

ROBOT SOCCER COMPETITION

INTRODUCTION

The objective of the robot soccer is to build a team of robots to play 5-a-side football against an opponent robot team. Each robot soccer team shall setup a global vision system, which is above the football field, to keep track of their robots and ball positions. A host computer may process the vision information and send the motion commands to soccer robots through radio frequency communication.

1. THE FOOTBALL FIELD AND THE BALL

1.1 Football Field Dimensions

A black (non-reflective) wooden rectangular playground 220cm X 180cm in size with 5cm high and 2.5cm thick white side-walls will be used. The playground is considered flat if a ball placed anywhere on the field does not start to roll. There should be no edges (such as through tape markings or gaps) on the playground. The topsides of the side-walls should be black in color with the interior walls painted in white (side view). Solid 7 cm x 7 cm isosceles triangles are to be fixed at the four corners of the playground to avoid the ball getting cornered. The surface texture of the board should be like a ping pong table. It should provide sufficient grip.

1.2 Markings on the Playground

The field of play shall be marked as shown in Figure 1. The center circle will have a radius of 25cm. All lines and marks should be white in color and 3 mm thick. The arc, will be 25cm along the goal line and 5cm perpendicular to it.

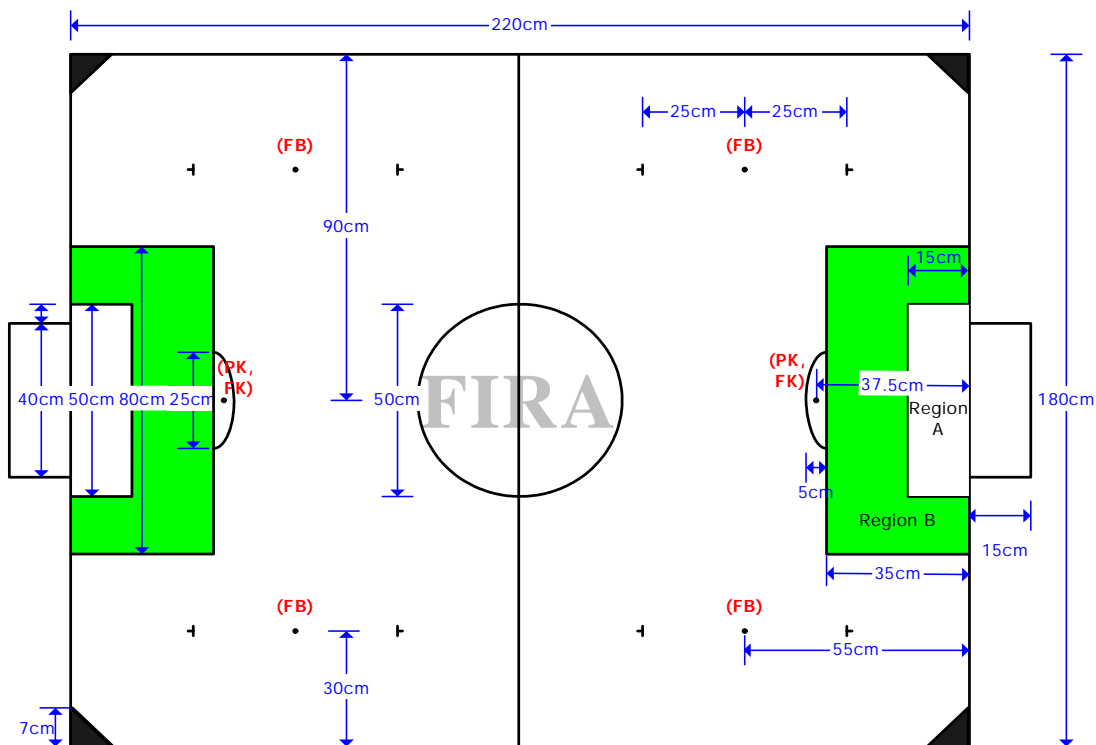


Figure 1: Dimensions and Markings on the Playground

1.3 The Goal

The goal is 40cm wide. There are no posts or nets at the goal.

