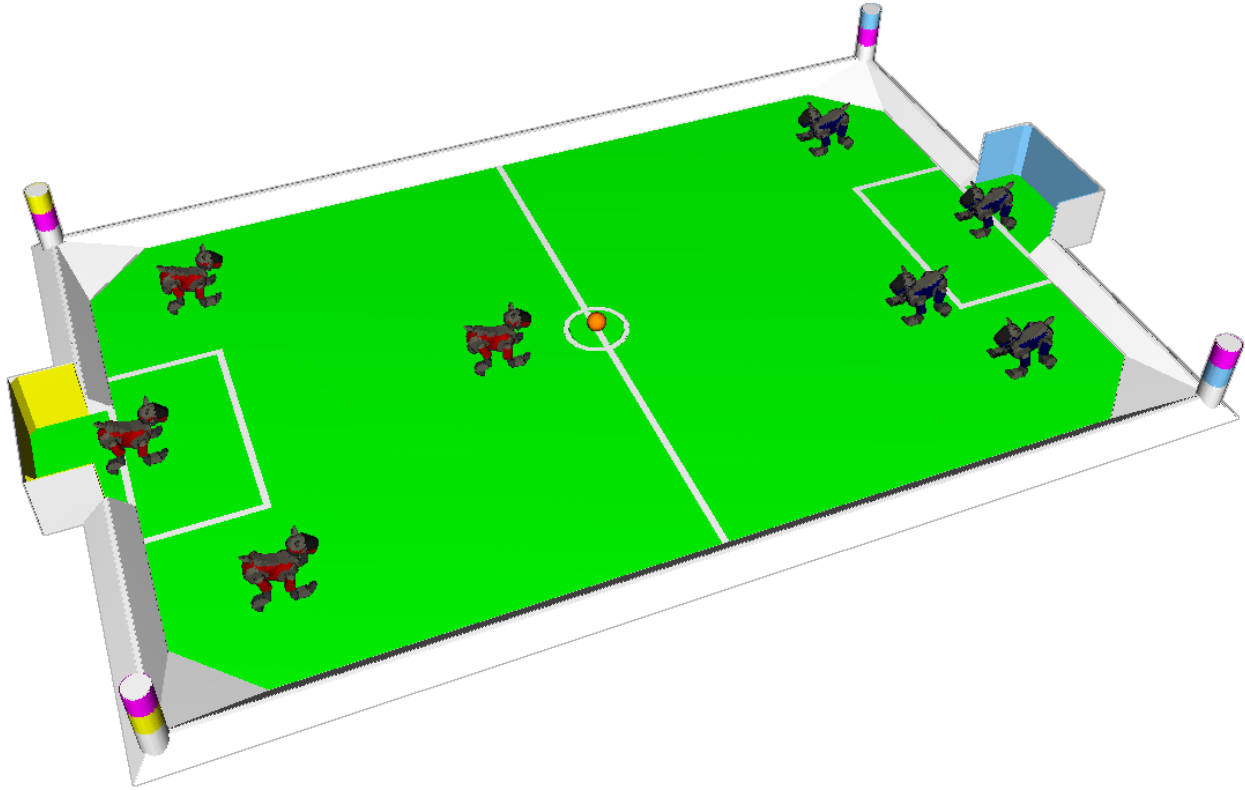


Figure 4: Field colors and manual setup for kick-off.

- The field (carpet) itself is green.
- The lines on the field, the field wall, and the outer wall surrounding the field are white.
- The red team defends the yellow goal.
- The blue team defends the sky-blue goal.
- In each corner of the field, there is a cylindrical beacon (cf. Figure 2b). Part C is always white. When looking from the yellow goal toward the sky-blue goal, part B of the two beacons on the right of this axis shares the color with the neighboring goal, and part A is pink. On the left side of the field, part B of the beacons is pink and part A shares the goal color.

1.4 Lighting Conditions

The lighting conditions depend on the actual competition site. In 2004, they may differ significantly from previous years, because only ceiling lights are used. The event organizers guarantee a brightness of at least 500 lux on the field.

2 Robot Players

2.1 Hardware

All teams must use robots of the following types:

- Sony AIBO ERS-210 (black (i. e. dark gray) or white)
- Sony AIBO ERS-210A (black (i. e. dark gray) or white)
- Sony AIBO ERS-7 (white)

The ERS-7 is recommended as it has a faster processor, a higher camera resolution, and it is the only model currently being sold that is permitted in RoboCup. Absolutely no modifications or additions to the robot hardware are allowed. No additional hardware is permitted including off-board sensing or processing systems. Additional sensors besides those originally installed on the robots are likewise not allowed. The only exceptions are:

- Attaching the red or blue team markers provided by Sony to the robots.
- Attaching the jersey numbers provided by the league to the robots.
- Adding some foam or sticky tape to the inner side of the cover of the battery compartment to prevent the battery from falling out.

