



AndroSot (Android Soccer Tournament) Laws of the Game 2023, FIRA RoboWorld Cup

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Abstract

The official version of the rules of the game for AndroSot is modified by the rules of the game for MiroSot initiated by FIRA founding President, Prof. Jong-Hwan Kim, and by the rules of the game for 2008 AndroSot proposed by Prof. Bing-Rong Hong. Some comments from Professor Jacky Baltes, the HuroCup Chair, have also been adopted to the rules for AndroSot. For an AndroSot game, each team has three autonomous Androids (kid-sized humanoid robots) one of robots playing role of goalkeeper is fully autonomous with on-board camera, two robots playing role of field players are teleoperated by off-board computer connected to two cameras which observe field from different angles.

The main changes of year 2023:

- 1) One global camera located on center top of field which was formerly connected to computer of one of teams is replaced by two cameras located on tripods which must be installed

behind of each goal at elevation 2m.

- 2) Outer size of field which had aspect ratio 16:9 is changed to 4:3 which is better serving new location of cameras and better follows FIFA rules.
- 3) Side walls of field are discontinued and throw-in procedure introduced (clause 5.1).
- 4) Field color is changed to green.

- 5) Field marking is modified to follow FIFA rules.
- 6) New way of marking players with colorized Aruco Cube introduced.
- 7) Scoring of goal is modified to follow FIFA rules (clause 3.3.1)
- 8) Overall robot weight limited to 2.5 kg
- 9) Point of re-entering player to game is modified (clause 3.4.1.b)

1. Setting up the Game

1.1 The Field ([Appendix A](#))

1.1.1 Playground Surface and Dimension

- (a) A **green (non-reflective)** flat and hard rectangular playground is **carpeted**. The game field is **400 cm x 300 cm** (outside, on carpet). Goals are made **5cm** thick and **5 cm high white boards**. Goals should be painted in white and fixed to the carpet.
- (b) The playing field should be on a level surface so that when a ball is placed anywhere on the field, it does not start to roll.

1.1.2 Markings on the Playground

- (a) All lines and marks are set covering with white non-reflective paint or white adhesive tape.
- (b) All lines will be in **5 cm** thick.
- (c) The penalty kick and free kick points are marked by cross using line segment with **5 cm** thickness and **15 cm** length.
- (d) The center circle will have a radius of **30 cm**.
- (e) All measurements between linear marking must be made from middle of line thickness.

1.1.3 The Goal

- (a) The goal is **120 cm** wide.
- (b) There are no posts or nets at the goal.
- (c) The goal is bounded by an **120cm** goal line. The goal is the three white walls **5cm** thick and **5cm** high have inside lengths of **15cm**, **120cm**, and **15cm**, respectively.

1.1.4 The Goal Line and Goal Area

- (a) The goal line is **120cm** long line in front of the goal.
- (b) The goal area is in front of the goal line and consists of a line segment of **140cm**, which parallels the goal line, and two orthogonal line segments of **20cm**.

1.1.5 The Penalty Line, Penalty Area, Penalty Kick Point

- (a) The penalty line consists of a line segment of **200cm**, which parallels the goal line and two orthogonal line segments of **90cm**.
- (b) The penalty area is comprised of the area contained by the penalty line and the goal line.
- (c) The penalty kick point is inside penalty area at distance 60cm from goal.

1.1.6 The Ball

A standard yellow tennis ball will be used as the ball, with **75~80 mm** in diameter and **56~59.4g** in weight.

1.1.7 The Field Location

The field should be indoors.

1.2 Vision and Lighting

1.2.1 The lighting conditions should be within **600~800 Lux** anywhere on the playing field.

The lighting should be diffused and evenly distributed. Flicker free lighting is recommended.

- 1.2.2 All cameras are unified as the [HD Pro C930 \(or C920\) web-camera](#) made by Logitech, where the price of the camera is affordable. It is able to provide onboard H.264 compression and full 1080p high-definition video recording. The focus, light balance, and frame rates are all excellent, with the latter touching 30 frames per second at 720p and 29 frames per second at 1080p.
- 1.2.3 Four cameras are paired side-by-side and mounted on two tripods at elevation 2m. Each tripod with two cameras must be located 1m behind each goal. Field of view of each camera has to cover whole playing field. Coverage can be regulated by inclination of cameras and distance to goal. One camera at each tripod is designated to be connected to computer of one team and other cameras are designated to other team. Connection between cameras and computers must be provided by 10m shielded USB2.0 extension cable with signal amplifier.
- 1.2.4 Besides the cameras above the playing field, the goalkeeper of each team may possess its own camera (the field of view of the camera must be limited to less than [180 degrees](#)), as shown in [Appendix B](#). The image of the camera may be sent via a wireless communication channel as described in [Rule 3.5.3](#) to an off-board computer for processing or can be processed onboard.
- 1.2.5 All active distance sensors are disallowed from setting up on the android to measure the relative distances among androids.