1.4 The Goal Line and Goal Area

The goal line is the line just in front of the goal which is 40cm long. The goal areas (The region A of Figure 1) shall comprise of the area contained by the rectangle (sized 50cm X 15cm in front of the goal) and the goal itself.

1.5 The Penalty Area

The penalty areas (The region B of Figure 1) shall comprise of areas contained by the rectangle (sized 80cm X 35cm in front of the goal.) The penalty area contains the goal area. The arc is not part of the penalty area.

1.6 The Ball

An orange golf ball shall be used as the ball, with 42.7mm diameter and 46g weight.

1.7 The Field Location

The field shall be located indoors.

1.8 Vision and Lighting

1.8.1 The lighting conditions should be more than 500 Lux anywhere on the playground. The lighting should be diffuse and evenly distributed. A flicker free lighting is recommended.

1.8.2 In order to identify the robots and the ball on the playground, a vision system can be used. Only one camera per team may be used.

1.8.3 The location of a team's camera or sensor system should be restricted to over and above their own half of the field including the center line, so that the camera need not to be moved after the side change at halftime. If both teams wish to keep their cameras over and above the center circle of the playground, they shall be placed side by side, equidistant from the centerline and as close to each other as possible. The location of the overhead camera or sensor system should be at a height of 2.5 m.

2. THE PLAYERS

2.1 The Overall System

A match shall be played by two teams, each consisting of five robots. One of the robots can be the goalkeeper (Section 2.2.5). Three human team members are allowed on stage. Only one designated team member is allowed to access the playground during a game (if instructed so by the referee), except during timeouts and halftime. The whole equipment for a team needed to play should fit on a single 120 cm x 80 cm table.