A computer will be provided by the event organizers for the purpose of forwarding wireless messages between the robots.

2.2 Teams

Each team consists of no more than 4 robots including the goal keeper.

2.3 Goal Keeper

The goal keeper is the only player that is allowed to stay within the penalty area of its own team. It always has the jersey number “1” attached to its back.

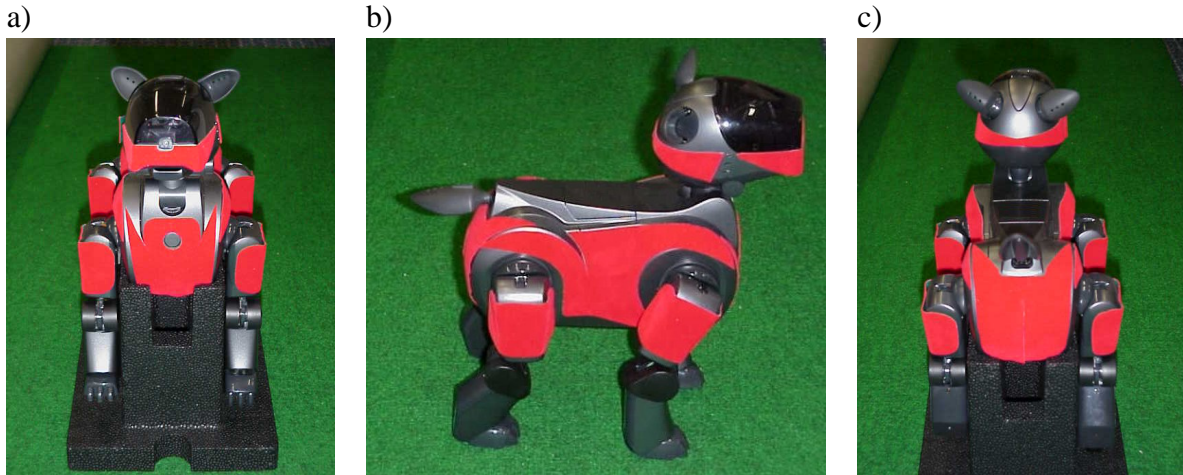


Figure 5: ERS-210 team markers. a) Front view. b) Side view. b) Back view.

2.4 Field Players

The field players are not allowed entering their own penalty area. The three robots have the jersey numbers “2”, “3”, and “4” attached to their backs.

2.5 Team Markers

Red and blue team markers will be provided to each team. All markers must be attached to each robot playing in a game (cf. Figures 5 and 6). As opponent players may try to detect these markers, playing with any markers missing is not allowed.



Figure 6: ERS-7 team markers. a) Front view. b) Side view. b) Back view.

2.6 Communications

2.6.1 Acoustic Communications

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

2.6.2 Wireless Communications

The only wireless hardware allowed to be used by the teams are the wireless network cards built into the Aibos, and the access points provided by the event organizers, i. e. any other wireless hardware has to be deactivated. A team may be disqualified if one of the team members violates this rule.

The MAC-addresses of all AIBOs participating in the competition will be registered. Only these MAC-addresses can be reached through the access points provided by the event organizers. In addition, the access points will be secured by different SSIDs and WEP-keys. Two of the access points will be connected to PCs running the GameController. The third access point is used for practise. It is connected to a hub with one port for each team. The teams have to bring their Ethernet cables by themselves.

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

Teams can use a bandwidth of up to 2 Mbps of the wireless. This includes any data transferred, namely the actual payload and any protocol overhead created, e. g., by TCP, UDP, the GameController, or Sony's tcpGateway.

There are two possibilities for robot to robot communications:

tcpGateway. This kind of communication uses the PC that runs the GameController to forward messages sent by one robot to another using the RP OPEN-R environment. The connections are configured by copying appropriate versions of the files *HOSTGW.CFG* and *CONNECT.CFG* on the GameController PC before the game starts.

Other communications. Any other form of wireless robot-to-robot communication is allowed, as long as it uses the access points provided by the event organizers (using the so-called ad-hoc mode is prohibited), it does not conflict with TCP/IP, and the maximum bandwidth of 2 Mbps allowed for each team is not exceeded. Each team will be assigned a range of 256 IP-ports that can be used for direct robot-to-robot communication. Broadcast and multicast messages on these ports are permitted.