2 The Overall System and Robots

2.1 The Overall system ([Appendix C](#))

- 2.1.1 A match is played by two teams, each consisting of at most three robots, including one goalkeeper.
- 2.1.2 Each team may prepare one more android for substitution.
- 2.1.3 All robots are controlled by off-board computers. (The goalkeeper with its own camera could be fully autonomous).
- 2.1.4 At most, two designated team members are allowed to access the playing field during a game (if instructed so by the referee), except during timeouts and halftime.
- 2.1.5 A team must make sure that all necessary equipment to play a match is close to the playing field.
- 2.1.6 Every team should attend the AndroSot Challenges, only some qualified teams can participate the AndroSot match.

2.2 The Robots

- 2.2.1 The robot should be a biped android.
- 2.2.2 The height of each robot shall be limited to $30 \leq H \leq 60$ cm. Each foot must fit into a rectangle of area $0.035 \times H^2$. The height of the head, including the neck, should be within 0.1H to 0.2H. The foot length of each robot cannot be greater than 70% of its height. The arm length of each robot also cannot be greater than 60% of its height, as shown in **Appendix D**.
- 2.2.3 The visible part of the robot should be non-reflective black or silver in color.
- 2.2.4 Overall weight of robot must be below 2.5 kg

2.3 Color marks of players (**Appendix J**)

- 2.3.1 All androids must be equipped with player marker.
- 2.3.2 Player marker must be in shape of cube with dimension 8cm ~ 9.5 cm. Cube must be fixed on top of android over its shoulders. 5 sides of cube must contain binary ArUco codes for recognition by machine vision.
- 2.3.3 Goalkeeper player which carries onboard camera can be equipped with cube covered by ArUco codes from 4 sides in order to keep one side free for camera.
- 2.3.4 Conventional ArUco marker contains 2 colors: Black and White. ArUco markers used for Androsot must be one from two combinations: Blue and White or Red and White depending on team color Blue or Red. In case if team color is Blue all codes of ArUco marker must be even, i.e. one code from sequence: 0,2,4,6,8,10,12 ... In case if team color is Red then all codes of ArUco marker must be odd, i.e. one from sequence 1,3,5,7,9,11,13...
- 2.3.5 The team color either blue or red, as assigned by the organizers, will identify the robots in a team. The color assigned to each team might not be changed during the match.

3 The Game

3.1 Game Duration

- 3.1.1 The *duration* of a game shall be two equal periods of 7 minutes each with a half time break of 5 minutes.
- 3.1.2 If a team is not ready to resume the game after the half time, additional 2 minutes shall be allowed. If the team is still not ready after the second break, that team will be disqualified from the game.

3.2 Game Commencement and Progress

- 3.2.1 At least 30 minutes before the commencement of a game, either the transmission frequency or the color should be decided by the toss of a coin.
- 3.2.2 Just 5 minutes before the commencement of the game, kickoff and side must be decided by the toss of a coin. The winning team should choose either kickoff or side, and the losing team must choose the rest.
- 3.2.3 At the start of the game, each team must have proper working robots on the playing field

as defined in [Rule 2.1](#).

3.2.4 At the beginning of **each half time** and after a goal has been scored, the ball is put at the center point. The attacking team is allowed to position its robots freely in its own half, but only one robot is able to be within the center circle of its own half. Then the defending team can place its robots freely in its own half except within the center circle. With a signal from the referee, the game is (re)started and all robots may move freely. The ball should be kicked out of the center circle or passed towards the teammates first. If this is not done, the kick-off must be repeated. The defensive team is not allowed to enter the center circle until the ball has been moved by the team at the kick-off or until the contest has already resumed for **10 seconds**. If the kick-off is done incorrectly again, a free kick will be called in favor of the other team.

3.2.5 After the half time, the teams have to change sides unless both teams agree not to change sides.

3.3 Winning

3.3.1 The Winner: A goal is scored when the ball touches longer board of goal. In case if ball stopped inside of goal, but don't touch longer board of goal, goal is scored if vertical projection of ball on field doesn't touch goal line. The winner of a game shall be decided by the number of goals scored.

3.3.2 The Tiebreaker:

(a) If the tournament rules call for a tie breaker it will be resolved as follows:

- 1) In the event of a tie after the second half, the winner will be decided by the sudden death scheme ("Golden Goal"). The game will be continued after a **5 minutes break** for a maximum period of **3 minutes**. The team managing to score the first goal will be declared as the winner.
- 2) If the tie persists even after the extra **3 minutes** game, the winner shall be decided through penalty-kicks.

(b) Each team takes three penalty-kicks, which are carried out as per [Rule 4.5](#). The only differences to that rule are that

- 1) Only a kicker and a goalkeeper are allowed on the playing field.
- 2) The kicker can try to score within **30 seconds**, until the ball is touched by the goalkeeper or enters the goal area.

