Singapore Robotic Games 2004

18 – 20 MAY 2004

RULE BOOK

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SRG Home Page : *http://guppy.mpe.nus.edu.sg/srg*
Rules in the SRG Home Page will be used eventually in the Games.

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OPEN CATEGORY

1. OBJECTIVE

The contestants are to demonstrate a robot that performs interesting tasks for applications such as in entertainment, domestic chores, industry etc.

2. BRIEF DESCRIPTION

2.1 The competing robots, which can be self-navigating or remote-controlled, will perform their capability on a 5m x 5m contest arena for a period of time.

2.2 The robots may move freely around the arena or be in a static position.

3. RULES AND GUIDELINES

3.1 The competing robots can start from any point in the contest arena.

3.2 A total duration of up to 10mins is allocated for setting up the robot and any accessory equipment and demonstration of its capability. The time duration will be measured from the moment the contestants enter the arena. If more than 10 minutes elapsed, the robot must be removed from the arena.

3.3 In the case where the contestants wish to employ radio control, they should inform the secretariat in advance. Contestants should not broadcast radio signals while another contestant's robot is performing.

3.4 In the case that a robot requires special accessory equipment or tools during its performance, the contestants will provide such items.

3.5 In the case that a robot performance is to be accompanied by music, the contestants should provide the means to reproduce this music.

3.6 There is no specific flooring material of the contest arena. The flooring will very much depend on the available contest site. However, if there is a special requirement such as carpet, the contestants will have to provide for it.

3.7 One power point of 220/230V, 50 Hz supply will be made available. However, the teams are to provide their own power adapter and extension means if it is required.

3.8 For air supply, the contestants are to provide their own air compressor units if necessary.

3.9 The designs of the competing robots must be original and unique. No two identical designs are allowed in the competition.

3.10 The expenses incurred in transportation and setup of equipment is to be borne by the individual teams.

3.11 The boundary for the area will be black or white depending on the floor.

3.12 Winning robots will not be allowed to participate in the subsequent two Robotics Games.

3.13 Robots that can, in principle, compete in other SRG events (e.g. Pole Balancing Robot competition) should not be allowed to compete in the open category event.

4. JUDGES

4.1 A panel of 3 or 5 judges will be present to judge the event.

4.2 All judges will be external judges except for the chief judge.

5. JUDGING CRITERIA

Degree of Innovation		20%
Design & Realisation		20%
Performance		30%
Content		30%
Choice of	Entertainment or Applications or Theme – Home Security	

6. EXHIBITION

6.1 All entries will be allocated exhibition space where the robots will remain throughout the day. Contestants are to man the exhibits at all times and should be available to answer questions from judges and members of the public.

6.2 Prize winners will only be announced at the end of the day of the competition.

6.3 Judges decision is final.

LEGGED ROBOT OBSTACLE RACE

1. OBJECTIVE

To design a Legged Robot to travel on a designated track by either walking, running or hopping.

2. SPECIFICATIONS OF ROBOT

2.1 The robot must have at least one leg. There is no limit to maximum number of legs used. The maximum length and maximum width of the robot is restricted to a **0.75 m x 0.75 m** square area in the starting zone. There is no height restriction on the robot. There is no restriction on the dimension and geometry of the robot once it started each race attempt (i.e., once any part of the robot crosses the starting line.)

2.2 The robots must be completely autonomous. It should contain both the controller and power units. The robot must not weigh more than 10 kg.

2.3 Radio-frequency (RF) control is strictly prohibited in the robot design except for start/stop operation of the robot (i.e., remote push button to start and stop the operation of the robot.)

2.4 Each leg of the robot must consist of minimum two limb segments and demonstrate relative motion between the limbs to realise a walking motion.

2.5 The limbs of the robot must include some means of controlled motion to realise the walking, running, and/or hopping action for the robot. The following are some examples NOT considered as a legged robot:

- Rotating wheel with spokes or any other structure sticking out radially to represent 'feet'.
- Traction belt with studs or roller chain with ‘feet’ mounted in any orientation.
- Robot, with feet or any floor contact point, mounted with motion-assisted roller wheel(s) is strictly prohibited.

2.6 Locus for every feet of the robot cannot be higher than its associated pivoting joint.

2.7 The robot **CAN ONLY** use its legs for the locomotion and negotiating the obstacles. There should not be any other parts of the robot sliding along any part of the race track.

3. SPECIFICATIONS OF RACE TRACK

3.1 The race-track is a raised platform of a fixed width of 1 m and a maximum length of approximately **10 m** (not inclusive of starting zone and finishing zone.) It comprises of straight and circular sections connected together to make up the entire length. The circular section consists of a one-eighth circular path (45-degree sector) with radius of 1m (with respect to the longitudinal centerline of the path). The straight segment consists of 1 m straight paths. There will be a 1 m **Starting Zone** and a 1 m **Finishing Zone** at the start and the end of the race-track. As an example, Fig.1 shows a top view of a competition race-track. It consists of 4 straight segments (A) (excluding the Starting and Finishing Zones) and 8 circular segments (B). The segments are at different elevations of 50 mm or 100 mm off the ground.

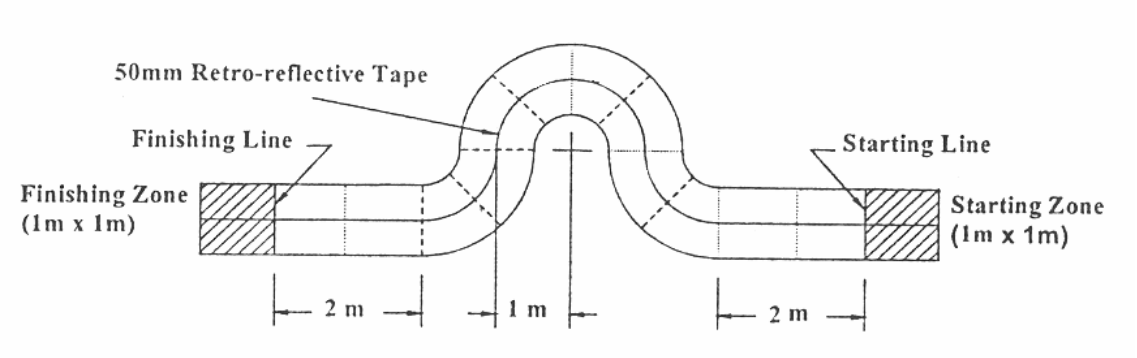


Fig.1 - Sample Legged Robot Race Track

3.2 The track is constructed with 1/4-inch plywood with circular and/or straight sections raised about at either **50 mm** or **100 mm** off the ground. It will be lined with 3 mm thick black rubber mat. It is designed to support a robot with a maximum weight of 10 kg. Each section of the track is not expected to be perfectly level and it may be uneven. Track sections at the same elevation are joined with a maximum step at the joints of 5 mm. There is a **50 mm** wide retro-reflective tape (3M Scotchlite - Industrial Grade) in the middle of the track for navigation purpose.

3.3 There is also a special section of the track that is a 5-step staircase, i.e. 5 steps up and 5 steps down as shown in Figure 2. The staircase section will only be placed between two low straight sections.

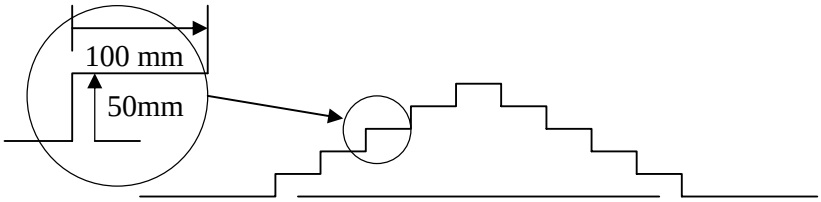


Fig.2 – Cross-Section of Staircase Section.

4. RULES OF COMPETITION

4.1 The robot will be "caged" at 15 minutes before the start of the competition. (This includes approved electronic spare parts and spare power unit. Mechanical spare parts are not required for the "caging" exercise.) Once the competition starts, no individual is allowed to access the robots in the "caging" area.

4.2 The robot is to start from a stationary position before the starting line in the Starting Zone. It has to travel along the designated track either by walking, running or hopping, or any other motion not identified as wheeled motion. A valid **Record Time** is measured from the instance any part of the robot crosses the starting line to the moment when any part of the robot crosses the finishing line. No parts of the robot are to be left behind in the race-track.

4.3 The robot must keep within the designated track during the race. The result is void if any part of the robot completely touches the ground or the robot fell off the track.

4.4 Each robot is given **4** minutes **Competition Time** to produce its best result (this includes setup time.) The Team may withdrawn temporarily within the 1st minute of competition and all successful run during the 1st minute (before they withdrew) will be void. In this case, they will then re-start their entry at a later time, but will be given only **3** minutes competition time to produce its best result.

4.5 Winning is based on the shortest time to complete the FULL competition track.

4.6 The robot must stop and stay on the track after reaching the finishing line.

4.7 Modification of robot during competition is STRICTLY PROHIBITED. No extra parts are to be added to or removed from the robot once the competition time starts. On the other hand, the robot is allowed to change identical mechanical spare parts, electronic components (except for the control and memory unit) and power unit.

4.8 During the competition, chassis of each robot are not allowed to be modified and used by different controllers; likewise, individual controller is not allow to be fitted on different chassis to represent different entries.

4.9 All robots should be returned to the caging area or a designated location after its run. The teams are not allowed to take back their robots before the whole competition is concluded.

5. CLONING

5.1 In accordance with the spirit of the competition, clones among the winning entries will only be awarded one prize. Clones will be identified during the "caging" procedure.

5.2 Clones are robots with substantially identical physical appearance and walking mechanism. Scaling of the same mechanism is considered as cloning. Robots with the same mechanism but different driving principles will not be considered as clones.

5.3 When in doubt, the decision of the Judges will be final.

LEGGED ROBOT MARATHON RACE

1. OBJECTIVE

To design a Legged Robot to travel on a designated track by either walking, running or hopping on a flat terrain for a total distance of approximately 23.56 metres.

2. SPECIFICATIONS OF ROBOT

2.1 The robot must have at least one leg. There is no limit to maximum number of legs used. The maximum length and maximum width of the robot is restricted to a 0.6m x 0.6m square area in the starting zone. There is no height restriction on the robot. There is no restriction on the dimension and geometry of the robot once it started each race attempt (ie: once any part of the robot crosses the starting line.)

2.2 The robots must be completely autonomous. It should contain both the controller and power units. The robot must not weigh more than 10 kg.

2.3 Radio-frequency (RF) control is strictly prohibited in the robot design except for start/stop operation of the robot (i.e., remote push button to start and stop the operation of the robot.)

2.4 Each leg of the robot must consist of minimum two limb segments and demonstrate relative motion between the limbs to realise a walking motion.

2.5 The limbs of the robot must include some means of controlled motion to realise the walking, running, and/or hopping action for the robot. The following are some examples NOT considered as a legged robot:

- Rotating wheel with spokes or any other structure sticking out radially to represent 'feet'.
- Traction belt with studs or roller chain with ‘feet’ mounted in any orientation.
- Robot, with feet or any floor contact point, mounted with motion-assisted roller wheel(s) is strictly prohibited

2.6 Locus for every feet of the robot cannot be higher than its associated pivoting joint.

3. SPECIFICATIONS OF RACE TRACK

3.1 The race-track is a raised platform of a fixed width of approximately 1.2m wide divide into 2 equal width (approximately 0.6m) path and is approximately 23.56m in length. There will be poles of approximate diameter 10mm and height 50mm running along the entire track at about 0.2m interval.

3.2 The track comprises of straight and circular sections connected together. The circular sections consist of a circle quadrant of radius (with reference to the retro-reflective tape) 0.5m or 0.8 m (depending on inner or outer path on the track) with respect to the longitudinal centreline of the path. There is designated Start Zone and Finish Zone on the track.

3.3 The entire track is constructed with 1/4-inch plywood with circular and/or straight sections raised about 50 mm off the ground (if 50 mm track is not available, the entire track will use 100 mm height). It will be lined with 3 mm thick black rubber mat. It is

designed to support a robot with a maximum weight of 10 kg. The joint between 2 track sections is **NOT** expected to be perfectly level and it may be uneven. Track sections at the same elevation are joined with a maximum step at the joints of 5 millimetres. There is a 50 millimetres wide retro-reflective tape (3M Scotchlite - Industrial Grade) in the middle of each path for navigation purpose.

Figure 1 shows a top view of the actual competition race-track which consists of a 11 straight segments and 10 circular segments forming a total close loop distance of 23.56 metres

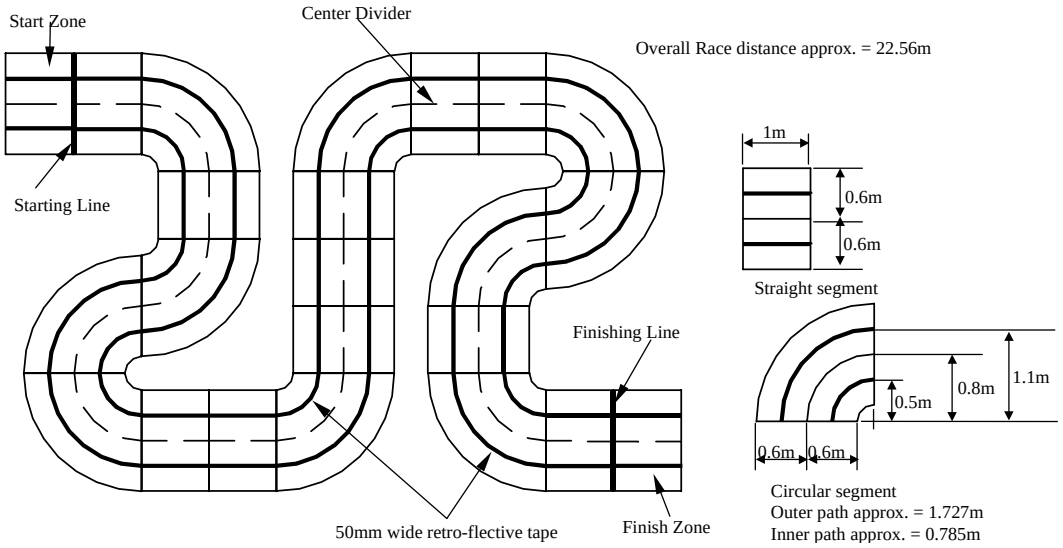


Fig. 1 The Legged Robot Race Track

4. FORMAT OF COMPETITION

4.1 There will be 2 phases in the competition:

a) The Preliminary Matches

b) The Knock-out Championship Matches

4.2 <u>The Preliminary Matches</u>

All robot entries will be randomly paired by drawing of lots. The odd number robot will run by its own. Every match will consist of 3 races. 2 robots competing in the race will be timed.

All the timing will be tabulated to determine the top 8 ranking for the next round of matches. If there are clones among the top 8 ranking, only the best clone will advance to the next round and the lower rank will be moved up.

The top 8 ranking will proceed to the Knock-out Championship Matches using Table of 8. (Note: If the total number of entries exceeded 30, table of 16 will be used to include more robots)

4.3 The Knock-out Championship Matches

The Table of 8 shown in Fig. 2 will be used. The pairing or opponents will go according to the ranking during the Preliminary Matches. Figure 2 shows the competition matches in a Table of 8.

