Rules B

AndroSot (Android Soccer Tournament) Laws of the Game 2025, 18th Malaysia FIRA RoboWorld Cup

Chair

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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. There are two challenge events in FIRA 2024 which are:

1st challenge event – Dribble and Attack

2nd challenge event – Free Kick

The main changes of year 2025:

- 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) New way of marking players with colorized Aruco Cube introduced.
- 3) Scoring of goal is modified to follow FIFA rules (clause 3.3.1)
- 4) Overall robot weight limited to 2.5 kg
- 5) Point of re-entering player to game is modified (clause 3.4.1.b)
- 6) Regulation of height of neck and head is discontinued (clause 2.2.2)
- 7) Regulation of foot size is modified (clause 2.2.2)
- 8) Total score will be multiplied by 2 because of using Rules B.

*: The laws have been modified subject to Leaders and Referees of Malaysia FIRA RoboWorld Cup 2025 meeting at Politeknik Merlimau, Melaka.

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 orange tennis ball will be used as the ball, with $60 \sim 70$ mm in diameter and $56 \sim 59.4$ g 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.
- *1.2.2* The lighting should be diffused and evenly distributed. Flicker free lighting is recommended.
- *1.2.3* 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.
- 1.2.4 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.
- 1.2.5 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 <u>Rule 3.7.3</u> to an off-board computer for processing or can be processed onboard.
- *1.2.6* 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 challenge is played by a team once, each consisting of two robots/one robot in the first/second challenge event respectively.
- 2.1.2 Each team may prepare one more android for substitution.
- *2.1.3* All robots are controlled by off-board computers. (Exception: The goalkeeper used in the 2nd challenge can 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 Each team should make sure that all necessary equipment is close enough to the court.

2.2 The Robot

- 2.2.1 The robot should be a biped android.
- 2.2.2 The height of each robot shall be limited to $30 \le H \le 60$ cm. Each foot must fit into a rectangle of area $0.038 \times H^2$. 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
- 2.2.5 Obstacle Robots:
 - (a) There are 2 obstacle robots placed on the dotted line area (Appendix A-1), in which each robot is placed in different area respectively, during the 1st challenge event. In addition, there is one goalkeeper placed on one of three given positions in the goal area (Appendix A-2) during the 2nd challenge event.
 - (b) The locations of the robots are decided and fixed by the referees for each task. Every team will get the same assignment.
 - (c) After each task, the referees will reassign the positions of the obstacle robots for the next task.
- 2.2.6 Playing Android:
 - (a) The team can only assign the same androids whenever doing every task. However, it is permitted to replace the bench android once for next tasks during a challenge. (as <u>Challenge Rule 2.1.2</u>)
 - (b) The android needs to be controlled by off-board computers and start from the preset position for every task.

2.3 Color marks of players (Appendix E)

- 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 is always blue in AndroSot Challenge games. The color red will be assigned to the obstacle robots during the 1st challenge event.

3 The Game

3.1 Game Duration

- *3.1.1* Each challenge will have 6 tasks in the 1st and the 2nd challenge events respectively. The total duration of each challenge (at most 6 tasks) for a team is 10 minutes.
- 3.1.2 During the same task or section for every team's challenge, all the androids and the systems are disallowed from tuning, modifying, setting up, debugging or changing components.

3.2 Game Commencement and Progress

- 3.2.1 20 minutes before each challenge event every team will get the same assignment.
- 3.2.2 At the start of the game, each team must have proper working robots on the playground as defined in <u>Challenge Rule 2.1.2</u>.
- 3.2.3 During every challenge event, only one bench android is allowed to be substituted for a team. If the team has no proper android to perform challenges, the undone tasks will score zero.
- 3.2.4 At the beginning of each challenge, the referee shall blow a whistle. The robots are disallowed to move before the whistle. If the task is done incorrectly, the task is regarded as failed.
- 3.2.5 When a task has been started and performed, if done without any referee's permission, all operators of the team members are prohibited from touching the mouse or sending any control command into the control systems; besides, sending or causing disturbance signals for the opposing side is also prohibited. If any team has committed such a violation for the first time, the task will be stopped and the score will be zero; for the second time or more, the team will be dropped from the challenge.

3.3 The 1st challenge event – Dribble and Attack task

In the 1st challenge event, each team must assign two androids to challenge the tasks.