3.4 Interruptions

The game is interrupted whenever the referee blows the whistle. The human operator must then stop the communication between the robots and the host computer.

3.4.1 Relocations: Relocation of Androids may be done by a human operator only during

- a) Timeouts, halftime and foul as described in [Rule 4](#). All Androids must be relocated within **10 seconds** after the whistle.
- b) When a robot falls down and is unable to stand up on its own for more than **10 seconds**, or the robots does not move for more than **10 seconds** and has obstructed opposing robots, the referee instructs a team handler to remove the robot and repair it if

necessary. A repaired or substituted robot can reenter the match by **being placed at own half of field beyond side line facing towards opposite side. From two possible reentry points handler must choose one which stands at longer distance to ball.** The robot can start moving after a minimum delay of **30 seconds**.

3.4.2 Timeouts and Substitutions: **4 timeouts** with a maximum combined duration of **8 minutes** will be permitted **for each team** while a game is in progress. During timeouts and at half time, unlimited substitutions can be made. When a timeout is desired while the game is in progress, the concerned team should call “time-out” to notify the referee and the referee will stop the game at an appropriate moment. The game will restart with a free- ball on the side of the calling team if the time-out has been called during the game.

3.5 Transmissible Information

3.5.1 While the game is not in progress, the teams may transmit any information to and from the robot they wish. Upon the commencement of the game through the referee, the teams may send a start signal to their robots. If the referee interrupts or ends the game, the teams must immediately send a stop signal to their robots.

3.5.2 While the game is in progress, the humans must not interact in any way with their system under any circumstances. The system must send and receive any information to and from the robots autonomously during that time.

3.5.3 The robots can be controlled by use of the following wireless communication: **Bluetooth, 802.1, 1.8G, WiFi, ZigBee, 40MHz, and/or 750MHz**. Before the game starts, all the team must notify the referee of the working frequency of the wireless module on all of the robots (the controllers). If the team uses FM radios, the team must prepare reserved channels to avoid the influence of the frequency interfere with each other.

4. Fouls

4.1 Advantage

The referee may decide not to call a foul if the fouled team has an advantage.

4.2 Free-Ball

4.2.1 The referee will call a free-ball when

- a) a robot is colliding with other of the opposite team, either intentionally or otherwise: the referee will call such fouls that directly affect the play of the game.
- b) no robot is touching the ball or if two or more opposing robots are blocking the ball for **15 seconds** outside of the penalty area.

4.2.2 When a free-ball is called within any quarter of the playing field, the ball will be placed at the relevant **free ball position (FB)**. One Android per team will be placed at locations **25cm** apart from the ball position in the longitudinal direction of the playing field. Other androids can be placed freely outside of the quarter where the free-ball is being called. The game shall resume when the referee gives the signal and all robots may then move freely. (**Appendix E**)

4.3 Free-Kick

4.3.1 The referee will call a free-kick when

- a) a defender robot intentionally pushes an opponent robot who possesses the ball or when it affects the game, a free kick will be given to the opposite team. This does not apply to normal fights for the ball.
- b) a robot is ramming an opponent robot in a way that might cause damage to it, no matter if the offending robot is playing the ball or not.
- c) any robot other than the goalkeeper catches (including with hands) the ball but its position is not on its **goal area**. This is also true if one or more robots of the same team block the ball for more than **10 seconds** without the influence of the other team.
- d) a goalkeeper fails to kick out the ball from his **goal area** within **10 seconds** (unless blocked by the other team, in which case, it is a goal kick, [Rule4.4](#)).

4.3.2 The ball will be placed at the relevant FK position of the half where the called foul happened but outside of the **penalty area** (as in case 1 and case 2 in **Appendix F**.) Besides, the ball will be placed at the relevant FK-line point paralleled to the location where the called foul occurred inside of the penalty area (as in case 3 in **Appendix F**.)

4.3.3 All androids except the android taking the free-kick must be placed outside of a **25 cm** radius circle around the ball position. When positioning robots, all other game rules still apply. The defending team gets precedence in placing their androids. Upon the restart of the game by the referee, no robot may move into the **25cm** circle before the ball has been moved or the contest has already resumed for **10 seconds**.

4.3.4 If the free kick cannot be accomplished twice because of illegalities on the part of the

defending robots, the referee may call a penalty kick ([Appendix H](#)) instead of a free kick.

4.4 Goal-Kick

4.4.1 The referee will call a goal-kick when

- a) a robot is charging the goalkeeper by touching or directly or indirectly blocking or pushing (with and without the ball in between) while the goalkeeper is inside its **goal area**;
- b) a team is attacking with more than one Android in the **goal area** (including touch of the line) of the opposite team for over **10 seconds**.

4.4.2 During goal kick only the goalkeeper will be allowed within the **goal area** and the ball can be placed anywhere within the **goal area, shown in Appendix G**. Other Androids of the team shall be placed outside the **goal area** during the goal kick. The defending team will get preference in positioning their Androids within their own side of the playing field. The attacking team (i.e. the team performing the goal kick) can then place its Androids anywhere on the playing field. The game shall restart normally with the referee's whistle.