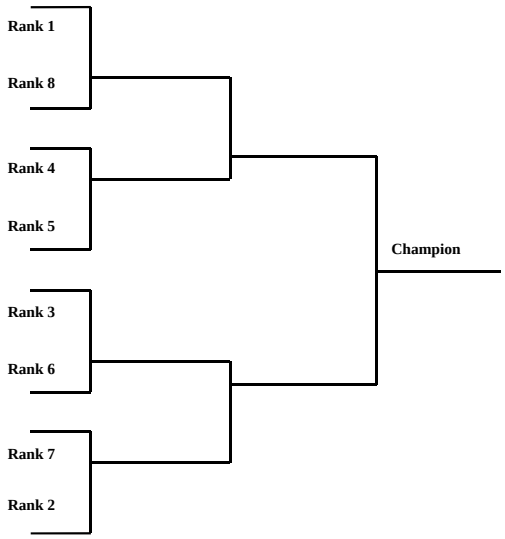


Fig. 2. Table of 8

Each Match consists of 3 races. The winner of each match is decided by number of winning races. 4 Winners of quarterfinal round will proceed to semi-final round after which 2 winners of semi-final round will proceed to the Championship round. The Champion is again decided by number of winning races.

5 RULES OF COMPETITION

5.1 Robot will be "caged" at least 30 minutes before the start of the competition. The caged robot should be the full robot **PLUS** all necessary power units of the same rate capacity. Once the competition starts, no individual is allowed to access the robots in the "caging" area.

5.2 Robot is to start from a stationary position before the Starting Line at the Start Zone. It has to travel along the designated track either by walking, running or hopping, or any other motion not identified as wheeled motion. The robot must stop after reaching the finishing line and remain on the platform. **Two** robots will be racing at any one time and the sequence will be determined by drawing of lots. The robot has to complete the entire competition race-track for each race.

5.3 Robot must keep within the designated track during the race. The result is void if

a) any part of the robot completely touches the ground or the robot falls off the track before fully crosses the Finishing line. Or

b) any part of the robot crosses the central divider.

If any of the above situations occurs, the participant, under instruction from the judge, must remove their robot immediately without disturbing the other robot in the same race.

5.4 The race and race time both starts by the blow of a whistle. In the **Preliminary Matches**, a valid **Recorded Time** is measured from the time then the whistle is blown until the moment when any part of the robot crosses the demarcation line at the Finish Zone. Any robot moved before the whistle is blown will be considered a **False Start**. All robots shall only be given 1 False Start warning and subsequent False Start will imply the robot has lost the race.

5.5 No parts of the robot are to be left behind on the race-track. Winning is based on the best time of a completed race for each robot. If the robot failed to achieve any single complete run, it shall be retired from the competition.

5.6 During the competition, If the robot, under any circumstance, does not demonstrates any positive action to start or complete the race (eg: always crash or run out of track for no apparent reason) may be asked to retire by the discretion of the judges while the other robot still carry on the competition on its own.

5.7 Once the robot has started its race, the robot handler can only access the robot after it crosses the Finishing Line or the robot runs out of the track completely.

5.8 Modification of robot during competition is STRICTLY PROHIBITED. No extra parts are to be added to or removed from the robot once the competition time starts. Every robot must have their individual parts and no sharing is allowed.

5.9 A 15-minute Servicing Time is allocated between the preliminary rounds and the championship matches. Only replacement of the power unit and identical parts are allowed during the Servicing Time.

5.10 All robots should be returned to the caging area or a designated location after its run. The teams are not allowed to take back their robots before the whole competition is concluded.

6. CLONING

6.1 Clones will only be awarded one prize. Clones will be identified during the "caging" procedure.

6.2 Clones are robots with substantially identical physical appearance and walking mechanism. Scaling of the same mechanism is considered as cloning.

6.3 When in doubt, the decision of the Judges will be final.

WALL CLIMBING ROBOT RACE

1. OBJECTIVE

The aim of this event is for mobile robots to demonstrate their horizontal and vertical surface climbing abilities during a race.

2. THE COMPETITION ENVIRONMENT

2.1 The wall is shown in Figure 1 below. It consists of three sections: a 2 metre long horizontal section (section A) on the ground followed by a 2 metre high vertical section (section B) followed by a 2 metre long horizontal section (section C) at the top, with each section at least 0.8 metres wide (the organiser reserves the right to provide wall sections that are wider than 0.8 m).

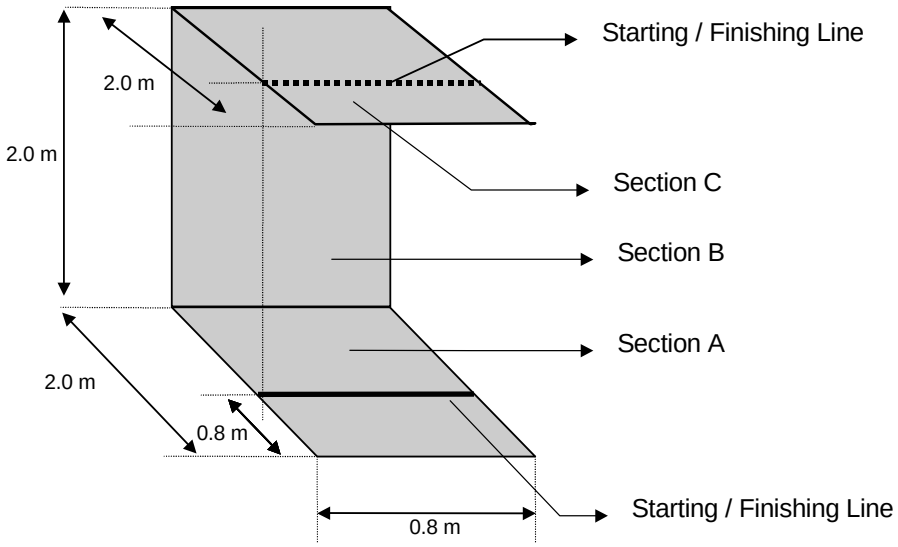


Figure 1: The wall for the wall-climbing robot race

2.2 The surface of the wall will be covered with mild steel sections with a thickness of at least 0.003 metres. The wall will have a matt black surface finish.

2.3 Starting / finishing lines will be located 0.8 metres from the beginning of the horizontal section on the ground (section A) and 0.8 metres from the end of the top horizontal section (section C). The line in section A will be used to demarcate the maximum size of the robot.

2.4 The supporting structure for the wall will have provision for *two* safety cables to be attached to the robot so that both cables can be used simultaneously during the race (*not* shown in Figure 1.)

2.5 The wall sections A and B will each have one obstacle consisting of a horizontal bar made of non-magnetic material (not shown) with 0.03 m X 0.03 m square cross-section will be placed laterally across the entire width the section. Both of these obstacles will be placed such that one of its sides is touching the wall section. Both of these obstacles will have reflective tape fully covering the exposed sides of the obstacle. The obstacle across wall section A will be placed randomly such that it is at least 0.5 m away from the

edge where it meets the next wall section (wall section B) and also at least 1.0 m from the opposite edge. The obstacle across section B will be placed randomly such that it is at least 1.0 m from the edge that meets the lower wall section (wall section A) and at least 0.5 m from the edge that meets the upper wall section (wall section C).

2.6 The wall structure will be constructed such that it conforms to the following:

(a) the length of each wall section should be 2000 mm ± 5 mm.

(b) the angle formed between two adjacent wall sections should be 90° ± 0.5°.

The wall will be deemed to have satisfied criteria (a) and (b) above and be considered fit for use if each of the two distances between diagonally opposite corners (using the side view in Figure 1) lies in the range 2733 mm to 2847 mm.

3. THE COMPETITION

3.1 Robots will start from a stationary position with the front-most part of the robot lying within a 0.05 m deep starting zone demarcated by the inner edges of the two lines positioned across wall section A on the ground. (see Figure 2 below)

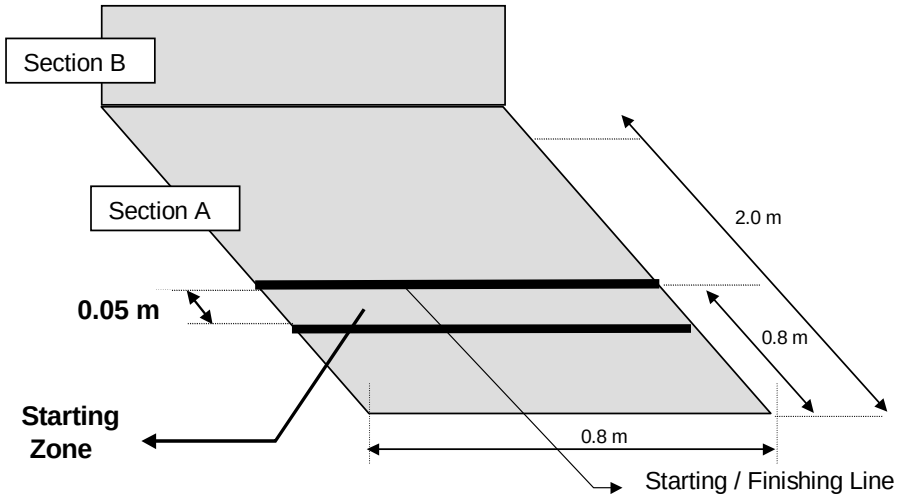


Figure 2: The starting zone for the wall-climbing robot race viewed from above wall-section A

3.2 On reaching the vertical section (section B) the robots will attempt to climb up the vertical section and subsequently climb 'upside-down' to the end of the top horizontal section (section C.) On reaching the end of the top horizontal section, the robot will attempt to return to the starting point by climbing back through sections C, B and A in sequence. The sequence of wall sections to be climbed from start to finish is A-B-C-C-B-A.

3.3 The robot that completes the entire sequence of wall sections according to paragraph 3.2 above in the least time, including the addition time penalties (if applicable) according to paragraph 3.4 below, wins.

3.4 If applicable, each robot will have penalties added to the shortest time that it is able complete its climb through the entire sequence of wall sections according to paragraph 3.4 above. The criteria to determine if a penalty is applicable and the actual penalties are tabulated below:

The robot that scores the highest number of points according the following formula wins:

S/N	Criterion	Penalty – Time to be added to the shortest recorded time in which the robot is able to complete its climb in the entire sequence of wall sections according to paragraph 3.2 above
1.	The robot fails to demonstrate a minimum degree of consistency in performance by successfully completing the entire course of all wall sections in the sequence according to paragraph 3.2 above in each run on at least two consecutive runs made during the race without falling off the wall.	30 seconds
2	The robot is not completely autonomous – it uses an external power source.	30 seconds
3	The robot makes use of magnets in order to climb any one of the wall sections.	120 seconds

Notes:

1. *All robots will be required to have their own control and intelligence built-in within the robot itself. No form of external or human control is allowed while a robot is climbing the wall.*
2. *Any robot which is manually re-configured or adjusted at any time after caging has taken place will be considered to be a human controlled wall climbing mechanism and hence disqualified.*

3.5 A robot is deemed to have started once any part of the robot crosses the starting line in the wall section A.

3.6 A robot is deemed to have completed its climb through a particular wall section when it fulfils all of the following conditions (a), (b) and (c) *in sequence*:

(a) the robot touches the wall section that it is about to complete

(b) the robot simultaneously touches both the wall section that it is about to complete as well as the next wall section in the sequence of wall sections that is consistent with its direction of travel

(c) the robot ceases to touch the particular wall section that it is about to complete and touches the next wall section in the sequence that is consistent with its intended direction of travel.

The above conditions apply to all wall sections except in the following cases:

(i) when the robot completes its climb through the wall section C *for the first time* in the sequence according to paragraph 3.2 above

(ii) when the robot completes the last wall section (wall section A) in the sequence according to paragraph 3.2 above;

In both cases (i) and (ii) above, the robot is deemed to have completed its climb through the wall section only when the entire robot has crossed the finishing line placed within that particular wall section.

3.7 For each team of participants, the race will begin once the participants remove their robot from the caging area. Once the race begins, each team of participants will be given a maximum of 6 minutes to produce its best result. *No* extra time will be given at the beginning for participants to set-up or prepare their robots.

3.8 After the race begins, any physical handling of the robot such as touching, pulling of cables or pushing of the robot during a climb will disqualify the result of that climb. However if a robot falls off while climbing the wall, using the safety cables to break the fall of the robot is allowed and the result of the climb will be determined as specified in paragraph 3.3 & 3.4 above.

4. THE ROBOTS

4.1 The dimensions of each of the competing robots must *not* exceed 0.75 metres in length and height, and 0.6 metres in width *at all times* while the robot is in operation. For non-autonomous designs these dimensions apply for the mobile or climbing part of the robot only.

4.2 The weight of each of the competing robots must *not* exceed 10 kilograms. For non-autonomous designs this weight restriction applies to the mobile or climbing part of the robot only.

4.3 Competing robots must not have parts removed or added to them during the competition except for replacement of batteries or for repairs essential to the operation of the robot. The competing robots are not allowed to discard any part of their chassis during operation. The competing robots must not use chemical or combustion power methods.

4.4 The competing robots must not damage the competition environment including the wall and its supporting structure and the sensors in any way.

4.5 The competing robots must not endanger the judges and the spectators in any way. All competing robots must be firmly secured with two safety cables at all times during operation.

4.6 A robot will be disqualified during the competition if it endangers the judges, the participants or the spectators in any way during the competition, or if it damages the competition environment. Alternatively a robot may be banned from competing if, in the opinion of the judges, it is likely to pose a safety hazard or cause damage to the competition environment.

5. CLONING

5.1 In accordance with the spirit of the competition, clones among the winning entries will only be awarded one prize. Clones will be identified during the "caging" procedure.

5.2 Clones will be identified by the working principles of the whole robotic system, such as the sequence of operations during the crossing of obstacles and negotiating the wall bends.

5.3 When in doubt, the decision of the Judges will be final.

ROBOT SUMO COMPETITION

1. OBJECTIVE

Participants are required to build a self-contained mobile robot that is able to push its opponent out of the specified ring in according to the tournament rules. Robot handlers are allowed to operate their robots either through the radio-controlled console or the robot is an autonomous type. All participants shall compete under the same category.

2. ROBOT SPECIFICATIONS

2.1 Dimensions and Weight

The size of the radio-controlled and autonomous robots shall not exceed 20cm (length) x 20cm (width) by any height. The robot can be in any shape but the whole robot has to pass through a 20cm x 20cm hollow container.

The weight shall not exceed 3 kg excluding the radio-controlled console used by the robot handler.

2.2 Don'ts in the Design

2.2.1 Do not disturb the opponent's radio-control by putting a jamming device in the robot.

2.2.2 Do not use parts that can break or damage the ring surface.

2.2.3 Do not use any devices that can throw liquid or powder or things at the opponent robot.

2.2.4 Do not use any inflamable devices.

2.2.5 Do not secure a robot on the ring surface by using any devices such as suction cups, diaphragms, sticky treads or glue.

2.2.6 Do not use any projectile weapons or saw-plates.

2.2.7 Do not accommodate any devices that cause damage to the opponent robot.

2.3 Radio-controlled Frequencies

The radio-controlled frequencies in use is only 27 MHz with FM (frequency modulation) in narrow bands from 1 to 12. Participants must be capable of operating in any of these bands; otherwise they shall be disqualified. The Futaba, Sanwa and Kagaku are the recommended brands for the radio-controlled console.

2.4 Labelling

All robots must be labeled with of their team names.