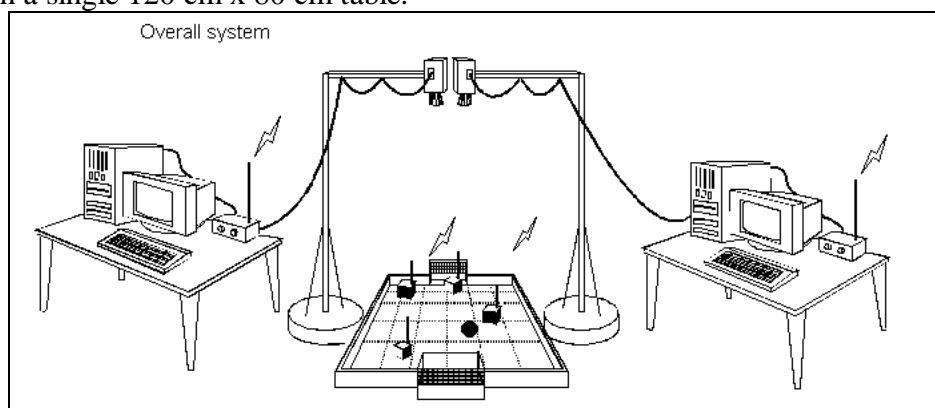


Figure 2: Overall System

2.2 The Robots

- 2.2.1 The size of each robot shall be limited to 7.5cm X 7.5cm X 7.5cm. The height of the RF communication antenna will not be considered in deciding a robot's size. The robots are allowed to equip with arms, legs etc., but they must comply with the size restrictions even with the appendages fully expanded.
- 2.2.2 The robots' weight may not exceed 650 g.
- 2.2.3 To enable infrared sensing a robot's sides should be colored light, except at regions necessarily used for robot functionality, such as those for sensors, wheels or a ball catching mechanism.
- 2.2.2 The topside of a robot must not be colored in orange. A color patch either blue or yellow, as assigned by the organizers, will identify the robots in a team. All the robots must have (at least) a 3.5cm X 3.5cm solid region of their team color patch, blue or yellow, visible on their top. A team's identification color will change from game to game, and the team color patch used should be detachable. When assigned with one of the 2-team colors (blue or yellow), the robots must not have any visible patches of those colors used by an opponent team.
- 2.2.3 The teams are recommended to prepare a minimum of 10 different color patches, other than blue and yellow, for individual robot identification.
- 2.2.4 To enable infrared sensing a robot's sides should be colored light, except at regions necessarily used for robot functionality, such as those for sensors, wheels and the ball catching mechanism. The robots should wear uniforms and the size of which shall be limited to 8cm X 8cm X 8cm.
- 2.2.5 A robot within its own goal area (Section 1.4) shall be considered as the "goalkeeper". The goalkeeper robot shall be allowed to catch or hold the ball only when it is inside its own goal area or penalty area.
- 2.2.6 Each robot must be fully independent, with powering and motoring mechanisms self-contained. Only wireless communication shall be allowed for all kinds of interactions between the host computer and a robot.
- 2.2.7 The robots are allowed to equip with arms, legs, etc., but they must comply with the size restrictions (Section 2.2.1) even after the appendages fully expanded. None of the robots, except the single designated goalkeeper, shall be allowed to catch or hold the ball such that more than 30% of the ball is out of view either from the top or from the sides. (See Figure 3.)

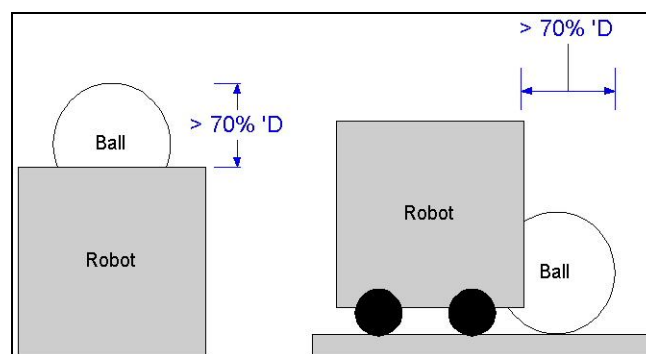


Figure 3: Catching/Holding of Ball

- 2.2.8 While a match is in progress, at any time the referee whistles the human operator should stop all robots using the communication between the robots and the host computer.

2.3 Substitutions

Two substitutes shall be permitted while a game is in progress. At half time, unlimited substitutions can be made. When a substitution is desired while the game is in progress, the

concerned team manager should call 'time-out' to notify the referee, and the referee will stop the game at an appropriate moment. The game will restart, with all the robots and the ball placed at the same positions as they were occupying at the time of interrupting the game.

2.4 Time-out

The human operator can call for 'time-out' to notify the referee. Each team will be entitled for four time-outs in a game and each shall be of 2 minutes duration.

3. TRANSMISSIBLE INFORMATION

The manager, the coach or the trainer may transmit certain commands directly from the remote host computer to their robots. It is not allowed to transmit commands such as reset signals to stop any/all of the robots or restart signals, without the permission from the referee. Any other information, such as game strategy, can be communicated to robots only when a game is not in progress. The human operator should not directly control the motion of their robots either with a joystick or by keyboard commands under any circumstances. While a game is in progress the host computer can send any information autonomously.

4. THE VISION SYSTEM

In order to identify the robots and the ball on the playground, a vision system can be used. The location of a team's camera or sensor system should be restricted to, over and above their own half of the field including the center line, so that the camera need not have to be moved after the side change at halftime. If both teams wish to keep their cameras over and above the center circle of the playground, they shall be placed side by side, equidistant from the centerline and as close to each other as possible. The location of the overhead camera or sensor system should be at a height of 2.5m or higher.

5. GAME DURATION

- 5.1 The duration of a game shall be two equal periods of 5 minutes each, with a half time interval for 10 minutes. An official timekeeper will pause the clock during substitutions, while transporting an injured robot from the field, during time-out and during such situations that deem to be right as per the discretion of the timekeeper.
- 5.2 If a team is not ready to resume the game after the half time, additional 5 minutes shall be allowed. Even after the allowed additional time if such a team is not ready to continue the game, that team will be disqualified from the game.