4.4.3 If a goal kick cannot be accomplished twice because of a similar situation as described in [Rule 4.5.1\(b\)](#), the referee may call a free kick at the relevant FK position of the half for the opposite instead of the goal kick.

4.5 Penalty-Kick

4.5.1 The referee will call a penalty-kick when

- a) a team is defending with more than one Android on the **goal line** (touching the line) of the team for over **10 seconds**. An exception to this is the situation when the additional Android on the goal line is not there for defense or if it does not directly affect the play of the game. The referee shall judge the penalty-kick situation.
- b) someone is repositioning the robots without the referee's permission during the game.
- c) a robot is handling when it is on its **goal line**. Handling, as judged by the referee, is when a robot other than the goalkeeper catches the ball and the robot is on its goal line. It is also considered handling if a robot firmly attaches itself to the ball in such a way that no other robot is able to manipulate the ball.
- e) the goalkeeper is considered to block more than **40 cm** of its goal line for more than **10 seconds**.
- f) During the game, if without any referee's allowance, any operator of the team is prohibited from touching the mouse or sending any control command to the control systems; also, sending or causing disturbance signals to the opposing side is prohibited. If the team has committed such a violation for the first time, the

opposing side will be awarded a penalty kick; for the second time or later, the opposing side will be awarded a goal each time.

- 4.5.2 When the referee calls a penalty-kick, the ball will be placed at the relevant penalty kick position (PK) on the playing field ([Appendix H](#)). The Android taking the kick shall be placed behind the penalty-kick mark. The defending goalkeeper is placed in upright position on the middle of its goal line, facing the kicker. It must remain upright on the goal line until the ball has been touched. Other Androids shall be placed freely within the other side of the half-line, and able to move over the center line only after the ball has been moved or **10 seconds** have passed. The android taking the penalty-kick may kick or dribble the ball.
- 4.5.3 If the goalkeeper falls or leaves the goal line before the kicker touches the ball as the penalty-kick is performing within **10 seconds**. If the kicker scores a goal, the penalty kick ends, otherwise, the referee will restart the penalty kick. If the goalkeeper falls or leaves the goal line before the kicker touches the ball (within **10 seconds**) again, the kicker will be awarding a technical goal.
- 4.5.4 If the penalty kick cannot be accomplished twice because of the early entrance of the attacking side in [Rule 4.5.2](#), the referee may call a goal kick for the opposing side instead of a penalty kick.

4.6 When It's Not A Foul However

- 4.6.1 It is permitted to kick the ball and an opponent player backwards provided the pushing player is always in contact with the ball, when the situation is caused by the opposite team, and if the situation has no effect on the game whatsoever.
- 4.6.2 It is upon the referee to judge such situations.