3. RING SPECIFICATIONS

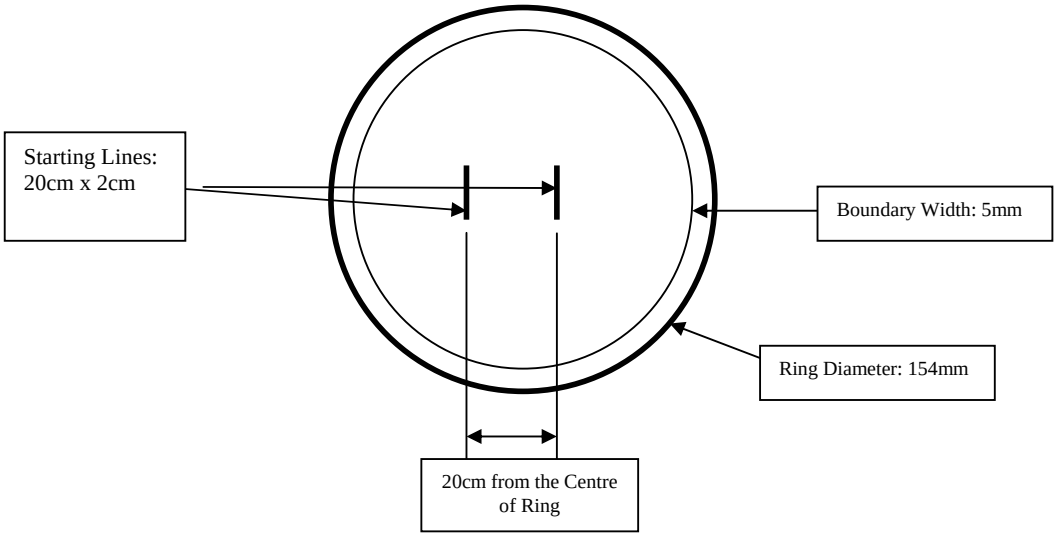
3.1 Dimensions and Materials

The ring arena is made of a single ½" MDF board and covered by a 3mm black hard rubber sheet. The diameter of the ring is 154mm including the boundary marking.

3.2 Markings

Two red-brown color starting lines (20cm x 2cm) locate at 20cm apart from the centre. They indicate the starting positions for two competing robots.

The boundary of the ring arena is marked in white color. The width is 5cm.



4. GAMES RULES

4.1 Sumo Game

A game consists of 3 matches. In the first rounds, every robot has to complete 3 matches. Each match lasts for 2 minutes. One point shall be given to every match winner. Zero point shall be given to a draw or a loser. The tournament shall divide the participating teams into groups of maximum 4 robots.

In the second rounds and above, every robot has to win two matches for qualifying to the next round. Each match lasts 3 minutes. The third match shall be carried out only if there is a draw. The third match shall continue in sudden death until a winner generates if the 3-minute match time is over.

4.2 Match Winner

Any robot is able to push its opponent robot until any part of the opponent robot touching the floor.

4.3 Time Out

Each team will be given One timeout (if necessary) for each game (for 3 matches). Participating team can not change their battery during the timeout period. The duration of the time out is 1 minute. No timeout shall be allowed during the match.

If the team can not play after the timeout, a point shall be given to the opponent team.

There is 1-minute interval between any matches.

Every team shall change their battery (if necessary) only before the game starts. Two minutes shall be given for this purpose.

4.4 Service Time

10 minutes is given for teams to service their robots before each round of competition after the preliminary rounds. A maximum of 2 handlers are allowed to service the robots at designated areas under supervision. Only replacement of identical parts are allowed during the Service Time.

4.4 Appeal

No appeal shall be allowed on the judge's decision in the game.

POLE BALANCING ROBOT

1. DEFINITION:

Any mechanism which supports an inverted pendulum which is free to swing around a horizontal axis with one degree of freedom and balances it to keep it vertical by moving the point of support shall be considered "the pole balancing robot."

2. ACCEPTABLE VERSIONS:

2.1 The inverted pendulum may be supported by a vehicle moving along a straight line. Any other innovative design which does not violate the spirit of the competition may be allowed at the discretion of the judges subject to the following conditions:

2.2 The inverted pendulum must be free to swing. It must be balanced by moving the pivoted support point parallel to the plane of the swing. The pivot must be fixed to the vehicle.

2.3 The robot must use a standard contest balance pole specified by the organisers. A sample pole will be supplied for the institutions participating in the competition. The pole material will be aluminium.

2.4 There is no size restriction on the robot. The overall size will be such that it would be able to operate on the table provided by the organisers. No part of the robot, other than its wheels, must touch the surface of balance table. It must not fall off the competition table surface during the operation.

2.5 Balancing the pendulum/pole using any form of gyroscopic principle is not admissible.

2.6 A self-balancing design in which the pendulum will always stand up due to the use of a balance weight below the axis of rotation is also not admissible.

2.7 There should be no relative motion between the pole-support axis and the body of the vehicle.

2.8 No guide rails are allowed.

2.9 The vehicle must be *completely* autonomous, with no wires connected externally and with no RF signals or power lines coming from outside.

3. POLE-SUPPORT MECHANISM AND OVERALL SIZE:

3.1. The supporting mechanism must be compatible to the diagram shown in Fig. 1 If the potentiometer or encoder is driven through gears then the gear friction must be very small as quantified in section 3.2. It must be able to swing freely from -45° to +45° from the vertical position when the vehicle is positioned in region B.

The pole should have the dimension shown in Fig.1, with the length of 990 mm and outer diameter of 12.7 mm with a tolerance of 5%. The pole must have uniform cross section and weigh 117 grams with in a tolerance of 5 %. When the pole is placed with its centre on the middle of a support surface of 1.5 cm width, with both sides overhanging, the pole should not topple. A few such poles will be collected from participants and the competition pole will be picked arbitrarily from the lot by the judge.

3.2 The friction of the suspension mechanism is quantified as follows: The pole used for balancing is also used for this purpose. The robot will be placed upside-down to make the pole a regular pendulum.

For the test, the robot is supported upside down such that the pole support axle is along the vertical line A, marked on the wall or the platform built for this purpose. There will be two vertical lines on the right side. One (extreme right line B) corresponds to 45° inclination of the pole. The second inner line C corresponds to 18° inclination of the pole, at a distance of 30 cm from line A.

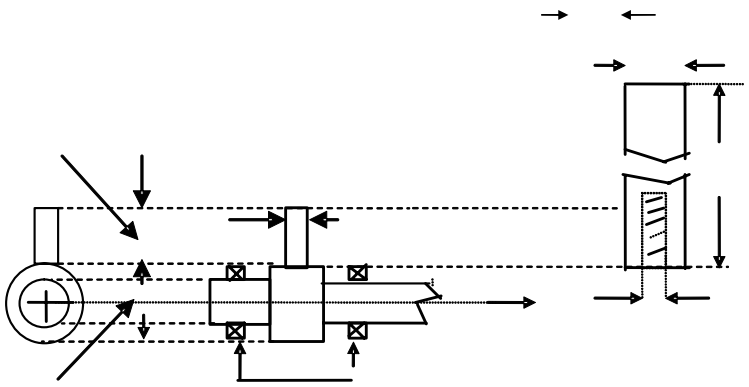


Fig.1. Pole Support Mechanism

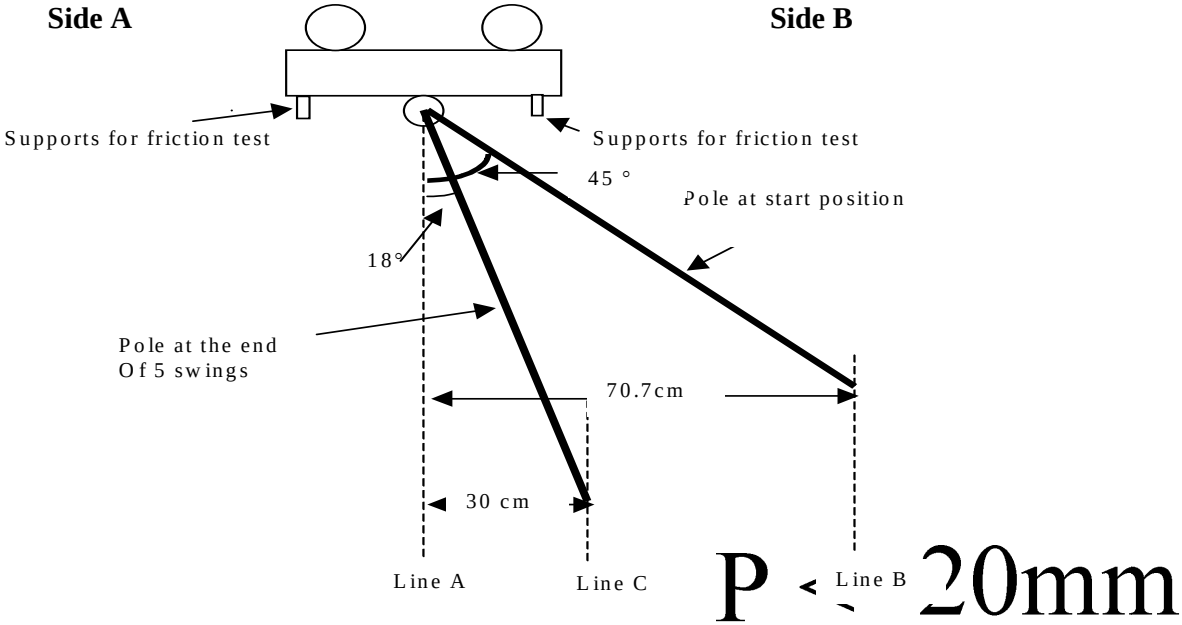
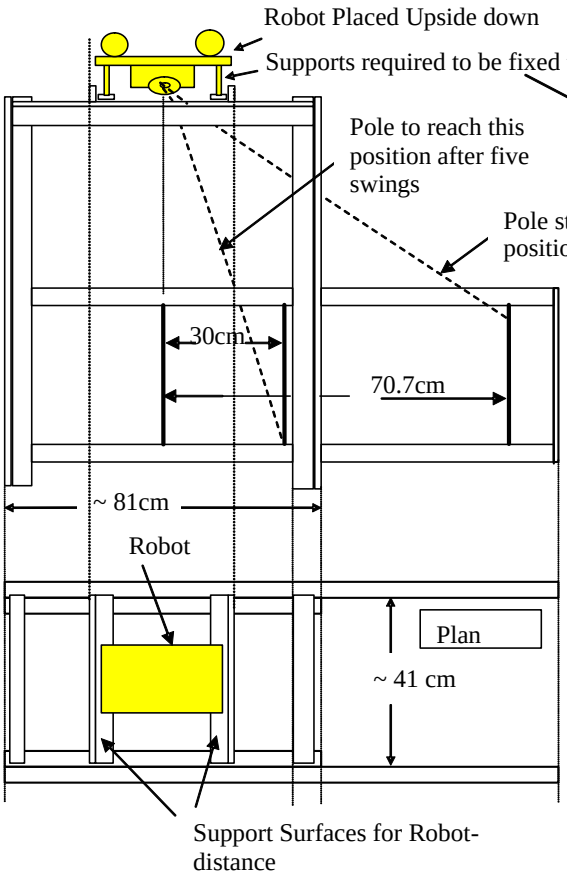


Fig.2 Friction Test Procedure with inverted Robot

The pole will be moved to side A to reach an inclination of 45° such that the tip touches the outer vertical line B and is released, so that it swings back and forth. At the end of the fifth swing cycle the pole should swing back to side A and reach a minimum angle of 18° such that the tip touches the inner vertical line C.

3.3. The organisers strongly recommend that the robots have projected supports perpendicular to the base plate at the front and back of the robot, to facilitate easy placement during friction test. See Fig. 3a. The dimensions of the support provided on the robot must be such that the inverted robot can be placed on the friction test structure shown in Fig.3.



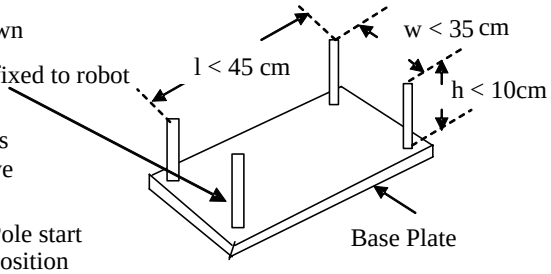


Fig.3a. Recommended attachment to the base plate (Please make sure that pole swings -45 to +45 degrees)

Fig.3. Friction Test Structure

4. TABLE:

4.1 The competition table is shown in Fig.4. One common competition table will be used by all competitors. The gradient will be approximately 5.7 degrees. The edges between the inclined surfaces and the horizontal surface will be rounded off and there will be no joints at those edges. A neoprene rubber mat of 3mm thickness will be used on the top of the table to improve the grip of the wheels.

5. CAGING:

5.1 The robots will be caged before the competition before the friction test.

5.2 No switching of EPROMs or downloading of programs will be allowed, after caging.

5.3 Once the robot has been caged, no change of batteries will be allowed.

6. COMPETITION:

6.1 The robotic vehicle would operate on the top of the table provided. Please see Fig. 4a. The table-top will have a slight gradient at the start (region A) and the end (region C) zones as shown in Fig. 4a.

A metallic wedge of cross section shown in Fig.4b (not to scale) will be used as an obstacle. The length of the wedge will match the width of the table. The wedge will be painted to match the table surface and a retro-reflective tape will be stuck to it at the middle, to match the one on the table. The judge will place the wedge in region B anywhere between the inner edges of the two innermost tapes so that the wedge is perpendicular to the path. It will not be moved thereafter.

6.2 The vehicle will be placed within the region A (see Fig. 4a). The operator may move the pole (the inverted pendulum) to an upright position and release it upon receiving the signal from the judges. The vehicle must balance the pole in the upright position for a minimum of 20 seconds without the vertical pole crossing the line X-X'.

6.3 Upon completion of the task (in 6.2 above), the vehicle should move across the line X-X' once, and move through the region B, until the pole clears the line Y-Y', without losing balance during transit, i.e. not hitting any part of the table or its own chassis.

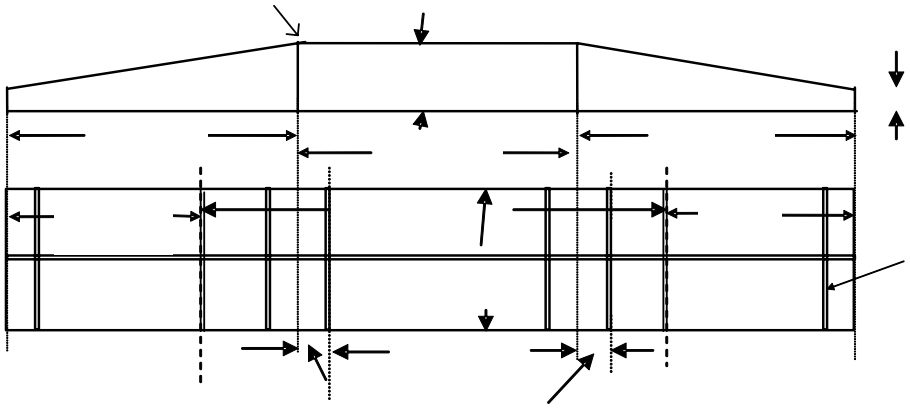


Fig.4a. Pole Balancing Robot Table

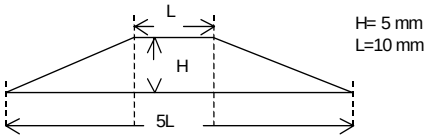


Fig.4.b.Wedge Section
(enlargded view)

6.4 Upon completion of task (in 6.3 above), the vehicle must retrace the path, cross the line X-X' again and get back to region A. This will complete one cycle. This time, during the retrace, the vehicle need not stay any length of time at region B or A, before the start of the second cycle.

