**Singapore Robotic Games 2002**

18 – 20 May 2002

**Rule Book**

V 6.2

20 February 2002

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SRG Home Page: [http://guppy.mpe.nus.edu.sg/srg](http://guppy.mpe.nus.edu.sg/srg)

Rules in the SRG Home Page will be used eventually in the Games.
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**LEGGED ROBOT RACE (OBSTACLE TRACK)**

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 1m x 1m 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 1m and a maximum length of approximately 10m (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-meter **Starting Zone** and a 1-meter **Finishing Zone** at the start and the end of the 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 millimeters. There is a 50 millimeters
wide retro-reflective tape (3M Scotchlite - Industrial Grade) in the middle of the track for navigation purpose.

Figure 1 shows a top view of an example of a competition race-track. It consists of 4 straight segments (A) and 8 circular segments (B). The segments are at different elevations of 50 mm or 100 mm off the ground.

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 the last part of the robot (trailing edge) 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 before fully crosses the Finishing line.

4.4 Each robot is given 4 minutes Competition Time to produce its best result (this include setup time) Team may withdrawn temporarily within the 1st minute of competition and all successful run during the 1st minute (before they withdraw) will be voided. 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. If the robot failed to achieve any single complete run within the Competition Time, the longest distance travelled at any single attempt will be recorded instead. As for the single attempt which started just before the lapse of the competition time, it will be allowed to continue till it crosses the Finishing line or step out / fall out of the track, and the result will be recorded.

4.6 The robot need not stop in the Finishing Zone. As there might not be any track provided after the Finishing Zone, it is the participants’ responsibility to take care of their robot if it chooses to overshoot the Finishing Zone.
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 a central divider of 10mm thick and 50mm tall running along the entire track. The central divider is not a rigid wall for robot to make contact with but mainly as a guide for official to check whether any robot crosses the designated path.

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.

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 The Preliminary Matches

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.

![Table of 8 Diagram](image)

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 15 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. 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 start 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 the last part of the robot (trailing edge) crosses the demarcation line at the Finish Zone. Any robot moved before the whistle is blown will be considered a False Start. Only 1 warning will be given to False Start any robot and any subsequent False Start will be considered 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 for any of the races, the longest distance travelled at any single attempt will be recorded instead.

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 at the Finish Zone on the competition track or the robot run out of the track completely. The robot need not slow down or stop after completing on the competition track.

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. The only replacement in the robot is the power unit which was declared during caging. Replacement of power unit is not allow in a same Match. Robots are not to share each other's power unit.

5.9 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.

6. CLONING

6.1 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. Robots with the same mechanism but different driving principles will not be considered as clones.

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).

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](image)

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:
### Wall Climbing Robot Race

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<table>
<thead>
<tr>
<th>S/N</th>
<th>Criterion</th>
<th>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</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>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.</td>
<td>30 seconds</td>
</tr>
<tr>
<td>2</td>
<td>The robot is not completely autonomous – it uses an external power source.</td>
<td>30 seconds</td>
</tr>
<tr>
<td>3</td>
<td>The robot makes use of magnets in order to climb any one of the wall sections.</td>
<td>30 seconds</td>
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**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 accordance 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 3Kg 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-controlled 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 inflaming 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 only 27 MHz with FM (frequency modulation) in narrow bands from 1 to 12. Participants can use any brands for the radio-controlled console but the console must able to change the frequency crystals for different bands. The Futaba, Sanwa and Kagaku are the recommended brands for the radio-controlled console.

2.4 Labelling
No label is required on any robots.

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.

#### 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. Ball bearings must be used in the axle of rotation supporting the pole, only exception being the instrumentation potentiometer or encoder. 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.

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
The second inner line C corresponds to 18° inclination of the pole, at a distance of 30 cm from line A.

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.
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. 4b. Wedge Section (enlarged 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 The vehicle should repeat these cycles.

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

6.7 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.