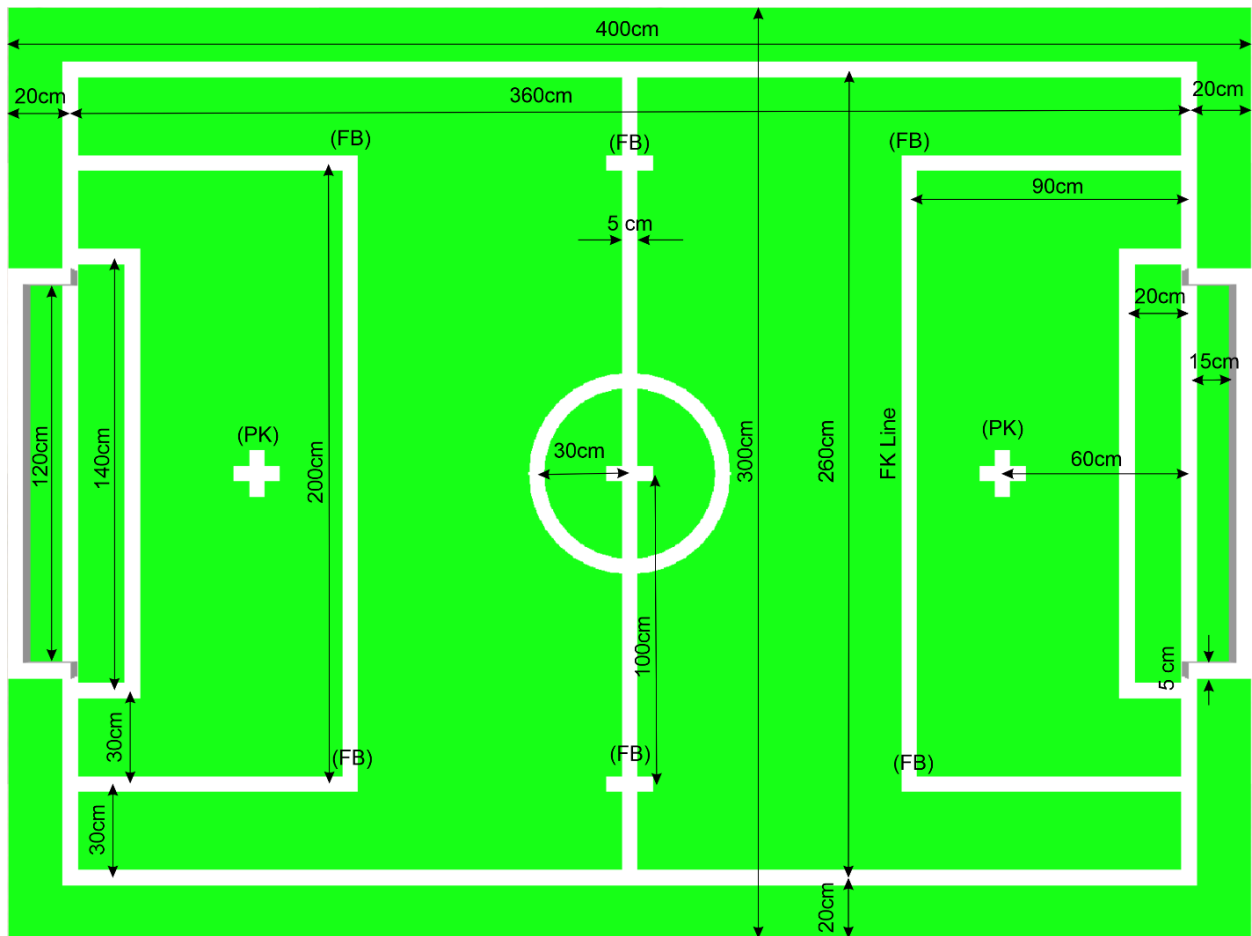
5. The Throw-in

5.1 The Throw-in

- 5.1.1 A throw-in is necessary if the ball leaves the field of play, by fully crossing a side line or a goal line (outside the goal) either on the ground or in the air.
- 5.1.2 Without stopping play, referee or 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.
- 5.1.3 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.
- 5.1.4 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

Restart points are marked with (FB) sign on [Appendix A](#)

Appendix A

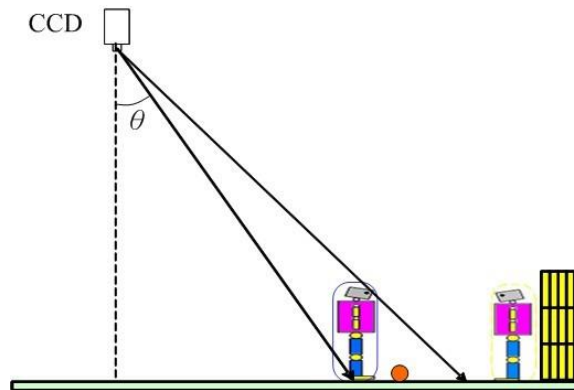


- (1) FB- Free-Ball positions
- (2) PK- Penalty-Kick positions
- (3) FK Line – The free ball/kick position will be placed at the respective position in the line while the foul occurs inside the penalty area