6. GAME COMMENCEMENT

- 6.1 Before the commencement of a game, either the team color (blue/yellow) or the ball shall be decided by the toss of a coin. The team that wins the toss shall be allowed to choose either their robot's identification color (blue/yellow) or the ball. The team who receives the ball shall be allowed to opt for their carrier frequency band as well.
- 6.2 At the commencement of the game, the attacking team will be allowed to position their robots freely in their own area and within the center circle. Then the defending team can place their robots freely in their own area except within the center circle. With a signal from the referee, the game shall be started and all robots may move freely.
- 6.3 At the beginning of the first and second halves, and after a goal has been scored, the ball should be kept within the center circle and the ball should be kicked or passed towards the team's own side. If this is not done, the kick-off must be repeated. If the kick-off is done incorrectly again, a free-kick will be awarded to the other team.
- 6.4 At the beginning of the game or after a goal has been scored, the game shall be commenced/continued, with the positions of the robots as described in Section 6.2.

6.5 After the half time, the teams have to change their sides.

7. METHOD OF SCORING

7.1 The Winner

A goal shall be scored when the whole of the ball passes over the goal line. The winner of a game shall be decided on the basis of the number of goals scored.

7.2 The Tiebreaker

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

7.2.2 Each team shall take three penalty-kicks, which differs from Section 11 in the following aspects:

- a) only a kicker and a goalkeeper are allowed on the playground, and
- b) the attacking robot may not touch the ball again after the goalkeeper has touched it.

After the referee's whistle, the goalkeeper may come out of the goal area. In case of a tie even after the three-time penalty-kicks, additional penalty-kicks shall be allowed one-by-one, until the winner can be decided. A penalty-kick will be completed, when any one of the following happens:

- (i) the ball has entered and left the goal area, or
- (ii) the goalkeeper catches the ball, or
- (iii) a foul occurs, or
- (iv) ten (10) seconds pass after the referee's whistle, or
- (v) the attacker touches the ball again after the goalkeeper has touched it

8. FOULS

A foul will be called for in the following cases.

8.1 Colliding with a robot of the opposite team, either intentionally or otherwise: the referee will call such fouls that directly affect the play of the game or that appear to have potential to harm the opponent robot. When a defender robot intentionally pushes an opponent robot, a free kick will be given to the opposite team. It is permitted to push the ball and an opponent player backwards provided the pushing player is always in contact with the ball.

8.2 It is permitted to push the goalkeeper robot in the goal area, if the ball is between the pushing robot and the goalkeeper. However pushing the goalkeeper into the goal along with the ball is not allowed. If an attacking robot pushes the goalkeeper along with the ball into the goal or when the opponent robot pushes the goalkeeper directly then the referee shall call goal kick as goalkeeper charging.

8.3 Attacking with more than one robot in the goal area of the opposite team shall be penalized by a goal kick to be taken by the team of the goalkeeper. A robot is considered to be in the goal area if it is more than 50% inside, as judged by the referee.

8.4 Defending with more than one robot in the goal area shall be penalized by a penalty-kick. (A robot is considered to be in the goal area if it is more than 50% inside, as judged by the referee.) An exception to this is the situation when the additional robot in the goal area 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 when the additional robot in the goal area 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.

- 8.5 It is referred to as handling, as judged by the referee, when a robot other than the goalkeeper catches the ball. It is also considered as handling, if a robot firmly attaches itself to the ball such a way that no other robot is allowed to manipulate the ball.
- 8.6 The goalkeeper robot should kick out the ball from its goal area (defined in Section 1.4) within 10 seconds. The failure to do so will be penalized by giving a penalty kick to the opposite team.
- 8.7 Giving a goal kick to the team of the goalkeeper will penalize the intentional blocking of a goalkeeper in its goal area.
- 8.8 Only the referee and one of the human members of a team (manager, coach or trainer) shall be allowed to touch the robots. The award of a penalty-kick shall penalize touching the robots without the referee's permission.
- 8.9 A penalty kick is awarded against a team whenever three robots of the opponent team are all together staying inside the penalty area while the ball is in play. (Only the robot whose 50% or more of the body enters the penalty area should be considered as staying inside the penalty area). In case a robot crosses through its own penalty area without intension of defense, this robot shall not be considered as staying inside the penalty area