6.8 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 does less than 20 seconds of initial static balancing
A = 1 if the robot completes 20 seconds of initial static balancing
B = number of cycles achieved during run time
C = 1.5, if the robot successfully completes 20 seconds of "the final static balancing" within the performance time.
C = 1.0, if the robot starts "the final static balancing" within the performance time, but the 20 seconds of "the final static balancing" extends beyond the performance time.
C = 0.0, if the robot pole falls before the 20 seconds of "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:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Round</td>
<td>Round Robin [maximum of five teams to one sub-group ]</td>
</tr>
<tr>
<td>Quarter-Final</td>
<td>Knock-out system [Draw lots for line-up]</td>
</tr>
<tr>
<td>Semi-final</td>
<td>Knock-out system</td>
</tr>
<tr>
<td>Final</td>
<td>Knock-out system [followed by Sudden Death if there is a draw]</td>
</tr>
</tbody>
</table>

2.2 During the preliminary rounds [round robin], entries are divided into several sub-groups, each with a maximum of five entries. Each entry in each sub-group will compete among themselves. Each match 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.

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 parts/mechanisms falling completely out of the body during the competition.
- any suction, anchoring or similarly 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, no matter 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 without the permission of the judges. Failure to observe this ruling will subject the participant with disqualification. However, before each level of competition i.e. quarterfinals, semi-finals and final, commences robots are allowed to replace their battery.

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 10mm to 20mm thick wood [table-tennis table quality finishing]. A Centre Line marked by blue paint [Fox-Blue: Nippon Sprayed Paint 307] of 10mm width. The arena is elevated at least 100mm above the ground level. The boundary of the arena is marked with a white reflective tape [approximately 25mm width]. The start boxes are of size 0.35m (L) x 0.5m (W). They are marked by blue paint [Fox-Blue: Nippon Sprayed Paint 307] of 10mm width. All dimensions are subject to +/- 3% tolerance. All platforms used in the competition must be uniform in size and finishing.
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.
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.

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 limited 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 a 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 = \( \frac{1}{60} \)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 $20 + \frac{1}{60}$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 $\frac{1}{100}$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.

3.2.2 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.

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

\[
\text{Score of Current Run (reached the destination successfully) = Run Time + Search Penalty + Touch Penalty}
\]

\[
\text{Search Penalty = } \frac{1}{60}\text{th of the Search Time, in seconds}
\]

\[
\text{Touch Penalty = 2 seconds}
\]

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 \( 20 + \frac{1}{60}\text{th of } (4 \times 60 \text{ seconds}) = 24 \text{ seconds} \). 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 1/100th 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:

\[
\text{Score of Current Run (reached the destination successfully) } = \text{ Run Time} + \text{ Search Penalty} + \text{ Touch Penalty}
\]

Search Penalty = \(\frac{1}{30}\)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 \(20 + \frac{1}{30}\) 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 2m x 2m as shown in Fig 1. There are no walls bordering the 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 2943035, 2941002, 2943147.
Fax: 2961762.

2.3 The centre area of the platform (dotted in the figure) (30cm x 30 cm square) will be the collection area where 30 of each coloured pellets will be placed (total 60). The orientation and layout of the coloured pellets placed in the collection area will be decided by the judges but each setup will be kept consistent for all teams.

One example of 60 pellets placement in the collection area.

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](image)

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 the centre 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 In the event that a robot runs out of the platform, it can be retrieved by the handler, the robot shall be replaced back in any start area.

5.7 If a robot appears to be malfunctioning or experiencing low battery power, the handlers may ask the judges for permission to retrieve and restart the robot from the start area.

5.8 Robots that are restarted in the start area will have any coloured pellet that it is carrying removed from the robot. The pellets will not be returned back to the platform.

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 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.
5.12 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**

1.1 The participant is required to design and build either a single robot or multiple robots to collect 15 tennis balls which are scattered on top of the specified arena plus a given tennis ball to the robot(s). The robot(s) needs to deliver all tennis balls in any 3 goal-containers within 10 minutes. The event is similar to the Intelligent Robot – Challenge Course event organized by Robofesta, Japan.