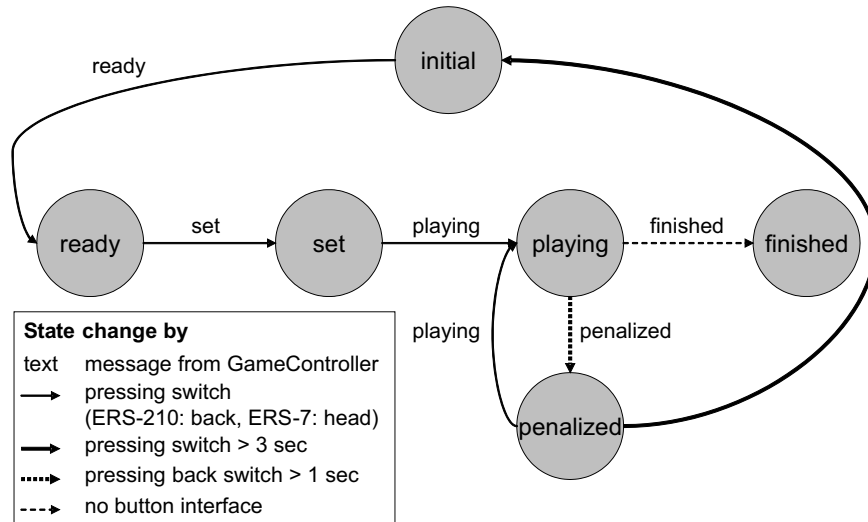


Figure 7: Robot states.

The GameController uses the first method to connect to the robots, i. e. all teams have to provide the configuration files mentioned above. The source distribution of the GameController provides the header file *RoboCupGameControlData.h* that defines all messages sent by the GameController to the robots. They correspond to the *robot states* described in Section 3.2.

The use of remote processing/sensing is prohibited.

3 Game Process

3.1 Structure of the Game

A game consists of three parts, i. e. the first half, a half-time break, and the second half. Each half is 10 minutes. The clock stops during stoppages of play¹ (such as kick-offs after goals). The extra time over 10 minutes total is referred to as “lost time”. The half-time break is also 10 minutes. If the game is a draw, there will be 5 minutes of extra time in which the team wins that scores first (golden goal). There is no break between the second half and the extra time. If no team scored the golden goal, a penalty kick shoot-out¹ employing sudden death (see Section 3.8) is started after a 5 minutes break.

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

¹This may not be the case during the preliminaries.

3.2 Robot States

Robots can be in six different states (cf. Figure 7). If the wireless is available, these states will be set by the GameController. However, as the availability of the wireless cannot be guaranteed, it must also be possible to switch between the states manually. As the assistant referees handle the robots, the button interface must be the same for all teams. However, it cannot be the same for all robot types, because the ERS-210² and the ERS-7 differ in the number of the buttons they have and the sensitivity of these buttons. For most switching between states, the back switch is used on the ERS-210 while the head switch is used on the ERS-7. The only exception is switching from the playing state into the penalized state, which is done with the back switch(es) for both robots, because it would be too complicated to continuously press the switch on a moving head for a longer period of time.

Initial. After booting, the robots are in their *initial* state. In this state, the button interface for manually setting the team color and whether the team has kick-off is active. The robots are not allowed moving in any fashion besides initially standing up.

ERS-210. The front part of the head switch toggles between the own kick-off and the opponent kick-off, while the top LED displays the current selection (on: own kick-off). The back head switch toggles between the red and blue team color. The team color is displayed by the LED in the robot's tail during the whole game (orange for the red team, blue for the blue team).

ERS-7. The middle back switch toggles between the own kick-off and the opponent kick-off, while the orange LED around this switch displays the current selection (on: own kick-off). To select the blue team color, press the front back switch, to select the red team color, press the rear back switch. The team color is displayed by the LEDs surrounding these switches, i. e. the red LED is on when the red team color is selected and the blue LED is switched on when the robot is part of the blue team.

Pressing the back switch of an ERS-210 or the head switch of an ERS-7 will switch it to the *ready* state.

Ready. In this state, the robots walk to their legal kick-off positions (cf. Section 3.5). They remain in this state, until all the robots have reached legal positions and have stopped, or until the head referee decides that there is no significant progress anymore. By pressing the back switch of an ERS-210 or the head switch of an ERS-7, it will be switched into the *set* state.

Set. In this state, the robots stop and wait for kick-off (cf. Section 3.5). If they are not at legal positions, they will be placed manually by the assistant referees to the positions shown in Figure 4. They are allowed to move their heads and tails before the game (re)starts but are not allowed moving their legs or locomote in any fashion.

Pressing the back switch of an ERS-210 or the head switch of an ERS-7 will bring them into the *playing* state, e. g. for kick-off.

²The identifier *ERS-210* is used for any version of the ERS-210(A/B) in this document.

Playing. In the *playing* state, the robots are playing soccer. When at least one of the back switches is pressed for more than one second, the robot is switched into the *penalized* state. Please note that this will happen automatically in most cases when an ERS-7 is picked up.

Penalized. A robot is in this state when it has been penalized. It is not allowed moving in any fashion, i. e. also the head has to stop turning. From this state, the robot can be reset to the *initial* state by pressing the back switch (ERS-210) or the head switch (ERS-7) for more than three seconds. If these switches are pressed shorter than that, the robot is returned into the *playing* state.