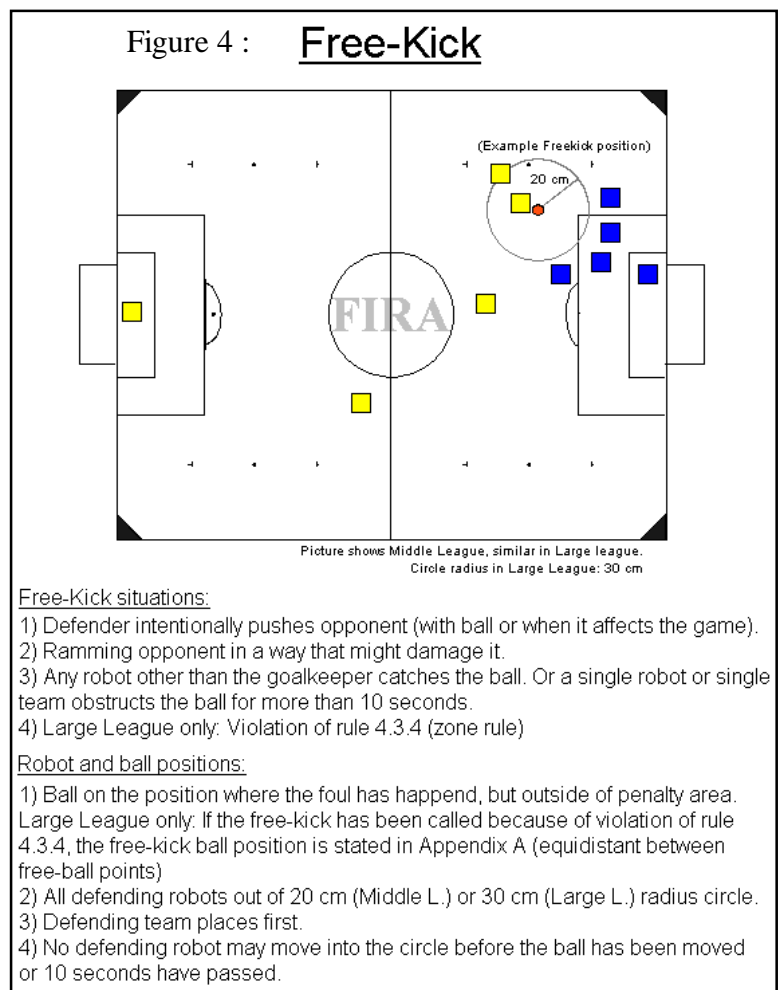
9. PLAY INTERRUPTIONS

The play shall be interrupted and relocation of robots shall be done by a human operator, only when:

- 9.1 A robot has to be changed.
- 9.2 A robot has fallen in such a way as to block the goal.
- 9.3 A goal is scored or a foul occurs.
- 9.4 Referee calls goal kick (Section 12) or free-ball (Section 13).

10. FREE KICK (SEE FIGURE 4)

When a defender robot intentionally pushes an opponent robot, a free kick will be given to the opposite team (Sec 8.1). The ball will be placed at the relevant free kick position (FK) on the playground (Figure 1). The robot taking the kick shall be placed behind the ball. The attacking team can position its robots freely within



its own side. The two defending robots are allowed to be placed at the leftmost and rightmost sides in touch with the front goal area line. With the referee's whistle all robots can start moving freely.