2. **ROBOT SPECIFICATIONS**

The dimensions of a robot shall not exceed 450mm (Length) x 450mm (Width) x 900mm (Height). If an entry submits multiple robots then all robots must be placed within the starting area which is 500mm (Length) x 500mm (Width). The overall robot weight shall not exceed 20 Kg.

The robot must be fully autonomous (One switch or a single key on the keyboard is only allowed to operate the robot). A robot can be self-contained or only contains the necessary parts to perform tasks in the competition arena and the host computer (system) to process the tasks shall be placed at a given table next to the arena. The connection between the host computer (system) and the robot is either by cables or by wireless modems.

If the connection is by cables, no part of the cables shall touch any objects in the arena otherwise the robot shall be disqualified. If the connection is by wireless modems, the handler must get approval from the SRG committee for the frequency that uses during registration.

3. **COMPETITION FIELD SPECIFICATION**

The 3-Dimensions view of the competition Field is shown in figure (a). The field contains 3 goal-containers at the left edge of competition field. A step is located at about the middle of the field. There are guidelines (markings) on the floor indicating the positions of the goal-containers (goal-boxes), the tennis balls area, and the step area.

![Competition Field](image-url)
The details of the dimensions of the competition field, an example of the tennis balls arrangement, and the designs of the goal-container and the tunnel are shown in figure (c), (b), and (d).

(b) An Example for Tennis Balls arrangement of Challenge Course

(c) The Details of Dimensions of Competition Field
4. GAME RULES

4.1 The robot(s) shall be placed at the starting area before the game starts. Each handler shall be given 2 minutes setup time. Any handler may start the robot(s) if he/she is ready within 2
minutes. Only single press is allowed to activate the robot. If the entry contains more than one robot, the handler is allowed to press once per robot.

4.2 Each entry is given 10 minutes to perform. The robot(s) may follow the guidelines to the tennis ball disposal area or go through the tunnel with the height limit of 390mm. The robot must be fully autonomous to search the tennis balls, to collect them and to deliver the balls to any goal-containers.

4.3 Each entry is given 5 chances of crash. A crash is defined as whenever a robot is not able to perform such as the robot(s) does not move or jams in the competition field. When a crash occurs, the handler must seek the judge’s permission to stop the robot. Before the handler restarts, the robot must empty any tennis ball collected. The handler is only allowed to press once to restart the robot.

4.4 Once the robot starts, the robot is given 30 seconds to leave the starting area otherwise the robot is considered as a crash.

4.5 An entry needs to withdraw from the competition if the robot(s) reaches 5 crashes or the 10-minute competition time reaches or the judge decides that the entry is dangerous to audience.

4.6 The performance of each entry judges by the number of tennis balls delivered to the goal-containers. If there is a tied, the time taken to deliver the tennis balls, the number of tennis balls collected but does not able to deliver and the number of crashes will be taken into consideration.

4.7 In the event of any ambiguity in the competition guidelines or rules, the judge’s interpretation shall prevail.

4.8 Should a situation arise that is not addressed in the guidelines and rules, the organizers and 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.

The robot soccer designers have to take up the challenges such as to identify their own robots, the ball, and the opponent robots through the vision information, and to establish a reliable protocol for the radio frequency communication. They need also to implement various strategies among the team robots for attacking and defending, and to manage the fouls that comprise of free ball, penalty kick, goal kick, and free kick.

1. **THE FOOTBALL FIELD SPECIFICATIONS**

1.1 The dimensions of the football field is 150cm (length) x 130cm (width) x 5cm (height). The whole field shall be made of wood and the surface texture shall be similar to the table-tennis table. The floor of the field is painted matted black and the walls that constitute the height are in white.
1.2 The markings on the football field are shown in figure 1. All markings are white in color. The thickness of marking for the half field line, the goal area box outlines, the half field circle, and the goal kick area arc outlines is 3mm. On the field, the four corners shall be fended off by 7cm to avoid the ball getting stuck at each corner. The cross markings for the penalty kick, free kick, and the free ball shall be 1mm thick and 5mm long. The solid circle markings for free ball positions are in white and of diameter 2mm.