6.5 When an electronic sensing system is used for detecting the pole crossing Y-Y' and X-X' lines, the pole sensors at both sides will be placed such that the line of sight of the

sensors will be 20 cm above the lines marked on the platform. This may warrant that the robot moves further for the pole to intercept the line of sight of the sensors. This is important since many robots have their poles inclined inwards towards the centre of platform at these points of turning back. Furthermore, no part of the robot other than the pole should be above 15 cm so that no other part of the robot (except the pole) would trigger the sensor.

6.6 The vehicle should repeat these cycles.

6.7 To count these cycles as successful cycles they must be followed by at least 20 seconds of static balancing at region A.

6.8 The robot may continue on (untouched) for more cycles, and *complete* them with 20 seconds of static balancing at the end, which if successful will be counted cumulatively.

6.9 If a robot is touched by the handler during the trial, it must be restarted for the next attempt.

7. NUMBER OF ATTEMPTS:

7.1 From the instant the team is called upon to take the arena, 2 minutes will be allowed for set up.

7.2 After the set up time, 5 minutes of *performance time* will be allowed for each robot. The *performance time* will start when the participant first releases the robot-pole. However if the set up time exceeds 2 minutes, then *performance time* will start automatically.

7.3 With in the time permitted, any number of attempts will be allowed. All the attempts must be *completed* within 5 minutes

7.4 The participants must vacate the competition area when the 5 minutes of *performance time* expires.

8. SCORING:

Final score = A x B x C

where A = 0 if the robot fails initial static balancing
A = 1 if the robot completes initial static balancing
B = number of cycles achieved during run time
C = 1.5, if the robot successfully completes the final static balancing within the performance time.
C = 1.0, if the robot starts the final static balancing within the performance time, but extends beyond the performance time.
C = 0.3, if the robot pole falls before the final static balancing is completed.

9. CLONING:

9.1 In accordance with the spirit of the competition, clones among the winning entries will only be awarded one prize. Clones will be identified during the "caging" procedure.

9.2 Clones are robots with substantially identical physical appearance and working principles.

9.3 When in doubt, the decision of the Judges will be final.

GLADIATOR

This game involves two robots combating in an arena. A robot is declared as the winner if it can force or push any part of the opponent's body to touch the ground outside the arena or when the judges declare its opponent as disabled/immobilised.

1. OBJECTIVE

To design an autonomous robot equipped with devices and mechanisms to force or push its opponent out of the arena.

2. LEVELS OF THE COMPETITION

2.1 This event comprises four progressive levels of competition as shown below:

Preliminary Round :	Round Robin [maximum of five teams to one sub-group]
Quarter-Final	: Knock-out system [Draw lots for line-up]
Semi-final	: Knock-out system
Final	: Knock-out system [followed by Sudden Death if there is a draw]

2.2 During the preliminary rounds [round robin], entries are divided into several sub-groups, each with a maximum of five entries. And entries in each sub-group will compete among themselves. Each game between two robots consists of three matches. The best of three matches wins the game and points will be awarded based on the following:

Win	:	3 point
Draw	:	1 point
Lose	:	0 point

The entry with the highest score from each sub-group will progress to the next level of competition.

2.3 The number of qualified entries for the next level of competition is subjected to the outcome of the competition at any level. The judges reserve the rights to choose a few entries from among the second and third ranking at any level of the competition to form the last eight entries for the quarterfinals and/or four entries for the semi-finals.

3 HOW THE GAME IS PLAYED

3.1 Every game comprises two robots fighting it out over three matches. Each match lasts 45 seconds. The task of each robot is to force or push its opponent out of the arena.

3..2 At the beginning of each match, the two competing robots are positioned inside the starting box in their own side of the arena. The front of the robot, which has to be identified and marked during cage-in, has to face each other.

3.3 During the preliminary rounds (Section 2.1), robots assigned to each group will compete against each other. In each game, the robot with the best of three matches wins and is awarded 3 points. If both robots draw, each robot is awarded 1 point. After all the rounds are completed, the robot scoring the highest points within the group will progress to the next level of competition.

3.4 During the quarter and semi-finals, knock-out system is adopted. In each game, the robot with the best of three matches will progress to the next level of competition.

3.5 Tie Breaker

Whenever a tie occurs in the preliminary rounds [applies to selection of entries to next level of competition only], quarterfinals and semi-finals, it will be resolved through a tie-

breaker system. The tie breaker system uses a Dummy Robot [weighing between 5 kg to 10 kg] as a 'stand-in' opponent. This dummy robot will be positioned at the centre of the arena. Robots involved in the tie will compete individually against this dummy robot. A match time of 45 seconds is given to push the dummy robot out of the arena. The robot that accomplishes it in the shortest possible time wins. However, if both fail to push the dummy robot out of the arena when the 45-second match time is up, then both will not be eligible to proceed to the next level of competition.

3.6 One-minute Set-up Time

Robot handlers are given a 'one-minute set-up time' to prepare the robot before each match. If a robot is not ready when the one-minute is over, it shall be deemed as a walkover for its opponent. The next match shall proceed immediately until all the three matches are played. A match can also commence early if both robots are ready before the one-minute set-up time is over.

Before a match commences, the robot must restore to the original size and shape that includes any mechanisms that extended out during the previous match and this has done within the one-minute set-up time.

When a match commences, the robot handler must activate his/her robot immediately.

4. RULES AND REGULATIONS

4.1 A robot wins if it can force, wrestle or push the opponent until any part of the opponent's body makes contact with the ground outside the arena.

4.2 A robot is retired if :

* it fails to perform after the one-minute set-up time is over.
* any suction, anchoring or similar devices are used to hold the robot firmly onto the ground.
* internal combustion engines are used.
* any linear or rotary cutting devices or tools e.g. chopper, rotating saw blades are used.
* Shooting weapons are used, e.g. projectiles/missiles, even if the projectiles can be retracted.
* any dangerous devices such as high emf/frequency emitter, corrosive liquid, explosives, etc. are used as weapons.
* During combat, the robot size is larger than half of the arena (1m X 1m) including any extended weapons or mechanisms.

4.3 Inspection of Robots

One hour before the competition commences; all participants must submit their entries for inspection by a panel of judges. After which the entries will be caged and displayed for public viewing. During caging, modification of the robots is allowed in order for the robots to pass the caging requirements. However, the extent of the caging is up to the discretion of the Judges.

4.4 After an entry has been submitted for inspection, no alterations, changes and/or modifications to their mechanical design, power supply, and/or electronic circuitry are permitted before and during the competition. Failure to observe this ruling will subject the participant to disqualification.

4.5 There will be a 10-minute service time before each level of competition i.e. quarterfinals, semi-finals and final. Robots are allowed to be serviced, eg. replacement of batteries and/or identical parts and tightening of fasteners.

4.5 The robot should have only one on-off toggle switch. The handler must start the robot with this switch only.

5. SPECIFICATIONS

5.1 Robots failing to meet any of the following specifications during the cage-in will be disqualified.

* Weight of robot ≤ 10.0 kg
* Physical dimensions : ≤ 300 mm [Length] x ≤ 300 mm [Width]
* The height of the robot : >150 mm [Height]
* Autonomous

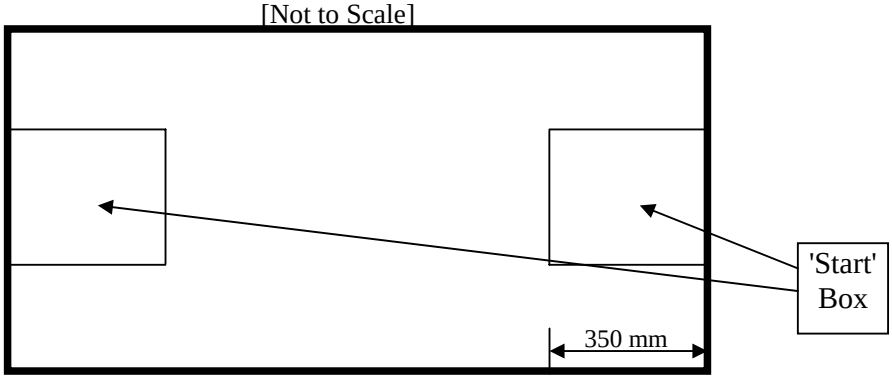
5.2 Specifications of Dummy Robot

A plastic container with dimensions of ≤300 mm [diameter] x ≤300 mm [height] is used as a dummy robot. And a pack of rice weighing at least 5 kg will be placed inside the container. However, the overall weight of the dummy robot shall not exceed 10 kg.

6. ARENA

The 1m (L) x 2m (W) x 0.1m (H) arena is made of wood. The arena is elevated at least 100mm above the ground level. The start boxes are of size 0.35m (L) x 0.35m (W) marked on the arena as indicated in the figure below.

[Not to Scale]



7. CLONING

7.1 Clones shall be identified during the entry caging. Once identified they will be grouped together separately and compete among themselves before the preliminary round commences. Eventually only one of the clones is permitted to enter the preliminary rounds.

7.2 Clones shall be identified either by substantially identical physical appearance and/or performance. Clones only apply to entries from the same institution/individual.

7.3 In the event of any ambiguity in the competition rules, the judge's interpretation shall prevail. Should a situation arise that is not addressed in the rules, the judges will decide on the matter, and their decision will be final.

MICROMOUSE COMPETITION

INTRODUCTION

Micromouse is an autonomous mobile vehicle, which is able to navigate its way through an unknown maze from the start to the destination. It is also required to search for the best path between the start and the destination for the micromouse to run along this path in the shortest time.

The main challenge for micromouse designers is to build a fast moving wheel-driven robot. They need to work out the maze solving intelligence for the robot that is able to handle different maze configurations and compute the optimum path for the shortest fast-run time, and to control the robot to run at very fast speed without hitting the wall.

1. MAZE SPECIFICATIONS

1.1 The maze is be configured by placing walls along the grid-points formed by multiples of 18cm square. The squares are arranged in a 16 x 16 row-column matrix. The walls constituting the maze are in 5cm high and 1.2cm thick. Passageways between the walls are in 16.8cm wide. The boundary of maze is enclosed with walls.

1.2 White plastics make the maze walls. The maze platform is made by plywood and finished with black color matted paint. The maze walls shall reflect infra red light. The maze floor shall absorb it.

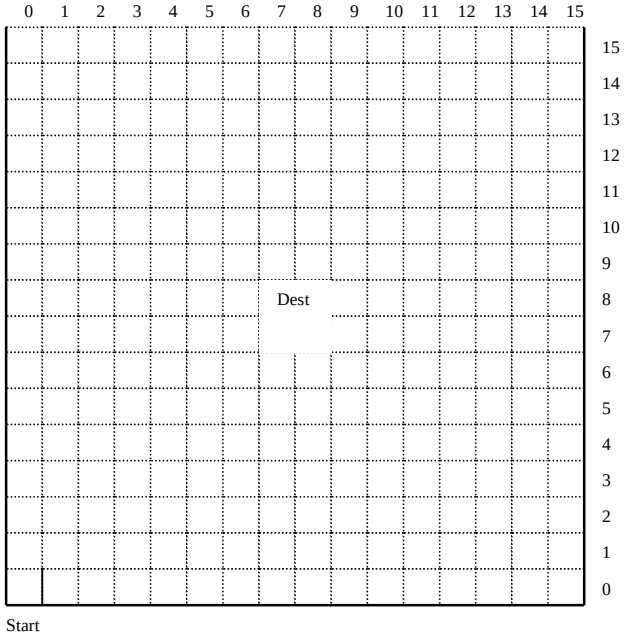


Figure 1: Start and Destination Points and Grid Lines for Maze

1.3 The starting position of the maze shall locate at one of the maze corner. There shall be three walls surrounding it. Its opening shall be towards destination that is the center of the maze, locating at the right of the starting square.

1.4 There are poles, in dimensions 1.2cm (length) x 1.2cm (width) x 5.0cm (height), locating at four Corners of each maze square. They are called lattice points. The maze shall be constituted such that there is at least one wall attached to each lattice point, except the lattice point that is locating at the center of the maze.

1.5 The accuracy of maze dimensions shall be within +/- 5% or 2cm; whichever is less. The assembly joints on the maze floor shall not involve steps of greater than +/- 0.5mm. The gaps between the walls of adjacent squares shall not greater than 1 mm.

2. MICROMOUSE SPECIFICATIONS

2.1 The length and width of any micromouse shall be within 25cm x 25cm. There is no limit on the height of the micromouse. The micromouse shall not change its dimensions while it is navigating along the maze.

2.2 The micromouse shall be fully autonomous and shall not receive any outside help throughout the contest.

2.3 The method of wall sensing is at the discretion of the designer, however; the micromouse shall not exert a force on any wall that is likely to cause damage. The method of propulsion is also at the discretion of the designer, provided that the energy source is non-polluted.

2.4 The micromouse shall not leave any parts on the passageway while navigating along the maze.

2.5 The micromouse shall not jump over, climb over, or damage the walls of the maze.

3. RULES FOR THE CONTEST

The crucial task of the micromouse is to navigate from the starting square to the destination square. This is called a run and the time taken is called the run time. Traveling from the destination back to the start is not considered as a run. The total time taken from the first time left the start square until the start of each run is also measured. This is called the search time. If the micromouse requires a manual assistance at any time during the contest, it is considered as a touch. A one-time penalty shall be added on those scores that are obtained after the touch. The run time, the search time and the touch penalty are to be used for the calculation of each score that the micromouse reaches the destination from the start successfully.

The micromouse competition is divided into three categories. They are the secondary schools (SSs) category, the junior colleges/institutes of technical education (JC/ITEs) category and the open (Open) category.

3.1 The Secondary Schools (SSs) Category

3.1.1 The SSs Category is opened for all full time students from secondary schools. Each school shall be limit to **Four** entries. However, the school may submit the excess entries to the Open Category provided they have more than four entries in this category. Each entry shall not be more than **Six** students and must have its own micromouse. No micromouse shall be shared by any entries neither in this category nor the Open category.

3.1.2 Each entry shall be given time limit of 8 minutes or 6 crashes to contest on the maze. The micromouse may make as many runs as possible within time limit provided the micromouse does not crash more than 5 times.

3.1.3 The score of a micromouse shall be obtained by computing a handicapped time for each run as follows:

Score of Current Run (reached the destination successfully) = Run Time + Search Penalty + Touch Penalty
Search Penalty = $1/60^{th}$ of the Search Time, in seconds
Touch Penalty = 2 seconds

For example, if a micromouse, after being on the maze for 4 minutes without being touched, starts a run that takes 20 seconds to reach the destination; the run will have a handicapped time score of 20 + $1/60^{th}$ of (4 x 60 seconds) = 24 seconds. However, if the micromouse has been touched before the run, an additional touch penalty of 2 seconds is added on giving a new handicapped time score of 26 seconds. The run with the fastest handicapped time score for each micromouse shall be the official time score of that micromouse. The accuracy of time score is to the nearest $1/100^{th}$ seconds.

3.1.4 The run time shall be measured from the moment that the micromouse leaves the starting square until it enters the destination square. A run shall be complete only if the whole of the micromouse enters the destination square.

3.1.5 A computer timing system with electronic triggering devices shall be used for measuring scores of each micromouse. The electronic triggering devices are locating at the exit and entry of the starting square and the destination square respectively. The triggering device is constructed from the infra red transceivers. They are placed about 1cm above the maze floor. Any failure on the electronic triggering devices shall be back up by a manual timing system.