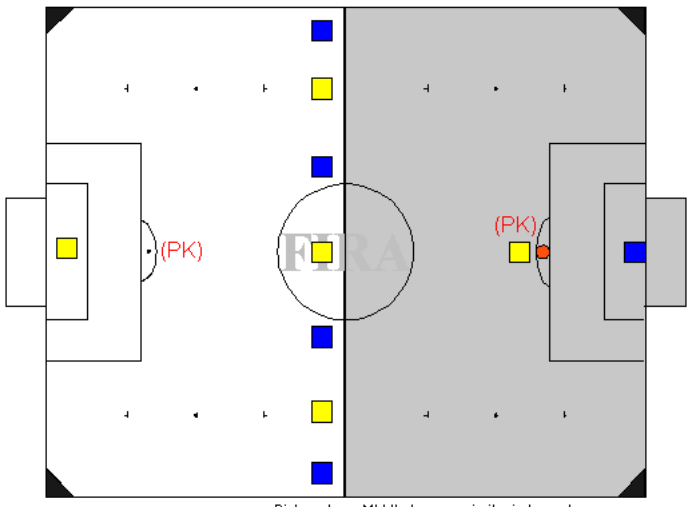
11. PENALTY KICK (SEE FIGURE 5)

11.1 A penalty-kick will be called under the following situations:

- 11.1.1 Defending with more than 1 robot in goal area (Sec. 8.4.)
- 11.1.2 Failure on the part of a goalkeeper to kick out the ball from its goal area within 10 seconds (Sec. 8.6.)
- 11.1.3 When any one of the human members touches the robots without the referee's permission, while the game is in progress (Sec. 8.8.)
- 11.1.4 Three robots of one team stay inside their own penalty area.(see Section 8.9).

11.2 When the referee calls a penalty-kick, the ball will be placed at the relevant penalty kick position (PK) on the playground (Figure 1). The robot taking the kick shall be placed behind the ball. While facing a penalty kick one of the sides of the goalkeeper must be in touch with the goal line. The goalkeeper's main axis of movement (if applicable) must be parallel to the goal line. Other robots shall be placed freely within the other side of the half-line, but the attacking team will get preference in positioning their robots. After the referee's whistle only the robot performing the penalty may move. All other robots may only move after the ball has been moved or 10 seconds have passed. The robot taking the penalty-kick may kick or dribble the ball.

Figure 5 : Penalty-Kick



Picture shows Middle League, similar in Large League

Penalty-Kick situations:

- 1) Defending with more than one robot in the goal area (except if it's not defending or does not affect the play).
- 2) Goalkeeper does not kick the ball out of his goal area within 10 seconds (except if stalemated by the other team).
- 3) A human operator touches a robot without the referee's permission outside timeout and halftime.
- 4) If any robot other than the goalkeeper attaches itself to the ball ("Handling").
- 5) More than three (Middle League) or more than four (Large league) robots of the defending team in the penalty area (including the goal area).

Robot and ball positions:

- 1) Ball on the penalty-kick position (PK), see Appendix A.
- 2) Robot taking the kick behind the ball.
- 3) Defending goalkeeper must touch goal line, main axis of movement parallel to goal line (if applicable).
- 4) All robots besides kicker and goalkeeper in other half. Defending team positions first. Large League only: Rule 4.3.4 (Zone rule) does not apply.
- 5) After the referee's whistle, kicker moves first. All other robots move after the ball has moved or 10 seconds have passed.
- 6) Large League only: If the game resumes normally (i.e. not an immediate goal), rule 4.3.4 resumes effect and the robots must strive to comply with it.

12. GOAL KICK (FIGURE 6)

12.1 A goal kick will be called under the following situations:

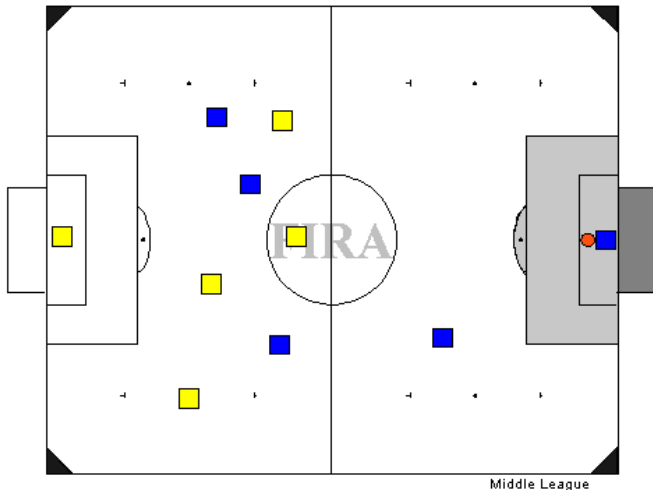
- 12.1.1 When an attacking robot pushes the goalkeeper in its goal area, the referee shall call goal kick as goal-keeper charging (section 8.2.)
- 12.1.2 Attacking with more than one robot in the goal area of the opposite team shall be penalized by a goal kick to be taken by the opposite team (section 8.3.)