Finished. This state is reached when a half is finished. There is no possibility to reach this state when wireless is not working.

Without the wireless, the procedure after a goal has been scored is a little bit complex. The robots have first to be switched into the *penalized* state, from which it is possible to return to the *initial* state. From there, everything is the same as before the first kick-off.

The team color should be displayed during the whole game. The selection whether the robot's team has kick-off should be visible in the states *initial*, *ready* and *set*. Both selections should also be visualized if the wireless is working.

3.3 Goal

A goal is achieved when the entire ball (not only the center of the ball) goes over the field-side edge of the goal line, i. e. the ball is completely inside the goal area³. The restart after the goal shall adopt the same rules as the kick-off.

3.4 Applying Penalties

See Section 4.1.

3.5 Kick-off

For kick-off, the robots run through three states: *ready*, *set*, and *playing*. In the ready state, they should walk to their legal kick-off positions. These positions are always located inside their own side of the field. Only two field players of the attacking team can walk to positions between the center line and the middle of their side. They may put their leg(s) on the center circle line, but no leg may be inside the circle line. The other field players (one of attacking team, three of defending

³The goal line is part of the goal area.

team) have to be located behind the middle of their side (none of their legs are allowed to go beyond the middle), but have to stay outside their own penalty area with at least two feet. In contrast, the goal keepers have to stay *inside* the penalty areas with at least two feet.

If robots collide during the autonomous placement, the “Goalie Pushing” and the “Field Player Pushing” rules are applied, but the penalty is manual placement by the assistant referees.

If all the robots have reached legal positions and have stopped, or if the head referee decides that there is no significant progress anymore, they will be switched into the *set* state (by the GameController or manually by the assistant referees), in which they must stop walking. Each robot that is not at a legal position at this point in time will be placed manually by the assistant referees to the positions as shown in Figure 4. In this case, the kicking-off robot shall be one robot length away from the center circle, while one robot of the other team shall be just in front of one corner of the penalty area. The other robots shall be on the left and on the right of their own penalty area. As autonomously placed robots are allowed being much closer to the ball, successful autonomous placement results in a significant advantage over manual placement.

After all robots are at legal positions, the ball is placed on the center point of the center circle by one of the referees.

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

Note that a goal can never be scored directly from a shot from the kick-off. See Section 4.4 for details.

If the assistant referees have misconfigured the robots (e. g. they set the wrong team color), the kick-off is repeated. In general, goals scored with at least one misconfigured robot on the field are not counted. The time that was played with a wrong configuration is counted as “lost time”, i. e. the half should be lengthened by it.

3.6 Free Kick

None.

3.7 Penalty Kick

A penalty kick is carried out using only a robot of the attacking side. There is no goalie. Other robots should be powered off and stay outside of the field. It is allowed to switch to specially designed software for a penalty kick. The attacker is given a chance to make a goal within 1 minute.

Standard penalty kicks are taken against the opponent goal.

The ball is placed on the center of the penalty line and the kicker is started on the center circle facing the goal. The robot shall not move its legs before the penalty kick starts. Movements of the robot's head and tail are allowed as long as the robot does not locomote. Technically, the robot is in the *set* state when waiting for the penalty kick to start. The robot is started by setting it into the *playing* state, which can either be done via the wireless or manually by an assistant referee. The penalty kick ends when the kicker scores the goal or the time expires. The time limit for the kicker is 1 minute after the penalty kick starts. The ball must be in the goal within this time limit in order to count as a goal.

All the rules such as "Ball Holding" and others are also applied during the penalty kick. The only exception is the "Illegal Defender" rule, i. e. the penalty shooter is allowed to enter its own penalty area.

3.8 Penalty Kick Shoot-out

A penalty kick shoot-out is used to determine the outcome of a tied game after the extra time. The penalty kick shoot-out is a sudden death contest. Each team selects a robot and a memory stick to be used for the penalty kick shoot-out. The memory stick cannot be changed in between kicks. Before the shoot-out, the head referee decides on five initial pairs of positions for the robot and the ball, i. e. before he or she sees how the kickers perform. The initial positions are marked with small pieces of transparent tape or other suitable mark which will be unobtrusive to the robots.

In a penalty kick shoot-out, all penalty kicks are taken against the *blue* goal.

The actual procedure is the same as for the normal penalty kick described in Section 3.7. If one team scores within the allotted time and the other does not, the scoring team wins. Otherwise, the shoot-out is continued with the next pair of positions. For the first four attempts, the time limit for the kicker is 1 minute after the penalty kick starts, such as for the normal penalty kick. However, for the fifth attempt it is 2 minutes. The fifth attempt is timed, i. e. if both teams score, the faster team wins, but only if the faster team is at least 2 seconds faster than the other team. Otherwise, the timed attempt is repeated by reusing the position pairs from the first, second, etc. attempts.

3.9 Throw-in

None. When the ball goes out of bounds, it shall be replaced inside of the field at the spot where it left the field.