3.1.6 The starting procedure of each entry shall be simple and must not offer a choice of strategies to the handler. Pressing a "Start" button/switch once shall activate the micromouse. Throughout the duration of the given time limit, the handler shall not enter any information into the micromouse (such as to change the search strategy, the speed and the maze data).

3.1.7 The handler shall be given a setup time of 1 minute to calibrate the sensors, if required. However the handler shall not select any strategies and enter the maze data into the micromouse. The search time shall be started upon the expiry of setup time if the handler still continues to calibrate the sensors. Only **One** handler shall be allowed to operate the micromouse throughout the contest.

3.1.8 When the micromouse reaches the destination square, it may stops on its own and remains at the destination or continues to navigate to other parts of the maze or makes its own way back to the starting square. If the micromouse chooses to stop at the destination, it shall be manually lifted out and restarted by the handler. Manually lifted the micromouse out shall be considered as a touch to the micromouse. Therefore a touch penalty shall be added on the scores for all subsequent successful runs.

3.1.9 If a micromouse appears to be malfunctioning, the handler may ask the judges for the permission to abandon the run and restart the micromouse from the starting square. The handler shall not require restarting only if the micromouse makes a wrong turn; the judges' decision is final. All handlers have to manage the technical problems within the time limit of 8 minutes given. No re-scheduling of the entry due to technical problems shall be allowed.

3.1.10 Before the complete maze is configured, all handlers have to register and cage their entries to the contest officials. Once the entry is caged, no replacement of any parts of the micromouse shall be allowed. Once a micromouse starts its run, no replacement of batteries shall be allowed otherwise considered as a touch to the micromouse and the touch penalty shall be added on for the subsequent scores made by the micromouse.

3.2 The Junior Colleges/Institutes of Technical Education (JC/ITEs) Category

3.2.1 The JC/ITEs Category is opened for all full time students from colleges/insitutes. Each college/institute shall be limit to **Four** entries. However, the college/institute may submit the excess entries to the Open Category provided they have more than four entries in this category. Each entry shall not be more than **Six** students and must have its own micromouse. No micromouse shall be shared by any entries neither in this category nor the Open category.

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For example, if a micromouse, after being on the maze for 4 minutes without being touched, starts a run that takes 20 seconds to reach the destination; the run will have a handicapped time score of 20 + $1/60^{th}$ of (4 x 60 seconds) = 24 seconds. However, if the micromouse has been touched before the run, an additional touch penalty of 2 seconds is added on giving a new handicapped time score of 26 seconds. The run with the fastest handicapped time score for each micromouse shall be the official time score of that micromouse. The accuracy of time score is to the nearest $1/100^{th}$ seconds.

3.2.4 The run time shall be measured from the moment that the micromouse leaves the starting square until it enters the destination square. A run shall be complete only if the whole of the micromouse enters the destination square.

3.2.5 A computer timing system with electronic triggering devices shall be used for measuring scores of each micromouse. The electronic triggering devices are locating at the exit and entry of the starting square and the destination square respectively. The triggering device is constructed from the infra red transceivers. They are placed about 1cm above the maze floor. Any failure on the electronic triggering devices shall be back up by a manual timing system.

3.2.6 The starting procedure of each entry shall be simple and must not offer a choice of strategies to the handler. Pressing a "Start" button/switch once shall activate the micromouse. Throughout the duration of the given time limit, the handler shall not enter any information into the micromouse (such as to change the search strategy, the speed and the maze data).

3.2.7 The handler shall be given a setup time of 1 minute to calibrate the sensors, if required. However the handler shall not select any strategies and enter the maze data into the micromouse. The search time shall be started upon the expiry of setup time if the handler still continues to calibrate the sensors. Only **One** handler shall be allowed to operate the micromouse throughout the contest.

3.2.8 When the micromouse reaches the destination square, it may stops on its own and remains at the destination or continues to navigate to other parts of the maze or makes its own way back to the starting square. If the micromouse chooses to stop at the

destination, it shall be manually lifted out and restarted by the handler. Manually lifted the micromouse out shall be considered as a touch to the micromouse. Therefore a touch penalty shall be added on the scores for all subsequent successful runs.

3.2.9 If a micromouse appears to be malfunctioning, the handler may ask the judges for the permission to abandon the run and restart the micromouse from the starting square. The handler shall not require restarting only if the micromouse makes a wrong turn; the judges' decision is final. All handlers have to manage the technical problems within the time limit of 8 minutes given. No re-scheduling of the entry due to technical problems shall be allowed.

3.2.10 Before the complete maze is configured, all handlers have to register and cage their entries to the contest officials. Once the entry is caged, no replacement of any parts of the micromouse shall be allowed. Once a micromouse starts its run, no replacement of batteries shall be allowed otherwise considered as a touch to the micromouse and the touch penalty shall be added on for the subsequent scores made by the micromouse.

3.3 The Open Category

3.3.1 The Open Category is opened for all individuals from the universities, the polytechnics, the industry, and the private. Each entry shall not be more than **Six** participants and must have its own micromouse. No micromouse shall be shared by any entries.

3.3.2 Each entry shall be given time limit of 10 minutes or 8 crashes to contest on the maze. The micromouse may make as many runs as possible within time limit provided the micromouse does not crash more than 7 times.

3.3.3 The score of a micromouse shall be obtained by computing a handicapped time for each run as follows:

Score of Current Run (reached the destination successfully) = Run Time + Search Penalty + Touch Penalty
Search Penalty = $1/30^{th}$ of the Search Time, in seconds
Touch Penalty = 3 seconds

For example, if a micromouse, after being on the maze for 4 minutes without being touched, starts a run that takes 20 seconds to reach the destination; the run will have a handicapped time score of 20 + $1/30^{th}$ of (4 x 60 seconds) = 28 seconds. However, if the micromouse has been touched before the run, an additional touch penalty of 3 seconds is added on giving a new handicapped time score of 31 seconds. The run with the fastest handicapped time score for each micromouse shall be the official time score of that micromouse. The accuracy of time score is to the nearest $1/100^{th}$ seconds.

3.3.4 The run time shall be measured from the moment that the micromouse leaves the starting square until it enters the destination square. A run shall be complete only if the whole of the micromouse enters the destination square.

3.3.5 A computer timing system with electronic triggering devices shall be used for measuring scores of each micromouse. The electronic triggering devices are locating at the exit and entry of the starting square and the destination square respectively. The triggering device is constructed from the infra red transceivers. They are placed about 1cm above the maze floor. Any failure on the electronic triggering devices shall be back up by a manual timing system.

3.3.6 The starting procedure of each entry shall be simple and must not offer a choice of strategies to the handler. Pressing a “Start” button/switch once shall activate the micromouse. Throughout the duration of the given time limit, the handler shall not enter any information into the micromouse (such as to change the search strategy, the speed and the maze data).

3.3.7 The handler shall be given a setup time of 1 minute to calibrate the sensors, if required. However the handler shall not select any strategies and enter the maze data into the micromouse. The search time shall be started upon the expiry of setup time if the handler still continues to calibrate the sensors. Only **One** handler shall be allowed to operate the micromouse throughout the contest.

3.3.8 When the micromouse reaches the destination square, it may stops on its own and remains at the destination or continues to navigate to other parts of the maze or makes its own way back to the starting square. If the micromouse chooses to stop at the destination, it shall be manually lifted out and restarted by the handler. Manually lifted the micromouse out shall be considered as a touch to the micromouse. Therefore a touch penalty shall be added on the scores for all subsequent successful runs.

3.3.9 If a micromouse appears to be malfunctioning, the handler may ask the judges for the permission to abandon the run and restart the micromouse from the starting square. The handler shall not require restarting only if the micromouse makes a wrong turn; the judges’ decision is final. All handlers have to manage the technical problems within the time limit of 10 minutes given. No re-scheduling of the entry due to technical problems shall be allowed.

3.3.10 Before the complete maze is configured, all handlers have to register and cage their entries to the contest officials. Once the entry is caged, no replacement of any parts of the micromouse shall be allowed. Once a micromouse starts its run, no replacement of batteries shall be allowed otherwise considered as a touch to the micromouse and the touch penalty shall be added on for the subsequent scores made by the micromouse.

4. CLONING (APPLIES ONLY TO OPEN CATEGORY)

4.1 In accordance with the spirit of the competition, clones among the winning entries will only be awarded one prize. Clones will be identified during the "caging" procedure.

4.2 Clones are robots with substantially identical physical appearance and working principles.

4.3 When in doubt, the decision of the Judges will be final.

ROBOT COLONY COMPETITION

1. OBJECTIVE

The objective of the competition is to build a self-contained autonomous cooperative pair of mobile robots that are able to search out and detect coloured pellets which must collected and deposited at a designated pocket for each colour. 2 different coloured pellets are available for collection on the platform that has to be delivered to its own designated area. The performance of each team is decided at the end of the run time of 6 minutes, the successful number of coloured pellets collected in each designated pocket. Each coloured pellet successfully collected and delivered to the correct designated area is worth 1 point. Coloured pellets delivered in the wrong designated pocket will have the 1 point deducted from the total score. Should the robot pair successfully collect and deliver all coloured pellets to their designated pockets before the total run time of 6 minutes has expired, then the shortest time duration for the collection will be considered as a further score.

2. SPECIFICATIONS FOR PLATFORM

2.1 The platform will cover a square area of dimensions 2.3m x 2.3m as shown in Fig 1. There are no walls bordering the platform.

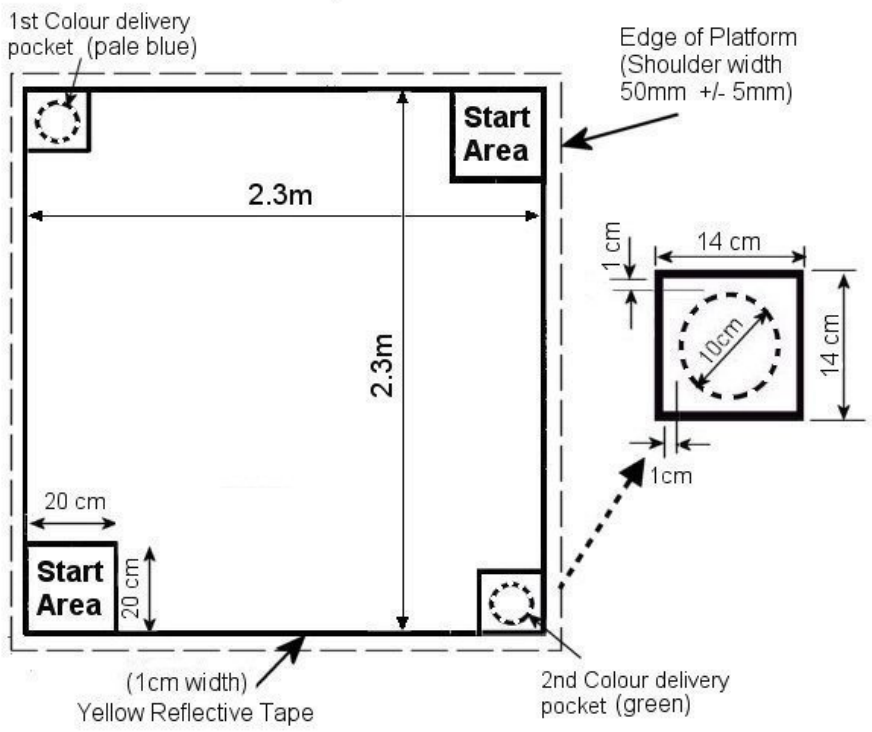


Figure 1 Robot Colony Platform

2.2 The start location for the robots can be at either corner or the same corner. Delivery pockets shall be located at the 2 opposite corners. The colour for each designated delivery area will be decided by the judges during the event. The delivery pockets and start square will have tape bounding them as shown in the figure. The floor of the

platform shall be made of wood and finished with a non-gloss black paint and the lines taped out with 1cm thick yellow reflective tape
The specifications of this tape are as follows:
Material Name : Fasign reflective sheeting.
Company: Fasign Reflective films.
Colour : Yellow.
Local Rep details.
Teck Seng Enterprises Pte LTD
14, Eunos Tech Park,
Tel : 62943035, 62941002, 62943147.
Fax : 62961762.

2.3 A total of 30 of each coloured pellets will be placed (total 60). The orientation and layout of the coloured pellets placed on any part of the colony platform will be decided by the judges but each setup will be kept consistent for all teams.

3. COLOURED PELLET SPECIFICATION

3.1 The coloured pellets will have a diameter of 25.4mm (1 inch) and have a general height of 20mm +/- 2mm height variation. (See figure 2)

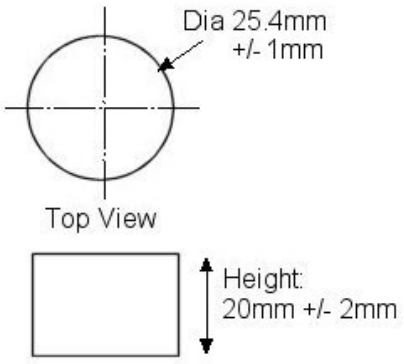


Figure 2 Specification of coloured pellet

3.2 The material specification of the pellets is as follows:

Green (Nyloil)	RS 771-162
Blue (Tuffset)	RS 771-538 (RS Catalog 2001 - Pg 1380)

4. ROBOT SPECIFICATION

4.1 The length and width of the robot shall be restricted to a square region of 15 cm x 15 cm. During collection and delivery, feelers or extending probes, collecting arms etc. of the robot should not extend beyond the 15cm x 15 cm area. There is no restriction on the height of the robot. The weight of each robot is restricted to 5 kg.

4.2 The robot must be completely self-contained and must receive no outside help. The robot pair are however free to communicate with each other by wireless means for cooperative benefits.

4.3 The methods, collection and delivery are at the discretion of the builder. The method of propulsion is at the discretion of the builder, provided the power source is non-polluting.

4.4 If any part of a robot should drop off while it is negotiating the platform, it will not be allowed to continue its run on the platform and will be removed.

5. Rules For the Contest

5.1 The goal of the robot pair is to detect various coloured pellets placed in any area of the platform and to deliver them to their respective pockets. The collection and delivery strategy is left to the robot builder. The robot builder is free to decide on the technique for identifying the colour, detecting the location of the coloured pellets on the platform, and then deciding on a collection and delivery strategy to take it to the respective area. A cooperative strategy between the two robots can be used to increase the productivity of the collection and delivery of the colour objects.

5.2 Each correctly delivered colour pellet in the colour delivery area will be awarded 1 point. Each incorrect colour pellet in any pocket will have 1 point deducted from the total score.

5.3 The competition time for each robot pair starts from the moment the judges give the signal to move off from the starting area.

5.4 At the end of the competition time, only pellets in the pockets will be counted. Pellets that are still held by or left in/on the robots will not be counted.

5.5 The starting procedure of the robot should be simple and must not offer a choice of strategies to the handler. The robot shall be started by pressing a "start" button once. The robot shall be placed at the start area and started by the handler under the officials' instructions. Throughout the duration of the robot's performance, the handler shall not enter any information into the robot.

5.6 Each team is allowed a maximum of 5 restarts. All restarts require the approval of the presiding Judges before the robot(s) can be removed from the arena. The team will be disqualified if the robots were handled within the arena without approval.