Appendix B

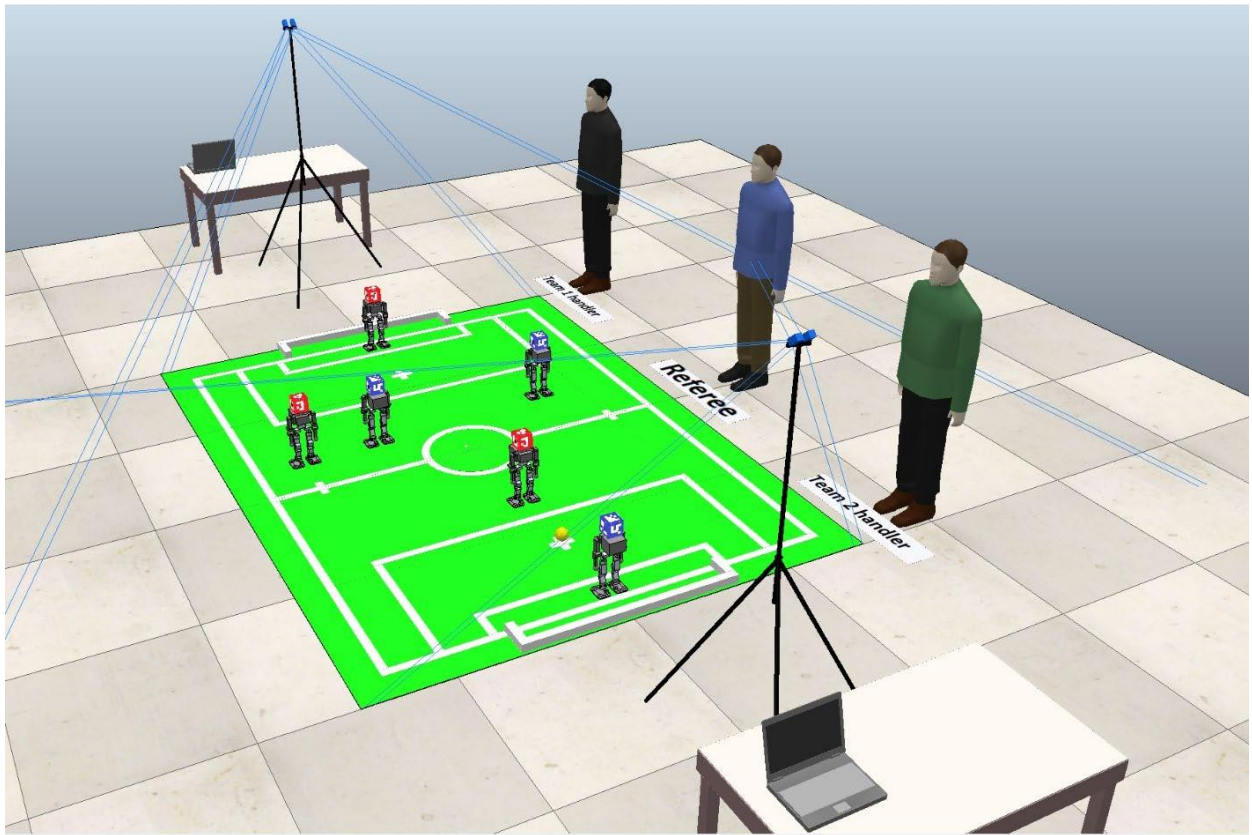


The appearance of the camera Logitech **HD Pro C930** (or Pro C920)



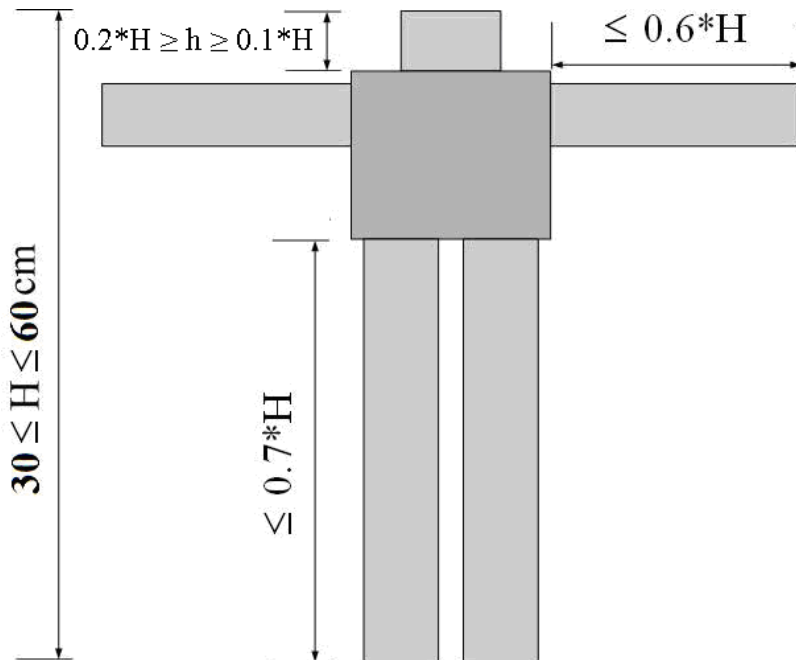
In some case, the above camera cannot find the ball. The goal keeper of each team may possess its own camera.

Appendix C



The 3D view of soccer field.