3.10 Game Stuck

3.10.1 Local Game Stuck

In the event of no substantial change in the game state (as shown in Figure 8) for 30 seconds, the referee shall pick up the robots which are jamming around the ball and move them to the half way line. The referee does *not* replace the ball. If the ball is accidentally bumped when removing the robots, the ball should be replaced where it was when the game stuck was called. As a special exception, if the goalie is involved in a game stuck situation while having 3 feet on its own half (on half line or closer to goal), the goalie will not be removed from the game stuck situation. In this case, only the other robots involved will be removed.

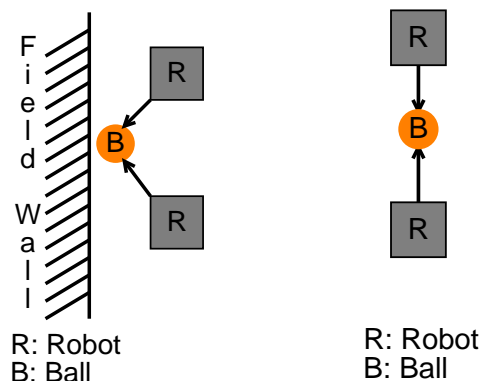


Figure 8: Local Game Stuck

3.10.2 Global Game Stuck

If no robot touches the ball for 30 seconds, the referee shall stop the game and restart the game from the kick-off formation. The kick-off will be awarded to the team defending the side of the field the ball is on when the game stuck is called.

3.11 Request for Pick-up

Either team may request that one of their players be picked up only for hardware dysfunction and software crashes at any point in the game (called “Request for Pick-up”). It is permitted to change batteries, fix mechanical problems or, if necessary, reboot the robots, but not to change or adjust their program. Any strategic “Request for Pick-up” is not allowed. The head referee will indicate when the robot is no longer affecting play and can be removed from the field by an assistant referee. The robot will be replaced on the half way line after 30 seconds following the normal replacement procedure used after the standard removal penalty (see Section 4.2).

If a robot has been rebooted and the wireless is not working, it is the responsibility of the team members (not the assistant referees) to configure its team color correctly.

3.12 Request for Timeout

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

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

If a team is not ready to play at the assigned time for a game, the referee will call the timeout for that team.

3.13 Winner and Rankings

The team which scored more goals than the other is the winner of the match. If the two teams scored the same number of goals, the game will be a draw. The draw will follow the same system defined in Section 3.1. Winning a game in the extra time (by a golden goal) is the same as winning it in the regular time. However, for winning a game in the penalty shoot-out, fewer points will be awarded. Total (and final) standings will be decided on points as follows (the points will be given based on the result of each game):

Win = 3 pts	Win PK = 2 pts	Lose = 0 pts
Draw - Tie	PK = 1.5 pts	
	LosePK = 1 pts	

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

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

4 Forbidden Actions and Penalties

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

4.1 Penalty procedure

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

4.2 Standard Removal Penalty

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

The operator of the GameController will send the appropriate signal to the robot indicating the infraction committed. If the wireless is not working and the penalty is timed, the assistant referee handling the robot will reset the robot into the *initial* state for the duration of the penalty. This is not done if the penalty is not timed, i. e. it is a 0 seconds penalty. After a penalty was signaled to the robot, it is not allowed moving in any fashion, such as being in the *initial* state. The removed robot will be placed outside of the field facing away from the field of play. The best option is to put them on robot stands that are located behind the goals.

The GameController will keep track of the time of the penalty. The operator of the GameController will signal the assistant referees when the penalty is over, so that one of them can put the robot back on the field. The assistant referee will then place the robot on the field on the halfway line as close to the sideline as possible. The robot should be pointed towards the opposite sideline. The robot should be placed on the side of the field furthest from the ball. If there is another robot already in this position, the robot should be replaced at a nearby location along the sideline facing towards the opposite sideline. If there are no practical locations nearby, a location along one of the sidelines should be found that is away from the ball (the robot should be set down facing

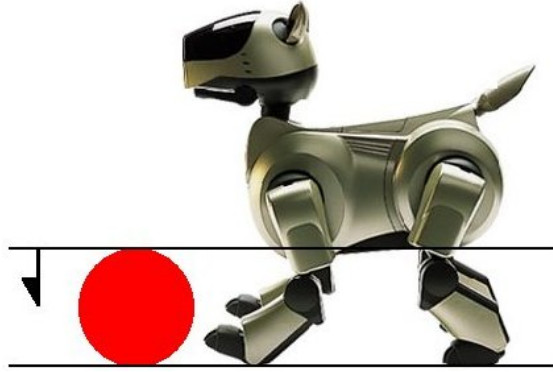


Figure 9: Robot parts which are taken into account for “Ball Holding”.

the opposite sideline). When finding a nearby location, locations away from the ball should be preferred.