- *3.3.1* There are 3 starting points on the field as shown in Appendix A-1. The team can start their tasks **twice** at every point. The total duration of all tasks (the most 6 tasks) is 10 minutes for each team.
- 3.3.2 For each task, the 1st android is placed 15 cm away from the preset ball and facing the goal; the 2nd android is placed at one of the other two ball positions by a draw before the task. However, after the draw, the referee will not at first announce the result. At first, the challenge team needs to run the programs in which it shall add enough idle time (10 seconds or more) in the beginning section, then the referee will announce the result of the draw to prompt the team to place the 2nd android at the set position. Ongoing, the androids will go and kick by off-board computers without other inputs, and the 1st android has to kick the ball after its movement within 20 seconds.

- 3.3.3 The team can repair or test the android or the system but the time still is counted continuously.
- 3.3.4 The team members can decide the order of the 6 tasks by themselves.
- 3.3.5 There is one of the following cases occurred, the task is finished.
 - (a) the ball enters the goal area,
 - (b) the duration of the challenge is over,
 - (c) the android touches any obstacle robot,
 - (d) the ball has passed all the obstacle robots but the 2nd android still hasn't touched the ball,
 - (e) there is no proper android to enter the challenge,
 - (f) any prohibited behavior occurs.
- 3.3.6 The 1st android has to kick or dribble the ball away at least 10 cm from the starting point firstly, and then only the 2nd android is allowed following to dribble, pass, kick and shoot the ball into the goal.
- 3.3.7 The 2nd android can kick, dribble, shoot or do any action if it does not meet <u>*Challenge*</u> <u>*Rule 3.3.5*</u>.
- 3.3.8 If the team does not prohibit <u>Challenge Rule 3.3.6</u> or <u>Challenge Rule 3.3.5(c),(d)</u>, while the ball passes the obstacle robots and/or enters the goal area, the team scores a goal. The referee or assistant records the accomplished time which will be rounded off to the nearest tenth in second.
- 3.3.9 Scoring:

(a) After the 1^{st} and roid kicks and dribbles the ball away at least 10 cm from the starting point and the 2^{nd} and roid then touches the ball, the team will score **10 points**.

(b) After the success of (a), while the ball is kicked by the 2nd Android (only) and passes any obstacle robot, it scores **additional 10 points** for each pass. (**20 points** total at most) It can be noted that the passes are only counted from the location while the 2nd android has caught the ball.

(c) After the successes of (a) and (b), while the ball enters the goal area successfully, it scores **additional 20 points**.

(d) The accomplished time is recorded but no additional point; it is just for counting the total duration.

3.4 The 2nd challenge event – Free Kick task

- 3.4.1 In the 2^{nd} challenge, each team only can assign one android to do the task.
- 3.4.2 There is only one starting area, which is inside the center circle. There are 3 free kick points on the field on which to place the ball, as shown in Appendix A-2.
- 3.4.3 There is an obstacle robot placed at one of the left, the center, or the right sections in front of the goal.
- 3.4.3 The android have <u>2 tasks to shoot the ball from the draw starting point</u> facing the obstacle robot placed at the same section. This means the obstacle robot is fixed and decides on the relevant position of the ball of each task respectively by drawing. A draw will result in two selected positions of the ball from 9 possible combinations such as 11, 12, 13, 21, 22, 23, 31, 32, and 33. If the combination 13 is selected, it means the team will free kick the ball at the 1st position first and then free kick the ball at the 3rd position. However, the result of the draw must be kept on the referee and announced according to <u>Challenge Rule 3.4.4</u>.
- 3.4.4 Before the start, the team places their android within the center circle and draws the position of the ball (not yet announced) first, then run the program (the first 10 seconds or enough duration of the program should be designed as idle). Next, the referee announce the result of the draw to prompt the team to place the ball at the set position, then finally the android go and kick by off-board computers without other inputs. The android has to kick the ball after its movement within 60 seconds. However, in each task, the android is only allowed to kick the ball once.
- 3.4.5 For each task, the off-board program has to wait the ball decision enough time (10 seconds or more). Each team can perform 6 tasks mostly and its total duration is 10 minutes. With the permission of the referee, the team can repair or test the android or the system, but the time still is counted continuously.
- 3.4.6 The team members can decide the order of the three obstacles challenges by themselves.
- 3.4.7 If one of the following cases occurs, a task is finished.
 - (a) the ball stops on the field,
 - (b) the ball enters the goal area,
 - (c) the ball touches the side walls,
 - (d) the duration of all the tasks is over,
 - (e) the android kicks the ball twice or more times,
 - (f) there is no proper android that could enter the challenge,
 - (g) any prohibited behavior occurs.
- 3.4.8 Scoring:

The score of each successful free kick (kick away the ball) is **10 points**. If the ball be kicked in the penalty area which including the penalty line, it is marked as a PA kick and scores **additional 20 points**. Moreover, if the free kick is a goal, it scores **additional 20 points**. This means the total scores of a task are **50 points** mainly. Total score will

be multiplied by 2 because of using Rules B.