Appendix D



Appendix E

Free Ball

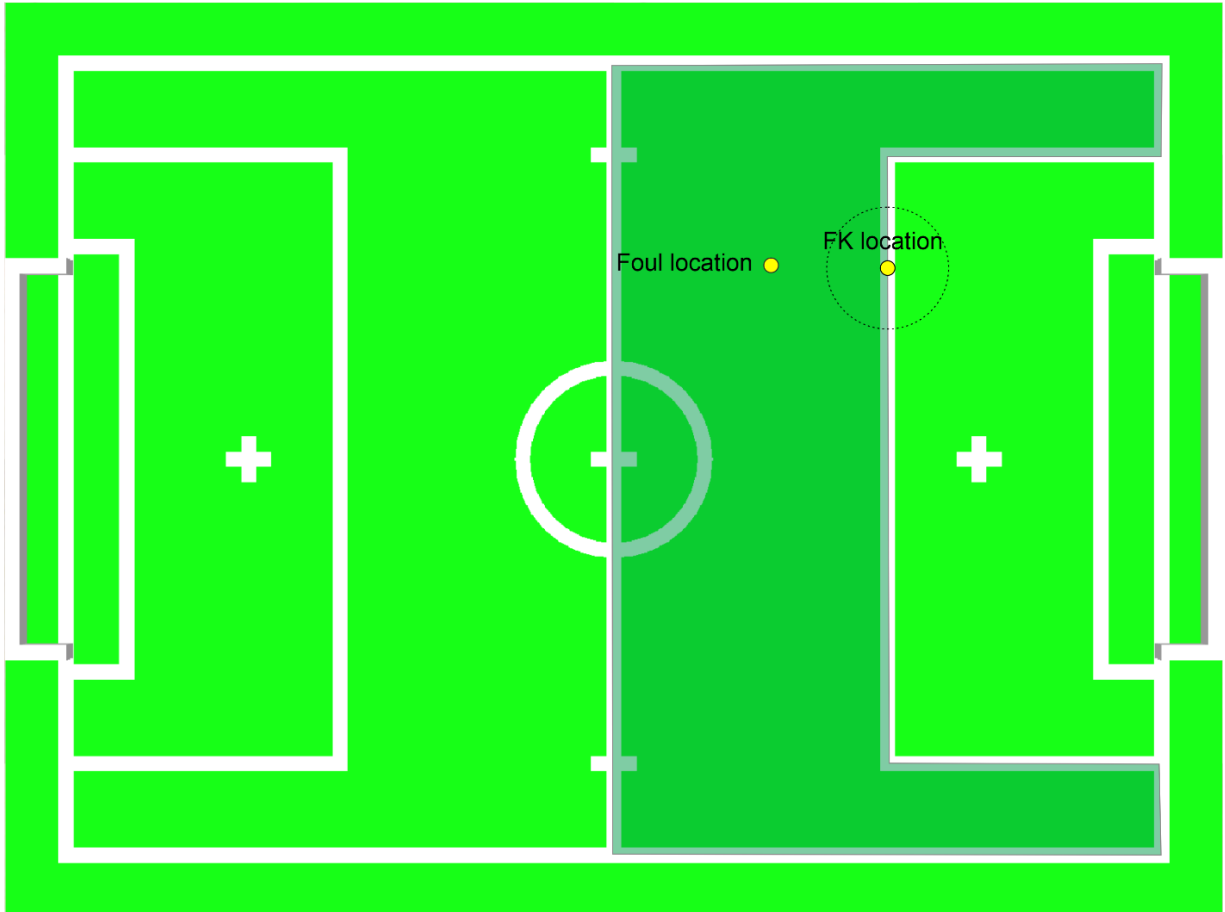


While the free ball is judged, the ball will be assigned at the relevant nearest FB point and both the teams' robots are starting outside the circle of radius 25cm to kick.