When the robot is on the field again, the operator of the GameController will send the *playing* signal to it. If the wireless is not working, the assistant referee who placed the robot back on the field has to bring it into the *playing* state again by pressing the back switch three times. Please note that this will also work if the robot actually is in the *penalized* state (previously signaled through the wireless) and is only waiting for a single click on its back switch, because any further short touches on that switch will be ignored.

4.3 Manual Interaction by Team Members

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

4.4 Kick-off Shot

A “kick-off shot” can never score a goal. A “kick-off shot” is a shot taken after a kick-off before the entire ball having left the center circle, including the boundary line. The ball must touch a player from the kick-off team after leaving the center circle before a goal can be scored by the team taking the kick-off. If a kick-off shot enters the goal (either directly or via contact with an opposing robot), no goal will be scored and a kick-off will be awarded to the defending team (as per Section 3.5).

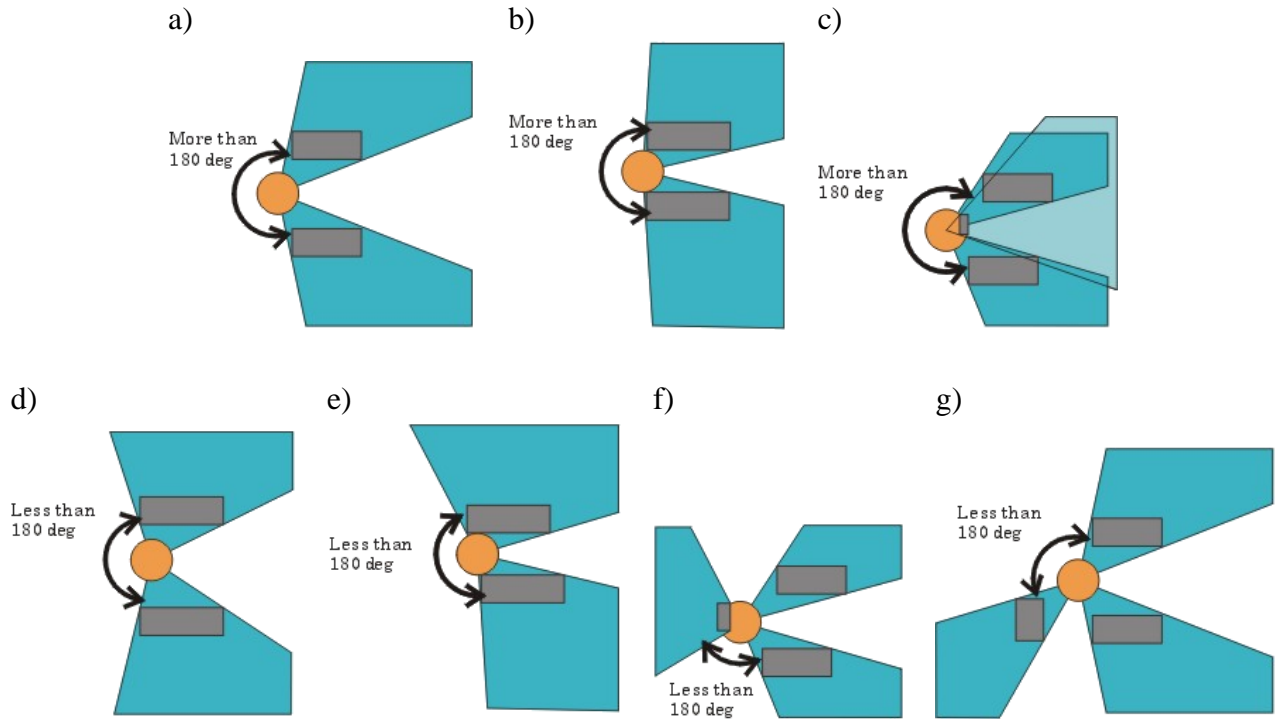


Figure 10: Examples for “Ball Holding”. The orange circle is the ball, the gray boxes are parts of the robot, and the blue area visualizes the ranges occupied by the robot. Situations a), b) and c) are legal, whereas d), e), f) and g) violate the rule.

4.5 Ball Holding

The goalie is allowed to hold the ball for up to 5 seconds as long as it has 2 feet inside in its own penalty area. In all other cases, robots are allowed to hold the ball for up to 3 seconds. Holding the ball for longer than this is “Ball Holding” and is not allowed.

A robot which does not leave enough open space around the ball will be penalized as “Ball Holding” if that situation continues more than 3 seconds. The robot parts taken into account are only those parts that are below the horizontal plane that is at the same height as the top of the ball (cf. Figure 9). The occupation of the ball is judged using the projection of the related robot parts onto the ground. “Enough open space” means one successive open area that covers more than 180° around the ball. It is not important whether the robot actually touches the ball (cf. Figure 10a, b vs. 10d, e). If the chin of the robot touches the ball, that part is also lower than the top of the ball, and therefore must also be taken into account (cf. Figure 10c, f, g).