5.7 In general, restarts are only allowed when robots crash or are out of control.

5.8 Robots that are restarted in the start area will have any coloured pellet that it is carrying or moving/pushing by the robot be removed from the platform. The pellets will not be returned back to the platform. The final decision of which exact pellets are to be removed will rest with the judges.

5.9 Team members will not be allowed to handle the coloured pellets. Only officials are allowed to handle the coloured pellets in any situation (e.g. to clear the delivery area, re-site a coloured pellet etc...)

5.10 If a robot handler elects to retire because of technical problems, there will be no appeal for a second attempt.

5.11 If only one robot remains in the competition, there will be no more restarts for the team.

5.12 Only one pair of robot handlers per entry is allowed. The same robot handlers from a previous event are not allowed to handle another entry's robots.

5.13 Prizes will only be awarded to the top 3 teams with the top 3 positive overall scores.

6. Caging

6.1 All robot entries will be caged 15 minutes before the start of the event.

6.2 Robot entries are not allowed to charge the batteries of the robot during caging but are allowed to cage spare batteries along with their robots.

7. Cloning

7.1 In accordance with the spirit of the competition, clones among the winning entries will only be awarded one prize. Clones will be identified during the "caging" procedure.

7.2 Clones are robots with substantially identical physical appearance and working principles.
7.3 When in doubt, the decision of the Judges will be final.

8. TIE-BREAK

Should a tie break be required because both teams have equal points, the tie break will be decided on the team which had the fastest successful 1st pellet delivery time.

INTELLIGENT ROBOT – CHALLENGE COURSE

1. OBJECTIVE

The participating team is required to design and build either a single autonomous robot or multiple autonomous/corporate robots to collect 15 foam balls in a competition arena. The balls are in green, yellow and pink colors. Each color has 5 foam balls. The collected color balls are delivered into 3 different goal-containers according to their respective colors within 6 minutes. An extra free yellow-greenish tennis ball is given to the robot handler either to place at any position in the arena or to carry by the robot directly. The free ball can be delivered into any one of the 3 goal-containers. The color foam balls are scattered randomly at the right section of the competition arena. They are located at least 100mm away from the nearest edge. The competing robots either go through the tunnel that is 390mm height or take a longer path to reach the ball collecting area.

2. ROBOT SPECIFICATIONS

The overall size of all participating robots shall not exceed 450mm (Length) x 450mm (Width) x 900mm (Height). The overall weight of all robots shall not exceed 20Kg. All robots operate autonomously or they perform corporately among themselves.

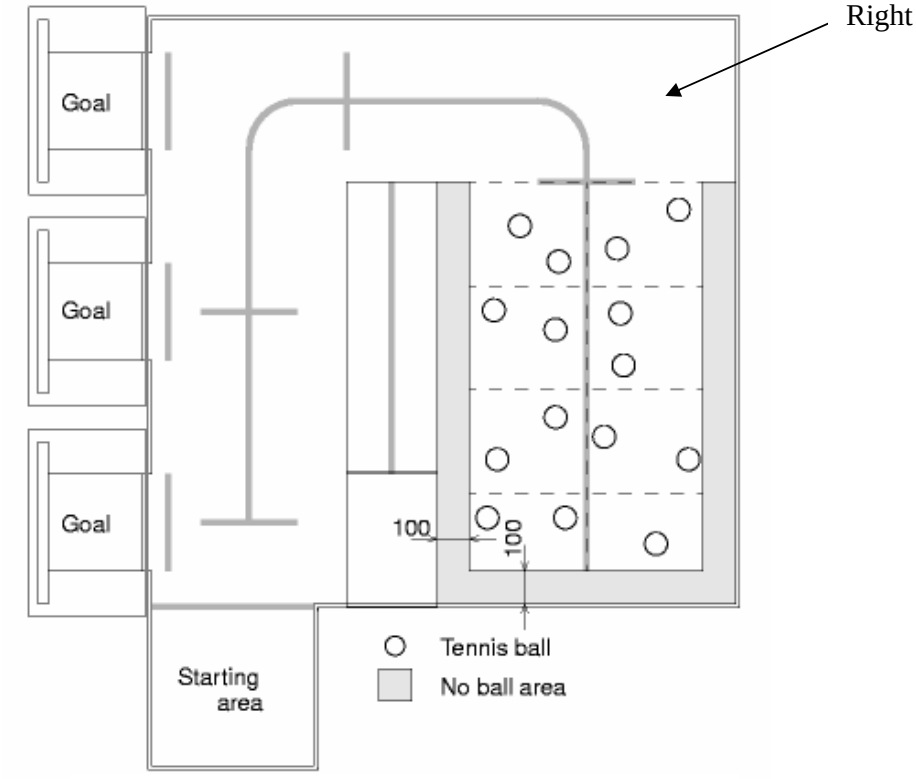


Figure 1: An Example of the layout of Competition

For single robot, no external power is allowed. The robot has to provide a start/stop switch for the handler to commence the contest. No external input on selection of tactics and performance is permitted throughout the competition.

For multiple robots, no external power is allowed but robots are legal to obtain power from other robots. Each robot has to provide a start/stop switch for the handler to commence the contest. All robots have to activate the start/stop switches together. Otherwise, one of the

competing robots has to provide a master start/stop switch to activate all robots. No external input on selection of tactics and performance on any robot is permitted throughout the competition. If the competing robots communicate through radio frequency (r.f.), the handler has to declare the frequency upon the submission of the entry.

The entry shall be disqualified if any part drops off from any competing robot during the competition.

3. Competition Field Specification

A 3D view of competition arena is shown in figure 2. The 2D drawings with dimensions and markings of the field, the goal-container and the tunnel are shown in figure 3, 4 and 5.

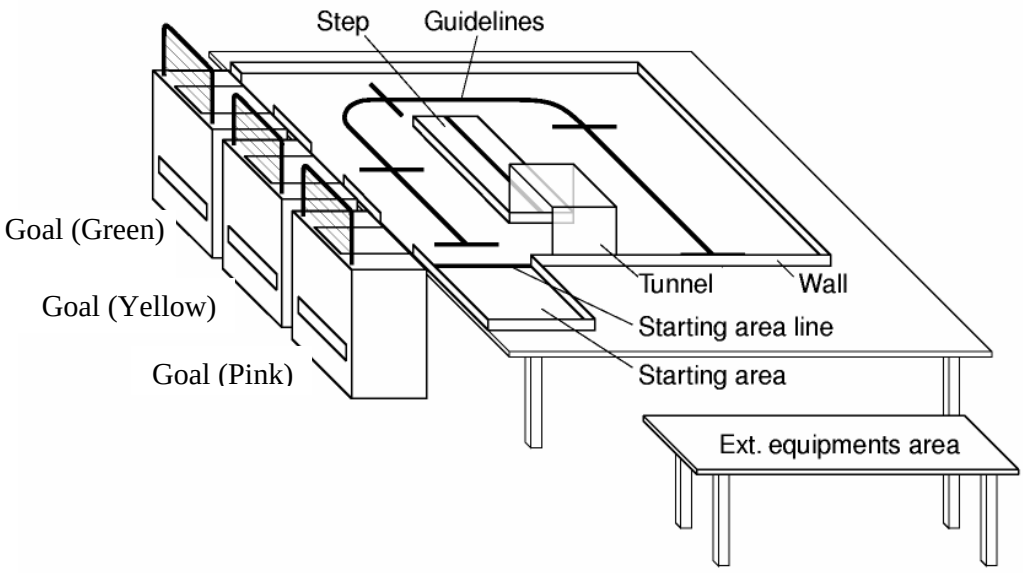


Figure 2: The 3D View of Competition Arena

4. Color Foam Ball Specifications

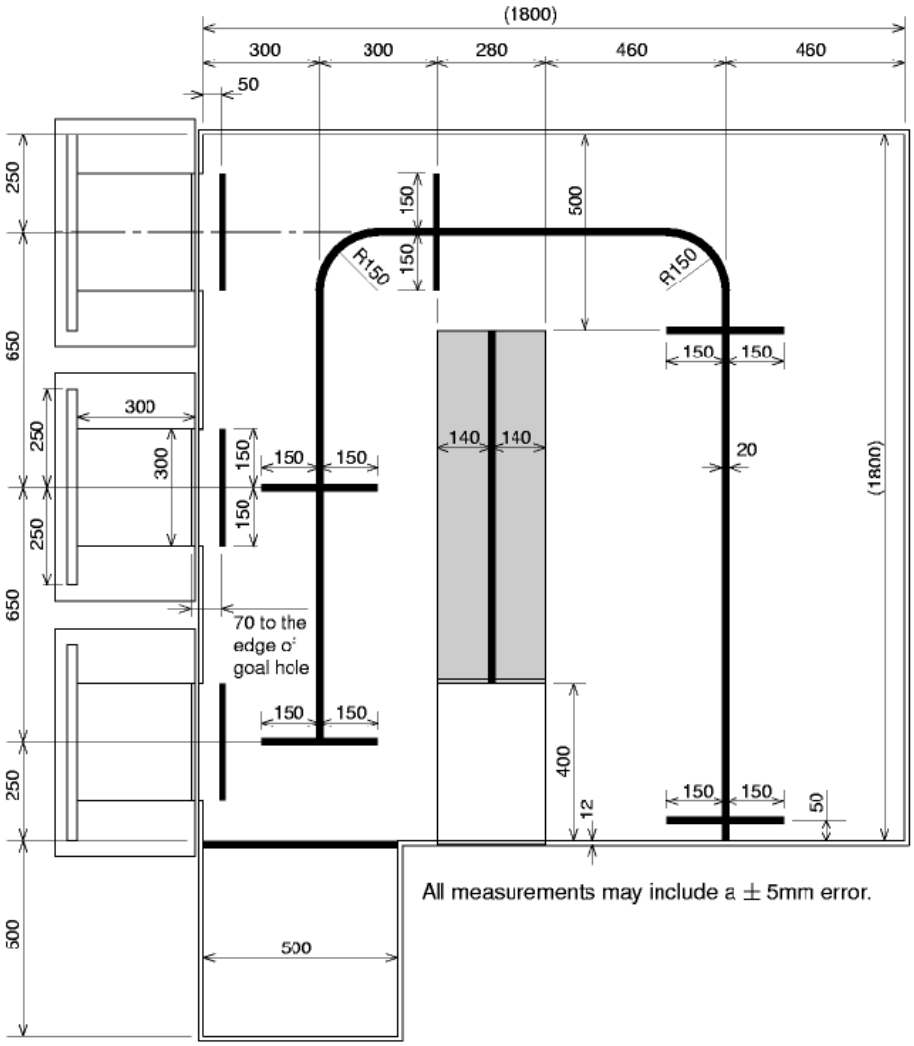
The diameter of color foam balls varies from 65mm to 70mm. The weight of each ball varies from 10g to 15g. The colors are in green, yellow and pink. There are 5 balls in each color. One of the suppliers is from http://www.promostressball.com.

5. Competition Rules

5.1. Each entry is given 1-minute setup time to get ready and 6-minute competition time to perform. Upon the setup time is over, the handler may request for 1-minute timeout otherwise the competition time starts even through the entry is not ready. Only one timeout is given to each entry.

5.2. The handler has to place all the competing robots within the starting area. The handler is only allowed to press the start/stop switch once to start the competition. For multiple robots, handler needs to press the start/stop switches on each robot together or one after another without any waiting interval.

5.3. Once the robot is pressed, it has to leave the starting area within 30 seconds otherwise it is judged as a crash. For multiple robots, at least one robot has to leave the starting area within 30 seconds otherwise the entry is judged as a crash.



Field	:	the floor: Made by lauan [19], Thickness: 15mm
	:	the wall: Made by lauan [19], Thickness: 12mm
	:	Color: horizontal surface=white vertical surface=yellow (painted)
Step	:	Made by lauan [19], Height: 40mm
	:	Color: horizontal surface=white vertical surface=yellow (painted)
Tunnel	:	Made by acrylic plate, Thickness: 10mm
Guiding Line	:	vinyl tape, Width: 19mm, Max. Error of width: -2mm, Color: black
Box of Goal	:	Thickness: 9mm, Made by lauan [19] , Color: blue, yellow and red (painted)
Buckct	:	plastics
Net	:	Green Net for baseball with 40mm×40mm stitch
Frame of the Net	:	pipes (dimeter is 28mm)
Starting Area Line	:	Same with the Guiding Line

Figure 3: The 2D Drawing of Competition field

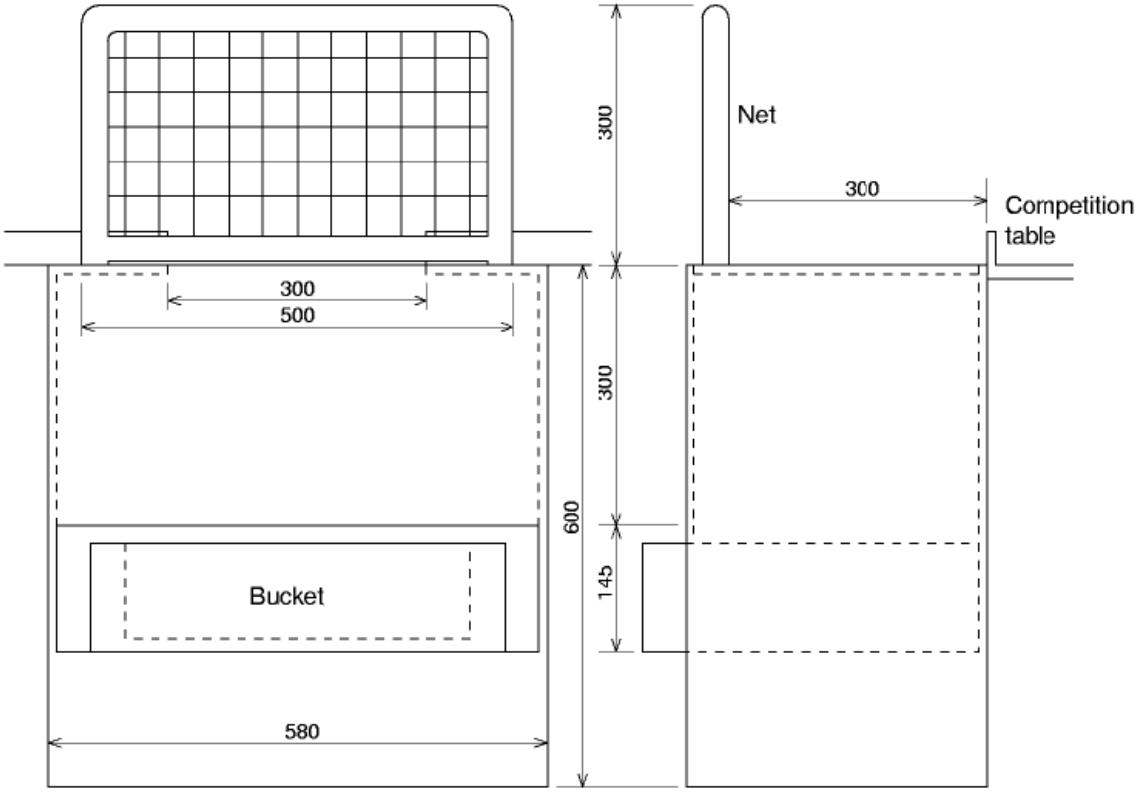


Figure 4: The Drawing of Goal-container

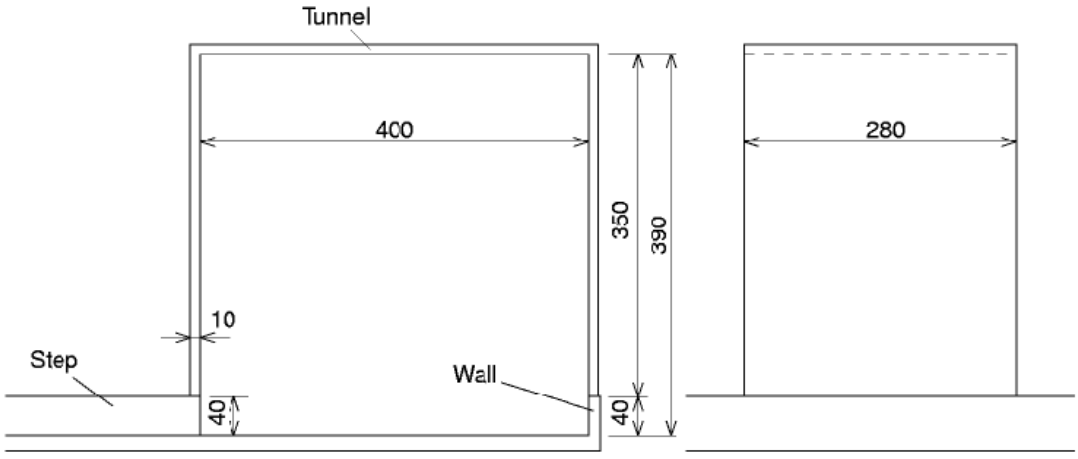


Figure 5: The Drawing of Tunnel

5.4. Each entry is given 5 chances of cash. A crash defines as whenever a competing robot is not able to perform such as any robot does not move or jam in the arena. When the handler wishes to restart the robot after a crash occurs, the handler needs to seek the judge's permission to stop the robot. For the multiple robots, all robots must stop and restart. Before restart, the handler needs to empty any tennis ball retained by the robots.