12.1.3 When an opponent robot intentionally blocks the goalkeeper in its goal area (section 8.7.)

12.1.4 When the goalkeeper catches the ball with its appendages (if any) in its own goal area.

12.1.5 When a stale-mate occurs in the goal area for 10 seconds.

Figure 6 : Goal-Kick



Goal-Kick situations:

- 1) Touching or directly or indirectly blocking or pushing the goalkeeper.
- 2) Attacking with more than one robot in the opposite goal area.
- 3) Attacking with more than three (Middle League) or more than four (Large League) robots in the opposite penalty area (contains goal area).
- 4) Goalkeeper catches the ball with its appendages (if any) in its own penalty area.

Robot and ball positions:

- 1) The ball can be placed anywhere in the goal area.
 - 2) Only the goalkeeper is allowed in the goal area.
- Middle League:
- 3) Defending team positions first, within their own half
 - 4) Attacking team places their robots anywhere on the field.

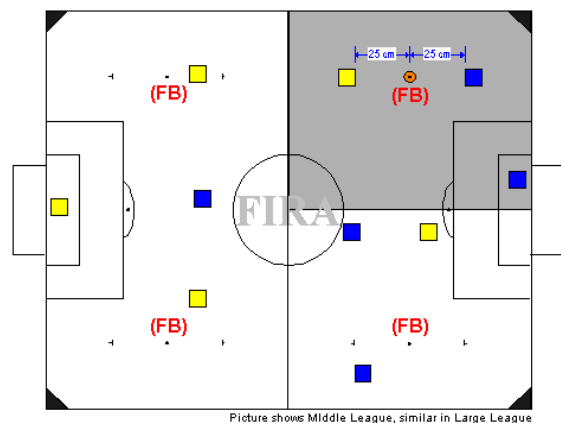
12.2 During goal kick only the goalkeeper will be allowed within the goal area and the ball can be placed any-where within the goal area. Other robots of the team shall be placed out-side the goal area during goal kick. The attacking team will get preference in position-ing their robots any-where on the play-ground, but it must be as per Section 8.3. The defending team can then place its robots within their own side of the play-ground. The game shall restart with the referee's whistle.

13. FREE BALL (SEE FIGURE 7)

13.1 Referee will call a free-ball when a stalemate occurs for 10 seconds outside the goal area.

13.2 When a free-ball is called within any quarter of the playground, the ball will be placed at the relevant free ball position (FB) (Figure 1). One robot per team will be placed at locations 25cm apart from the ball position in the longi-tudinal direction of the playground. Other robots (of both teams) can be placed freely outside the quarter where the free-ball is being called, but with the rule that, the defending team will get their preference in position-ing their robots. The game shall resume when the referee gives the signal and all robots may then move freely.

Figure 7 : Free-Ball



Free-Ball situations:

- 1) Colliding with a robot of the opposite team if it affects the play (Free-Ball on the side of the offending team.)
- 2) Stalemates outside of goal area for 10 seconds with no or two or more robots of different teams involved.

Robot and ball positions:

- 1) Ball on the appropriate Free-Ball position (FB).
- 2) Robots on the appropriate Free-Ball robot positions. 25 cm (Middle League) or 30 cm (Large League) apart horizontally, defending team towards their goal.
- 3) All other robots can be placed freely outside of the Free-Ball quarter, the goalkeepers may be placed anywhere in the goalarea. The defending team will position first.