Intentional continual holding is prohibited even if each individual holding time does not continue for up to the time limit. In this case, the continual holding is regarded as a continuous hold from the very beginning and the holding rule is strictly applied. The violation of this rule will result in having the penalized robot removed from the field for 30 seconds as per the standard removal penalty (see Section 4.2 for details). In case of a violation by the goal keeper, the robot will be

removed for 0 seconds as per the standard removal penalty, i. e. he will be placed on the halfway line immediately (no need to be kept outside of the field). The ball should be removed from the possession of the robot and placed where the foul occurred. If the robot that held the ball has moved the ball before the robot can be removed, the ball shall be replaced where the foul occurred.

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

4.6 Goalie Pushing

When the goalie is in its own penalty area (2 feet on or inside line), no attacker may be in contact with the goalie for more than 3 seconds. Intentional continual contact is prohibited even if each individual contact time doesn't continue for up to the time limit. In this case, the continual contact is regarded as a continuous contact from the very beginning and the goalie pushing rule is strictly applied. When violating this rule the attacker will be removed for 30 seconds as per the standard removal penalty (see Section 4.2). If a goal is scored by an action performed after the 3 seconds of contact are over, but before the robot can be removed, the ball and the robots involved in that action (the goalie, other robots, but not the penalized robot) shall be replaced where they were when the foul occurred.

Example 1. The attacker that has pushed the goalie shoots a goal after the violation but before it was removed. In that case, the goalie and the ball are replaced to the locations they were when the violation happened, and the goal is not counted.

Example 2. A second attacker scored a goal after the violation but before the pushing robot was removed. In that case, the goalie, the second attacker, and the ball are replaced to their original locations when the violation happened, and the goal is not counted. This is necessary, because the pushing robot prevented the goal keeper from defending its goal.

4.7 Field Player Pushing

Any robot pushing another robot for more than 3 seconds will be removed from play for 30 seconds as per the standard removal penalty (see Section 4.2). The closest robot (including the goal keeper) to the ball on each team, if it is within 2 dog-lengths of the ball, cannot be called for pushing. If a robot is standing still it cannot be called for pushing. If two moving robots are charging into each other then both robots are removed. The goalie cannot be called for pushing as long as it is within its penalty area at least with two legs.

Example 1. If two robots of different teams are fighting for the ball and a third robot touches one of them, it will be removed.

Example 2. If two robots of the same team are—for some reason—fighting for the ball, the robot that is further away from the ball will be removed.

Example 3. If two robots are pushing each other without a ball in the vicinity, they are both removed. If only one of them is moving, only the moving robot is removed.

4.8 Damage to the Field/Robots/Ball

A robot that damages the field and/or other robots will be removed from the field for the remainder of the game. Similarly a robot that poses a threat to the spectator’s safety will also be removed. In such a case, a normal penalty kick will be awarded to the opposing team (cf. Section 3.7).

4.9 Illegal Defender

Only the goalie can be within the penalty area of its side. Having three legs inside the penalty area is the definition of being in the penalty area and that situation is not allowed for the field players. When other robots enter the area, they will be removed for 30 seconds as per the standard removal penalty (see Section 4.2). This is called the “Illegal Defender Rule”. This rule will be applied even if the goalie is outside of the penalty area, but not if an operational defender is pushed into the penalty area by an opponent.

If an illegal defender kicks an own goal, the goal is scored for the opponent.

4.10 Illegal Defense

The vertical projection of the goalie to the goal line should not occupy more than 50 percent of the length of the goal mouth. Those robots that commit this action (intentionally) will be replaced immediately on the halfway line as per the standard removal penalty for 0 seconds (see Section 4.2). Robots may violate this rule for brief periods of time to, for example, block a shot. These brief periods of time should be no longer than 3 seconds and must not be done continually as per the holding rule (see Section 4.5).

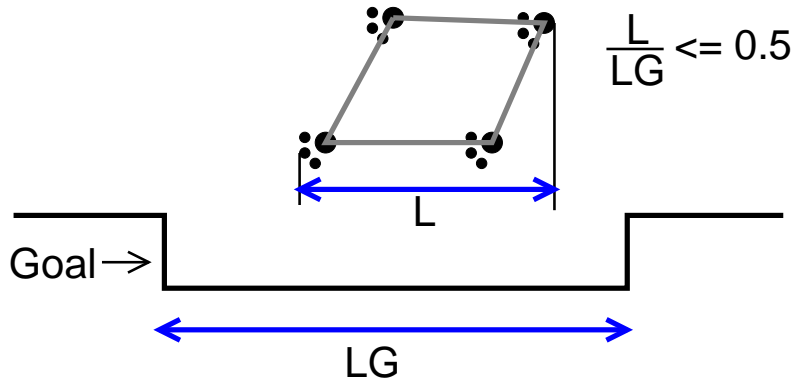
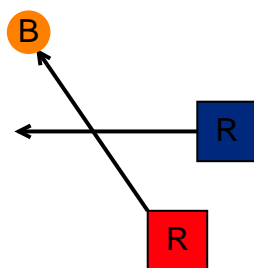