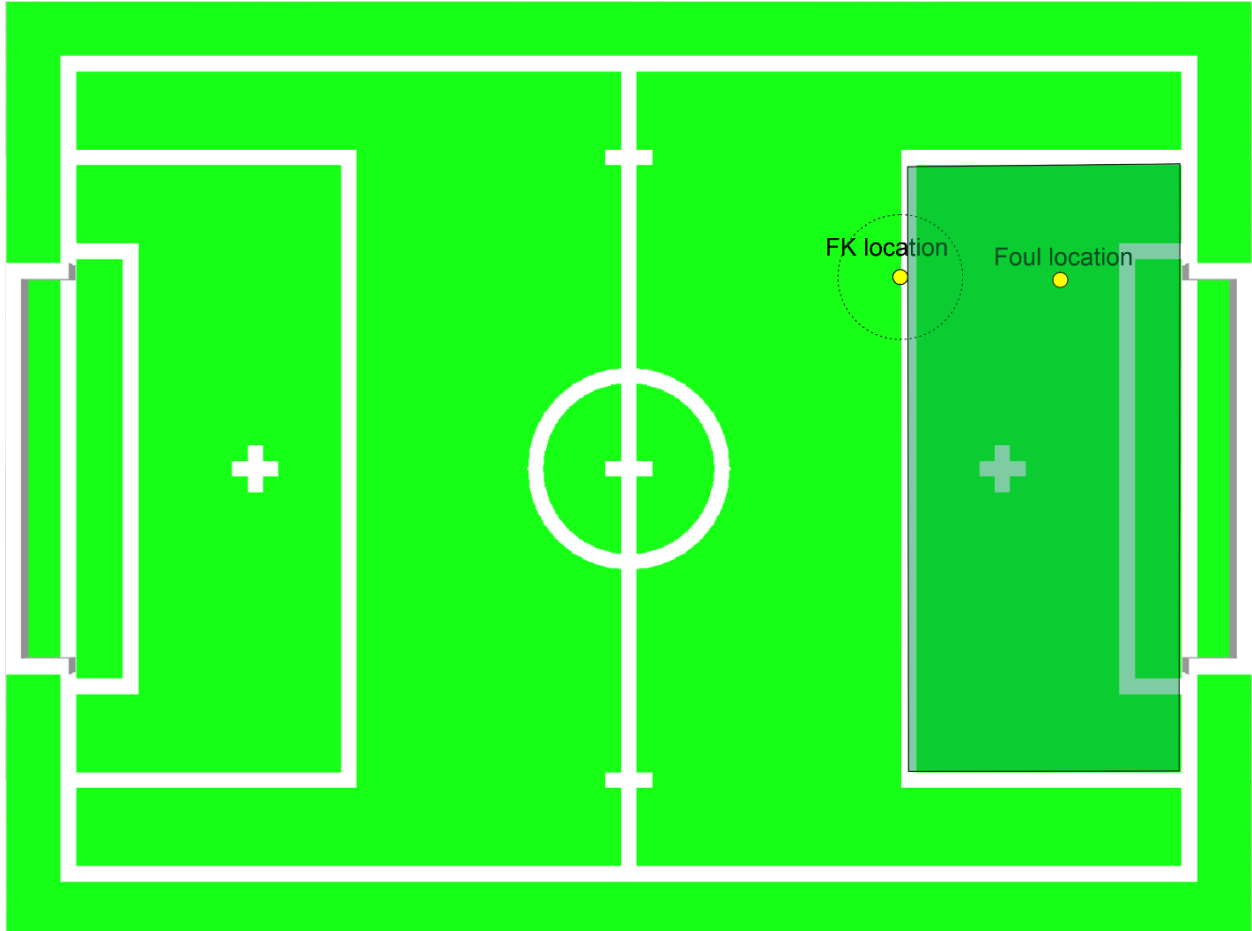
Appendix F

Free Kick (1/2)

Case 1



Case 2



If the free kick is judged whose foul location **inside the penalty area**, then the ball will be assigned on the relevant FK-line point paralleled to the first location and the defense team's robots start outside the circle of radius **25cm** to kick.

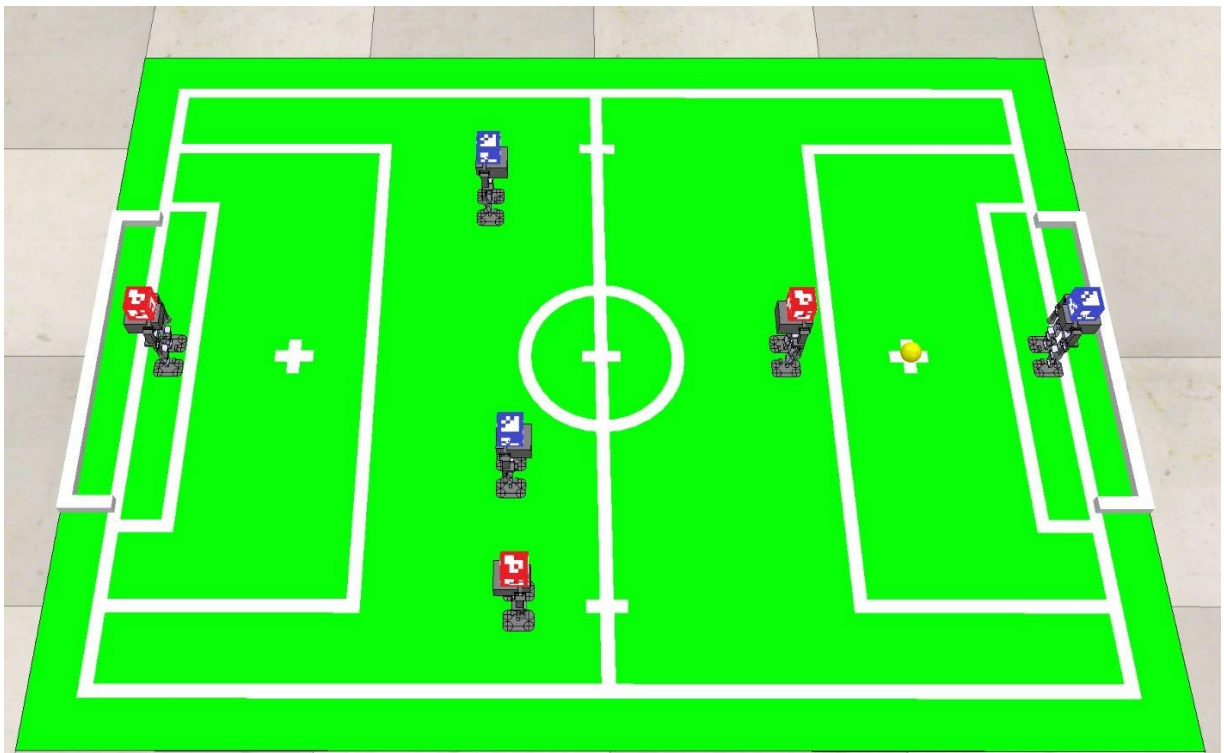
Appendix G

Goal Kick



Appendix H

Penalty Kick



Appendix J