![Figure 1: The dimensions of the Football Field](image)

1.3 The goal shall be 40cm wide. No posts and net shall be used to avoid obstruction to the global vision system.

1.4 The football field shall be located indoor and the luminous level shall be about 700 lux.

2. **Football Specification**

An orange golf ball shall be used as the football. Its diameter is 42.7mm and the weight is 46g.

3. **Robot Specifications**

3.1 The dimension of each soccer robot shall be 7.5cm (width) x 7.5cm (length) x 7.5cm (height). The robot height shall not include the antenna.
3.2 Each robot shall put on a costume and the dimension shall not exceed 8cm (width) x 8cm (length) x 8 cm (height). The costume shall not cover the antenna.

3.3 A color pad shall be printed or stuck on the top of the costume for team identification. Yellow and blue shall be used for team colors. The officials shall leave the two competing teams to decide which color to represent their robots. Otherwise the selection of team color shall be done by the toss of coin.

3.4 The dimension of color pad shall be not less than 12.25cm² or 3.5cm (length) x 3.5cm (width). The color pad shall not exceed the top area of the costume. A team may use more than one color for the robot identification provided the other color shall not be the same color as the ball (orange) or the opponent team color (yellow or blue).

3.5 All robots shall be fully autonomous (no external power source and manual control). The communication among the team robots and the host computer shall be through the radio frequency (rf). Each robot team shall accommodate two frequency channels so that no team shall share the same frequency channel with the opponent team.

3.6 Any robot may install a shooter or catcher but the overall robot size shall not exceed its allowable dimension (7.5cm (length) x 7.5cm (width) x 7.5cm (height)) when the shooter or catcher is activated. No team robot (except goalkeeper) shall be allowed to cover the ball more than 30% (neither from the side or top) when it occupies the ball. The goalkeeper robot shall hold and cover the ball completely only within the specified goal area.

The diameter of the ball D = 42.7 mm

![Top View of the Robot](image1.jpg)

![Side View of the Robot](image2.jpg)

3.7 Whenever the referee whistles, all robots shall stop either by themselves or through the commands sent by the host computer.

4. **Global Vision System Specifications**

4.1 Each team shall be allowed to use their own vision system and camera for their robots. They may use their own camera stand provided the height of the camera is 2 meters or above with respect to the floor level of the venue. The official camera stand shall be moved away if both
teams provided their own stands. If both teams are not able to settle on their stand placements, the official stand shall be used.

4.2 The height of the official camera stand is 2 meters above the floor level of the venue. There shall be only One beam across the center of the football field supported by the camera stand. Either team may mount their camera on the left or the right side of the beam. The organizer shall leave the two competing teams to settle the camera positions. Shall there be any disagreement, the organizer shall decide the camera positions for both teams by the toss of coin.

5. Host Computer Specification

Each team shall be allowed to use more than one computer (any computer) as the host computer. The host computer may send any information to the soccer robots through the rf communication while the match is in progress. But the host shall not control the motion of robots directly through the host keyboard or joystick. However the soccer strategies can be modified through the host computer while the match is paused.

6. Rules for the Competition

6.1 All participating teams shall compete among each other through a mixture of the league and knock out systems. The final decision for the competition shall be announced upon the closure of the registration.

6.2 The duration of a match for two competing teams shall be divided into two periods. Each period shall last for 5 minutes, excluding the time for robot substitution, timeout, and any fouls encountered. A timekeeper shall be appointed to stop the official clock when all these happened. There is a half time break of 10 minutes between the two periods.

6.3 Any team shall be given an additional 5 minutes if they are not able to start the match or resume the match upon the expiry of the half time break. The team shall be considered to have lost the match if they are still unable to play after the additional 5 minutes is over.

6.4 Any team shall be given 3 chances to substitute faulty robots throughout the match. These chances shall be used either in the first period or the second period or both but the total substitutions shall not exceed 3 times. However, there will be no limits to the number of substitutions during the half time break. When a team requires a substitution, the handler shall notify the referee by calling substitution and the referee shall stop the match only when a foul or free ball situation is encountered.