Figure 11: Illegal Defense



R: Robot
B: Ball

Figure 12: Obstruction

4.11 Obstruction

When a robot that is not heading for the ball is actively, and intentionally, blocking the way to the ball for a robot of the other team, this is an obstruction (cf. Figure 12). The obstructing robot will be removed for 30 seconds as per the standard removal penalty (see Section 4.2). Note: The obstruction rule this year is significantly different from the obstruction rule in previous years. In general, collisions should now be handled using the 'pushing' rules (see Sections 4.6 and 4.7).

Example. If a robot of one team, robot A, is heading for the ball, but a robot of the other team, robot B, is in its way without heading for the ball, this, by itself, is not an obstruction. But, if robot A starts to move around robot B, and then robot B intentionally moves to block robot A again, this is an obstruction, even if the robots do not actually touch.

Note: The intent of the obstruction rule is to stop people implementing code that deliberately attempts to obstruct opponent robots. We hope that this penalty never needs to be called.

4.12 Jamming

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

Wireless communication. Teams can use a bandwidth of up to 2 Mbps of the wireless. This includes any data transferred, namely the actual payload and any protocol overhead created, e. g., by TCP, UDP, the GameController, or Sony's tcpGateway. If a team uses more bandwidth over a couple of seconds in a game, it will be disqualified for that game.

Except from the wireless cards and the access points provided by the organizers of the competition, nobody close to the field is allowed using 2.4 GHz radio equipments including cellular phones and Bluetooth devices.

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

Visual perception. It is only allowed using the white, green, and red LEDs in the robot's head to avoid confusing other robots. In particular, orange LEDs are not allowed.

In general, the use of flashlights is not allowed during the games.

5 Judgement

The referees are the only persons that are allowed being inside the area surrounded by the 30 cm high outer white wall.

5.1 Head Referee

The head referee signals game starts, restarts, when a goal was scored, the case of *game stuck*, and penalties by a single whistle. In general, the head referee first whistles and then announces the reason for the whistle. The only exception is the case of the kick-off, in which the reason for the whistle is obvious. The whistle defines the point in time at which the decision is made. If the head referee has to announce many decisions in short sequence, he may skip whistling. For penalties, he announces the infraction committed, the team color, and the jersey number of the robot, e. g. "illegal defender, blue number 4". In case of a goal scored, local or global game stuck, this is also announced verbally. By two whistles, the head referee terminates the first half; by three whistles

he terminates the second half, i. e. the whole game. The head referee is also keeping the time of each half, i. e., he or she stops the clock after a goal or game stuck, and continues it at the kick-off⁴.

In the penalty kick shoot-out, the head referee decides the positions of kicker and ball for all five attempts before the shoot-out starts. Again, he or she also keeps the time.

Any decision of the head referee is valid. There is no discussion about decisions during the game, neither between the assistant referees and the head referee, nor between the audience or the teams and the head referee. Neither the teams, nor the audience can have any influence on the positions the head referee selects for the penalty kick shoot-out.

5.2 Assistant Referees

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

5.3 Operator of the GameController

The operator of the GameController sits at a PC outside the 30 cm high white wall. He or she will signal any change in the game state to the robots via the wireless as they are announced by the head referee. He or she will also inform the assistant referees when a timed penalty is over and a robot has to be placed back on the field.

It is also the responsibility of the operator of the GameController to initially establish all connections between the GameController and the robots, as well as all connections between the robots of each team itself, as long as they use Sony's tcpGateway to communicate. During the game, teams can request to reestablish these connections, e. g. after a robot was rebooted.

5.4 Selection of the Referees

At least in the preliminaries, the games will be refereed by members of teams from a different Round-Robin group. Each team has to referee a number of these games. For each of the games, it can either provide the head referee and the operator of the GameController, or the two assistant

⁴The clock may not be stopped during the preliminaries.

referees. These persons must have good knowledge of the rules as applied in the tournament, and the operator of the GameController must be experienced in using that software. The persons should be selected among the more senior members of a team, and preferably have prior experience with games in the RoboCup Four-Legged Robot league.

5.5 Referees During the Match

The head referee and the assistant referees should wear black or white clothing/shoes and avoid reserved colors for the ball, the goals, and player markings in their clothing. They will be inside the outer white wall but off the field during play. They may enter the field in particular situations, e. g., to reposition the robots when applying a penalty or stuck. They should avoid interfering with the robots as much as possible.

6 Questions/Comments

Questions or comments on these rules should be mailed to legged_tech@pdp.crl.sony.co.jp