5.5. For the multiple robots using r.f. communication among themselves, the handler has to anticipate the interference arising in the environment. If any case happens and the

interference is not able to resolve, the handler needs to bear with it to proceed for the competition.

5.6. The entry shall withdraw from the competition if the entry crashes 5 times or the 5-minute competition time elapsed or the entry is dangerous to audience.

5.7. The number of color foam balls including the free ball collected and delivered into the right goal-container by the robots determines the event winners. 1 point is given to the team for the robot to deliver a ball into the right container. If a robot delivered a color ball into the wrong container, 1 point will be deduced from the team score. If there is a tier, using the number of tennis ball retained by the robots determines the winners. If the tier still remains, using the elapsed time to complete the competition determines the winners.

5.8. In the event of any ambiguity in the competition rules, the judge's interpretation shall prevail. Should a situation arise that is not addressed in the rules, the judges will decide on the matter and their decision will be final.

ROBOT SOCCER COMPETITION

INTRODUCTION

The objective of the robot soccer is to build a team of robots to play 3-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 150cm x 130cm in size with 5cm high and 2.5cm thick white side-walls will be used. The topsides of the side-walls shall be black in color with the walls painted in white (side view.) Solid 7cm X 7cm isosceles triangles shall be fixed at the four corners of the playground to avoid the ball getting cornered. The surface texture of the board will be that of a ping pong table.

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 20cm. The arc, which is part of the goal area, will be 20cm along the goal line and 5cm perpendicular to it. The major lines/arcs (centerlines, goal area borderlines and the center circle) will be white in color and 3mm in thickness. The free ball (see section 13) robot positions (circles) shall be marked in grey color.

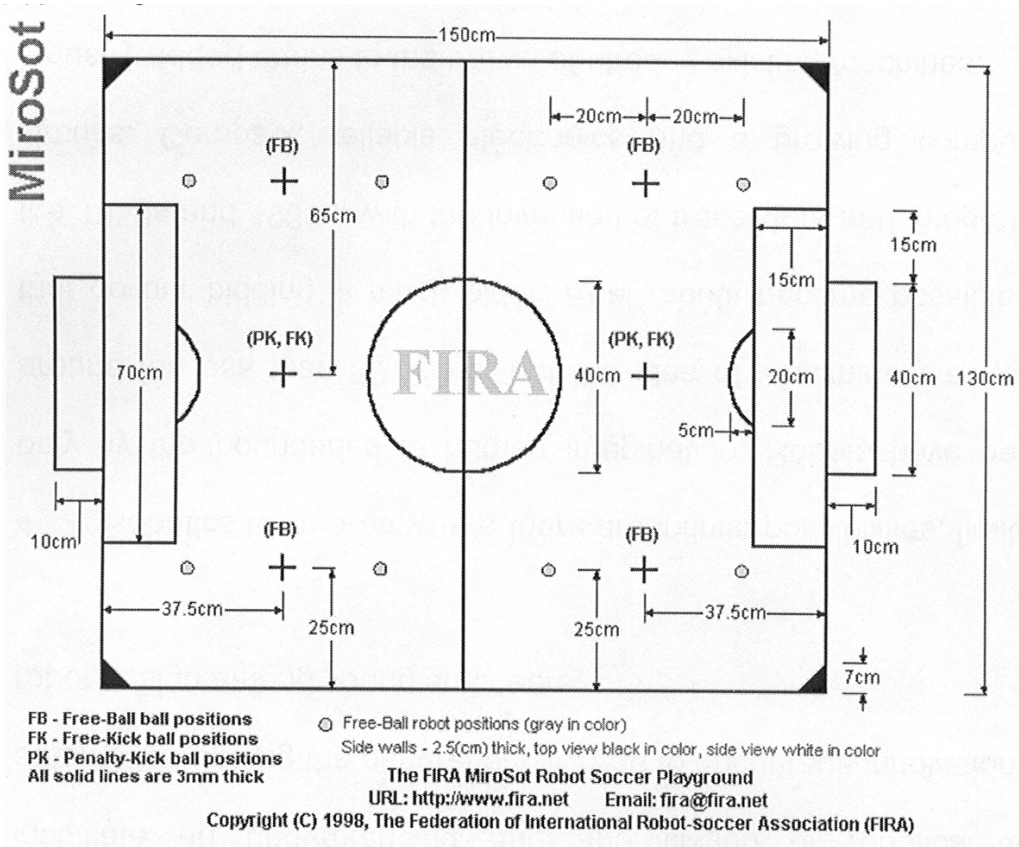


Figure 1: Dimensions and Markings on the Playground

1.3 The Goal

The goal shall be 40cm wide. Posts and nets shall not be provided 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 area shall comprise of areas contained by the rectangle (size 70cm X 15cm in front of the goal) and the attached arc (20cm in parallel to the goal line and 5cm perpendicular to it.)

1.5 The Ball

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

1.6 The Field Location

The field shall be located indoors.

1.7 The Lighting Conditions

The lighting condition in the competition site shall be fixed around 1,000 Lux.

2. THE PLAYERS

2.1 The Overall System

A match shall be played by two teams, each consisting of three robots. One of the robots can be the goalkeeper (see section 2.2.5.) Three human team members, a “manager”, a “coach” and a “trainer” shall only be allowed on stage. One host computer per team, mainly dedicated to vision processing and for location identifying, can be used. (See Figure 2.)

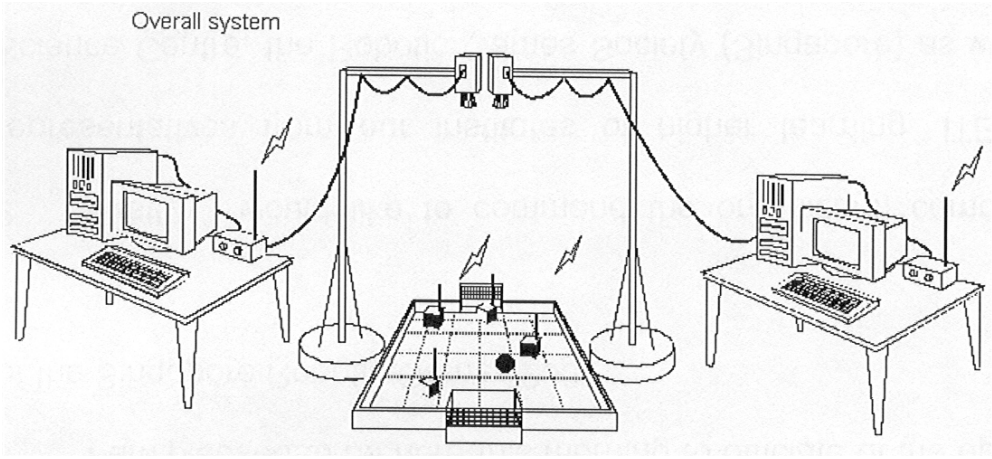


Figure 2: Overall System

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.

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 6 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.

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.)

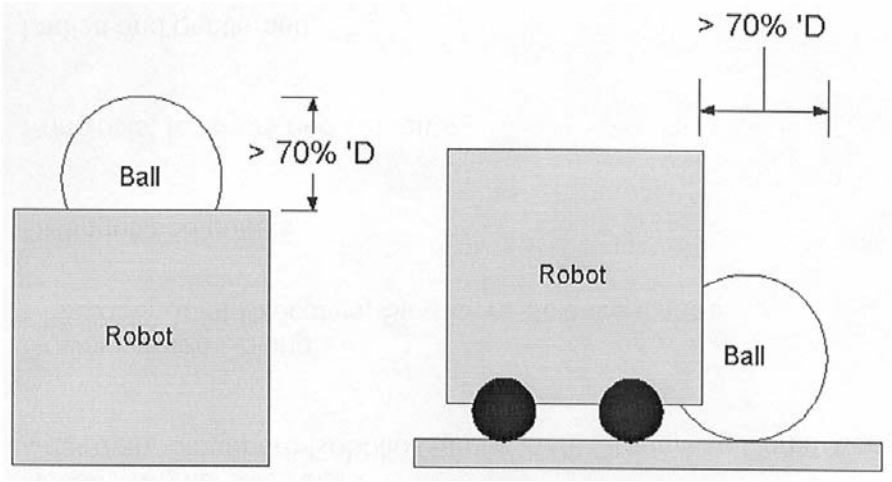


Figure 3: Catching/Holding of Ball

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 two 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 has 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 2m 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.

5. 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.

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. With a signal from the referee, the game shall be started and all robots may move freely.

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 Law 11 as only a kicker and a goalkeeper shall be allowed on the playground. The goalkeeper should be kept within its goal area and the positions of the kicker and of the ball shall be the same as per the Law 11. 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. All penalty-kicks shall be taken by a single robot and shall commence with the referee's whistle. A penalty-kick will be completed, when any one of the following happens:

(i) The goalkeeper catches the ball with its appendages (if any) in the goal area.

(ii) The ball comes out of goal area.

(iii) Thirty (30) seconds pass after the referee's whistle.

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 in 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.

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).

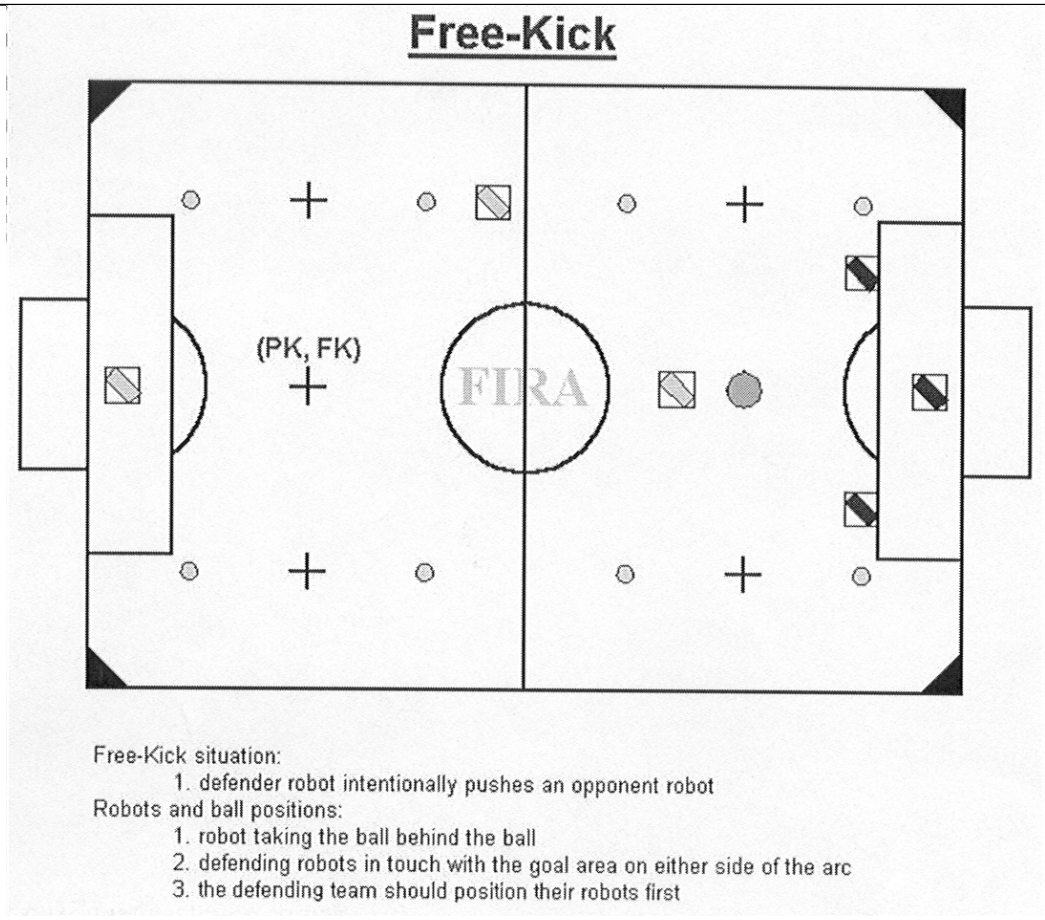


Figure 4: Free Kick Position

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 (section 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 defending robots shall be placed in touch with the goal area on either side of the arc. With the referee's whistle all robots can start moving freely.