For example as tabulated in the *Table 3.4.1*.

Table 3.4.1. The total scores of different cases after 2 tasks facing the left position obstacle Case 1 (the ball pos. are 1,3 by drawing)

Position L (obstacle robot)	Touch ball	PA kick	Goal	Score	Bonus
(ball pos. 1) 1 st Task	O (10)	O(20)	Х	30	60
(ball pos. 3) 2 nd Task	O (10)	O(20)	O(20)	50	100
Total Score of Pos. L		·	÷	80	160
Case	2 (the ball pos. a	re 2,2 by drav	wing)		
Position L (obstacle robot)	Touch ball	PA kick	Goal	Score	Bonus
(ball pos. 2) 1 st Task	O (10)	Х	Х	10	20
(ball pos. 2) 2 nd Task	Х	Х	Х	0	0
Total Score of Pos. R				10	20

3.5 Winning

3.5.1 The Winner:

In each challenge event, there are different objectives for scoring. However, the winner of each challenge event shall be decided by the total score.

3.5.2 In a tie:

If there are two or more teams in a tie by compared with the total score will be resolved as follows:

- (a) In the 1st challenge: The team that accomplishes all the tasks in the shortest time totally will be the winner.
- (b) In the 2nd challenge: The total number of goals is compared which the higher is the winner. If also, the total number of the PA kicks is higher and regarded as the winner. If also, those same score teams get the same rank.

3.6 Interruption

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

- 3.6.1 When a robot falls down and is unable to stand up on its own for more than 20 seconds, or the robots take no action for more than 20 seconds, the referee instructs a team handler to remove the robot(s) and repair it if necessary. A repaired or substituted robot can start the following undone challenges.
- *3.6.2* The duration of each task consists of the total time of repair and substitution and is limited to the lawful game duration in <u>*Challenge Rule 3.1.*</u>.
- 3.6.3 Each team just could only substitute the robot once during every challenge event.
- *3.6.4* If the robot restarts from the beginning area because of a team's request, the score in this task will be reset to zero at the moment. However, in the 2nd challenge event, it is

not allowed to restart a done task.

3.6.5 Teams can only enter the court under the permission of the judge.

3.7 Transmissible Information

- 3.7.1 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.
- 3.7.2 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.
- 3.7.3 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 The 1st challenge event – Dribble and Attack tasks

- 4.1.1 The following actions are disallowed.
 - (a) A robot collides with any obstacle robot, either intentionally or otherwise: the referee will call such fouls that directly end the game.
 - (b) A robot starts before the referee blowing a whistle.
 - (c) The team members enter the court or execute disallowed actions such as touching or remote controlling the androids without the permission of the referees.
- 4.1.2 The following cases are regarded as failures.
 - (a) The 1st android goals directly.
 - (b) The ball enters the goal area because of the touch by robotic hands.
 - (c) To goal occurs after the end of lawful duration.

4.2 The 2nd challenge event – Free Kick tasks

- 4.2.1 The following actions are disallowed.
 - a) The android kick the ball twice or more times.
 - b) The robot starts from the outside of the center circle.
 - c) The robot starts before the referee blowing a whistle.
 - d) The team members enter the court or execute disallowed actions such as touching or remote controlling the androids without the permission of the referees.
- 4.2.2 The following cases are regarded as failure.
 - a) A robot cannot go closer to kick or touch the ball within the limited time in <u>Challenge Rule 3.3.3</u>.
 - b) The ball enters the goal area because of the touch by robotic hands or being reflected off the side walls.
 - c) A goal occurs after the end of lawful duration.

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 A-1



A successful case of a dribble and attack task (with successful catching, passing, dribbling and attacking)

Appendix A-2



There is one of the 3 possible positions of the ball selected by a draw to free kick facing each position of the obstacle robot.

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 E