11. PENALTY KICK (SEE FIGURE 5)

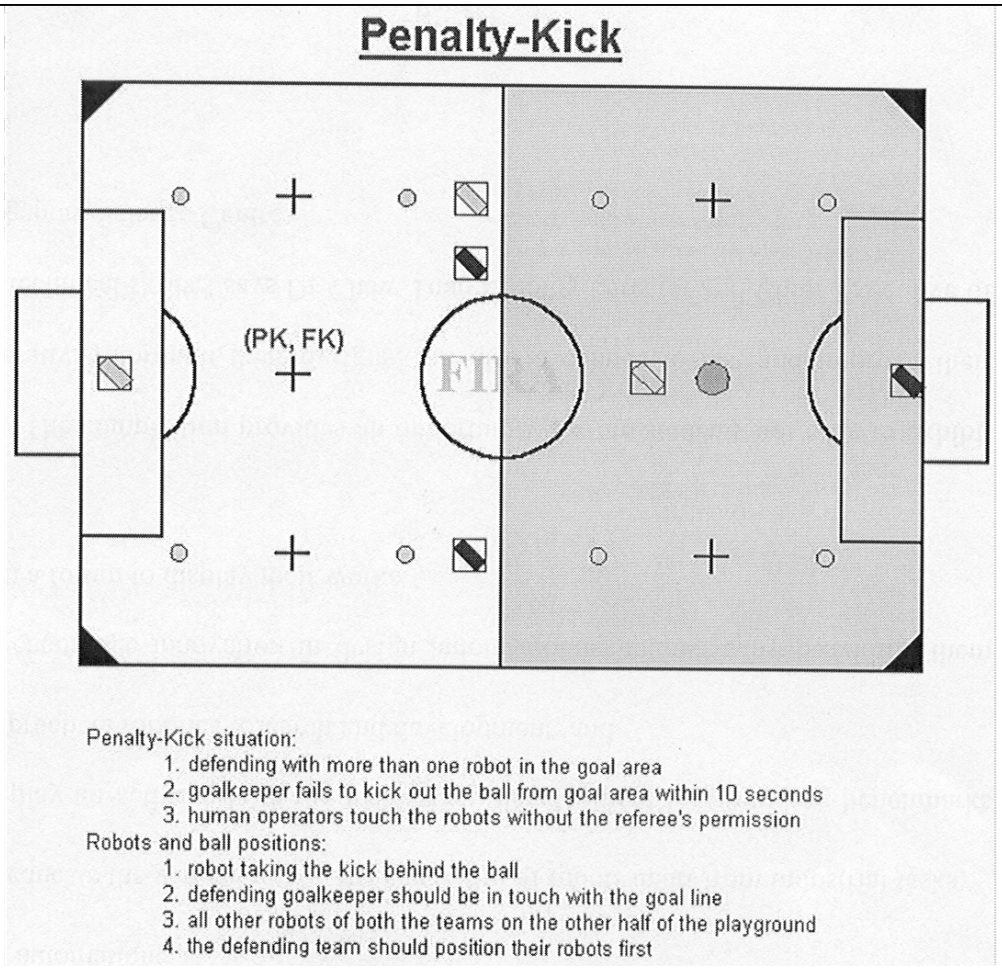


Figure 5: Penalty Kick Position

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

11.1.1 Defending with more than one robot in a goal area (section 8.4.)

11.1.2 Failure on the part of a goalkeeper to kick out the ball from its goal area within 10 seconds (section 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 (section 8.8.)

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 may be oriented in any direction. 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. The game shall restart normally (all robots shall start moving freely) after the referee's whistle. The robot taking the penalty-kick may kick or dribble the ball.

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 goalkeeper 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.)

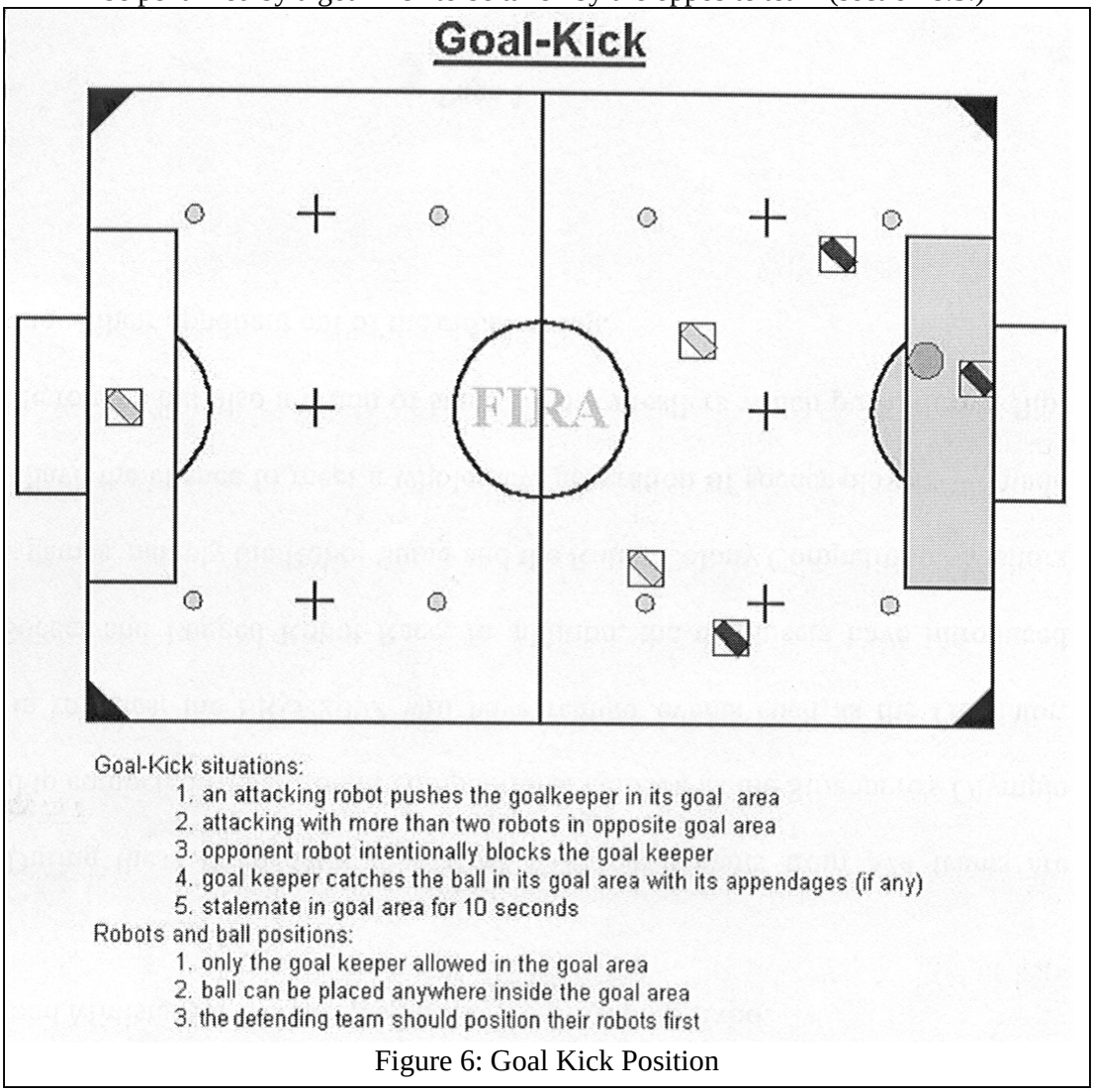


Figure 6: Goal Kick Position

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 stalemate occurs in the goal area for 10 seconds.

12.2 During goal kick only the goalkeeper will be allowed within the goal area and the ball can be placed anywhere within the goal area. Other robots of the team shall be placed outside the goal area during goal kick. The attacking team will get preference in positioning their robots anywhere on the playground, but it must be as per section 8.3. The defending team can then place its robots within their own side of the playground. 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 20cm apart from the ball position in the longitudinal 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 positioning their robots. The game shall resume when the referee gives the signal and all robots may then move freely.

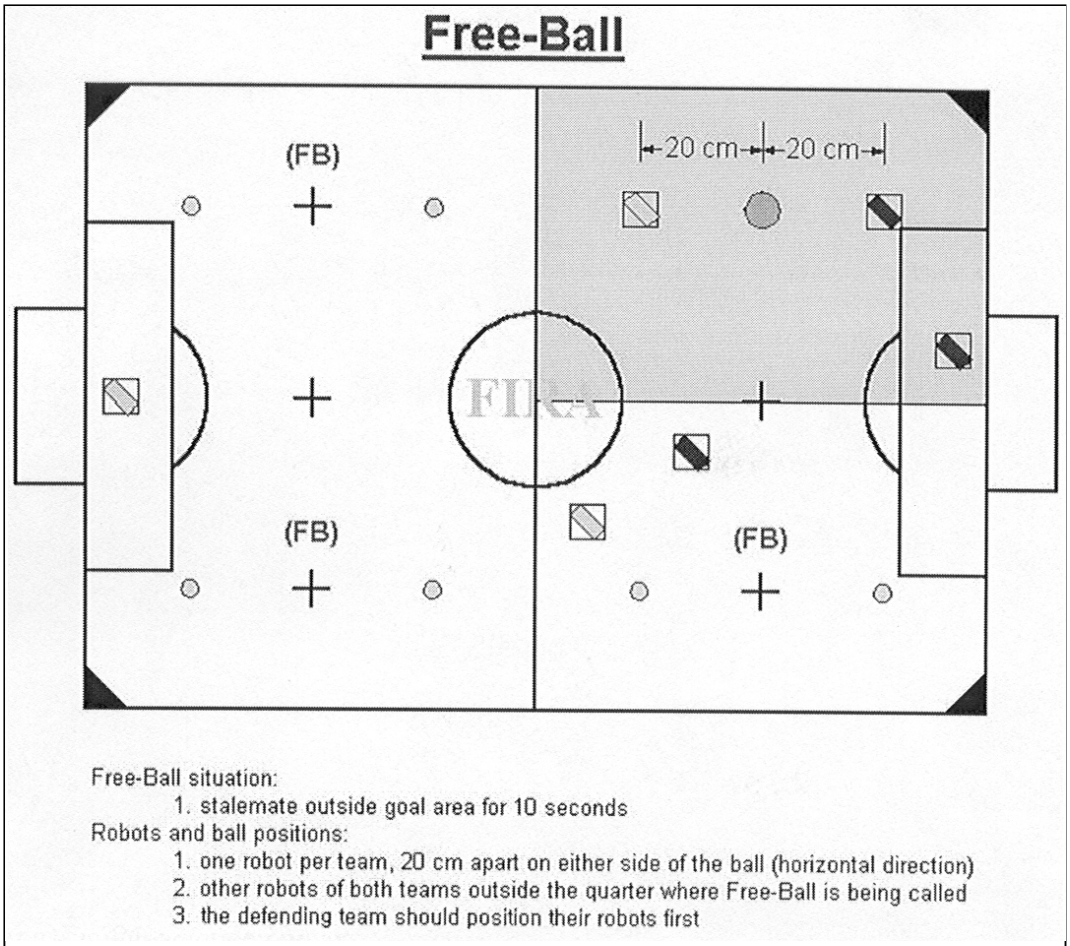


Figure 7: Free-Ball Position

SCHOOLS' ROBOTIC COMPETITION – ROBO CAN - COLLECTOR

1. OBJECTIVE

To design and build an autonomous robot that is able to follow a black path. At the end of the path, it is to collect empty cans and to return to the starting position before unloading.

2. JUDGING CRITERIA

The robot that is able to collect the most number of empty cans within the stipulated time is the winner.

3. RULES AND REQUIREMENTS

3.1 The robot is to be controlled by an on-board programmable microcontroller and powered by two 9-volt motors (from 6 AA size batteries or equivalent). The robot should not exceed 30 cm in length and width.

3.2 The field (Figure 1) is of a rectangular shape with an approximate size of 2.44 m (8 ft) in length and 1.22 m (4 ft) in width. There is a box measuring 25 cm by 25 cm at one end of the field where the robot would start and finish. Empty cans are pre-loaded on rocker arms and positioned at one end of the field.

3.3 The robot should be designed to negotiate and follow the black path (on white background). Obstacles would be placed randomly to prevent robot from taking "short cut" to reach the target. On reaching the empty can, the robot should collect it. It could then make a U-turn to the starting position following the same path taken earlier or to another track to collect a second can. Upon reaching the finishing position, the empty can should be unloaded by the handler and robot repositioned to start the next run. One point is awarded for every empty can collected. Only one handler is allowed to assist the robot at the starting and finishing position.

3.4 It is considered an aborted run should the robot drop its only empty can in the course of its run.

3.5 It is possible for the robot to collect TWO or MORE empty cans at one outing but all the cans must be brought back to the starting position without dropping along the way. Only empty cans that are brought back successfully would be counted.

3.6 There will be a "BONUS CAN" that account for 2 points and placing of this "BONUS CAN" on which track would be decided by the judges before the run commences.

3.7 The robot is given 5 minutes to collect as many empty cans as possible.

3.8 No adjustment is allowed in the open field during the run. The robot must be brought back to the starting position and restart when being inactive, disabled or out of control in the open field. This will be considered as one aborted run, and the decision to abort the run is at the discretion of the handler.

3.9 Permission may be granted for 1 recess (10 minutes) and it carries a penalty of 2 minutes on the competition time.

3.10 In the event of a tie, the robot with the least number of aborted runs during the game will be ranked the highest. On further tie, the rank will be determined by either the shortest time for a successful collection or the furthest distance covered for a non-collection, of **ONE** final run.

3.11 Each school can submit 3 entries and no cloning (identical design) are allowed. Entry closes two weeks before the competition. The robot must pass inspection at the beginning of the competition. Further details are available from the official web site.

3.12 All robots shall be caged at the beginning of the competition and will be returned only at the end of entire competition.

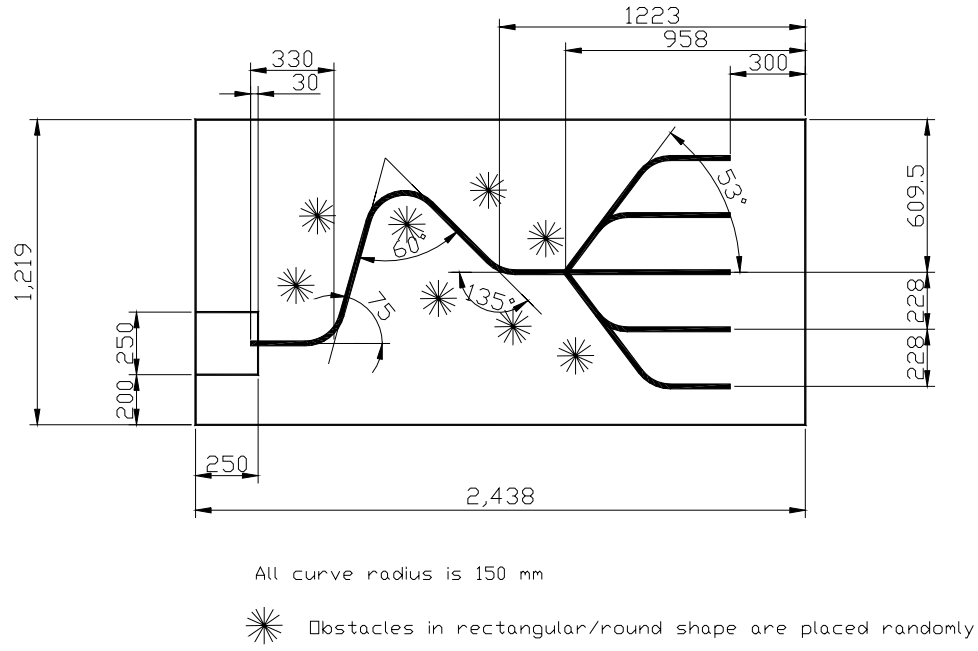


Figure 1. Playing Field

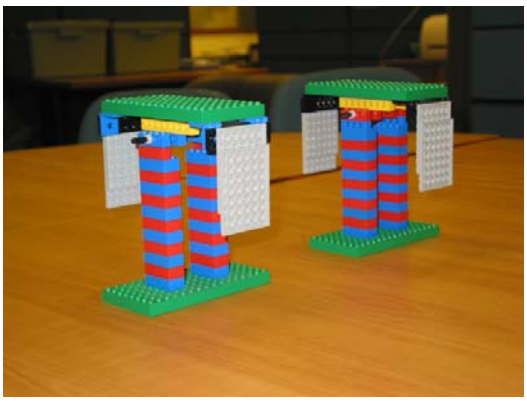


Figure 2. The Rocker Arm

VERSION NOTES (V8.0)

1. DESCRIPTION

This section lists the revisions made to the Rules in the current version as compared to the previous release. The list will only mention the specific sections revised and the pages the sections were located in the current rulebook, but not the detailed contents.

2. CURRENT REVISION (DATED 30 SEPTEMBER 2003)

No.	Event Name	Section	Page	Brief Description
1	All events	all	all	Update of Rules