6.5 Any team shall be given 2 time-outs throughout the match that includes the first period and the second period. When a team requires a time-out, the handler shall notify the referee by calling time-out and referee shall stop the match only when a foul or free ball situation is encountered.

6.6 Each team shall be allowed two members to handle the match. One of the members is to operate the host computer. Another is to place the robots in the football field during the start of the match period, the substitution, the time-out, and when any foul is encountered. The rest of members shall keep away from the football field area. A referee shall be appointed by the official to blow the match. He/she shall be a neutral person and is not a member of the competing teams.
6.7 When a match is about to start, the referee shall decide which home field for the two competing teams and which team to kick off first by the toss of coin. Both teams shall settle the team color (yellow/blue) and the rf channel by themselves before seeking the referee’s decision. The kick-off team shall place their robots in their own field first, followed by the opponent team. A kick-off robot shall be placed in the opponent field (within the center circle) for the kick off.

6.8 The ball shall be placed by the referee at the center of the center circle for the kick off. The kick-off team shall pass or kick the ball back to its own field area first. If a kick-off team fails to complete this task for twice, a goal kick shall be awarded to the opponent team. The defending team has to wait for the kick-off team to touch the ball before their robots start to move.

6.9 A sample for the robot kick-off positions is given below

![Diagram](image)

6.10 The robot kick-off positions shall be applied after a goal is scored by a competing team. The loser shall be the kick-off team.

6.11 After the half time break, both competing teams shall exchange their home field before the kick-off.

6.12 A team shall be considered to have scored a goal if its robot passes/kicks the ball across the goal line. The number of goals scored shall determine the match winner. If there is a draw after the second period, the match shall continue for an additional 3 minutes under the 'sudden death' rule that is the match winner is determined by the team which scores the goal first within the additional 3 minutes. During the additional 3 minutes match, there shall be no changing of field between the two teams.

6.13 If a draw still persists after the additional 3 minutes has expired, the match winner shall be determined by penalty kicks. Each team shall be given 3 chances. Any team robot shall be the penalty kicker. The referee shall place the ball at the penalty kick marking. The kicker shall place the robot behind the ball first and the opponent goalkeeper robot shall be placed along
the goal line later. After the referee’s whistle, the goalkeeper may move freely within the goal area box and the kicker shall kick the ball. A penalty kick shall be completed, if:

1. the ball crosses the goal line,
2. the goalkeeper catches the ball in the goal area box,
3. the ball comes out from the goal area,
4. 30 seconds have passed after the referee’s whistle.

If the score is still a draw after the 3 penalty kicks from each team, the penalty kick shall proceed on a one-to-one basis until a match-winner is decided. A goal scored shall be disqualified if the kicker pushes the goalkeeper and the ball across the goal line.

6.14 There shall be 8 fouls situations, they are

6.14.1 Any robot shall not adopt pushing away the opponent robots (except the opponent goalkeeper) as the match strategy. The referee shall award a free kick to the opponent team whenever this happens. However the referee shall allow both competing robots to push each other indirectly through the ball or if the push (directly or indirectly) does not affect the play of the match.

6.14.2 Any attacking robot shall not be allowed to push the defending goalkeeper robot and the ball to score a goal. Any goal scored under this circumstance shall be disqualified. The referee shall award a goal kick to the goalkeeper.

6.14.3 The attacking team shall not send any robot to block the defending goalkeeper robot from attending the ball as the match strategy. If this happens, the referee shall award a goal kick to the goalkeeper.

6.14.4 An attacking robot shall not stay within the opponent’s goal area box for more than 10 seconds. The robot has to retrieve from the goal area within 10 seconds and then re-strike again if necessary. The referee shall award a goal kick to the goalkeeper if the attacking robot stayed longer than 10 seconds. Under no circumstances shall two attacking robots be allowed to stay in the opponent’s goal area. Whenever this happens, the referee shall award a goal kick to the goalkeeper immediately. An attacking robot shall be considered to be within the opponent’s goal area if more than 50% of its body is inside the goal area.

6.14.5 Only the goalkeeper shall be allowed to stay within its own goal area box. Any additional team robots, besides the goalkeeper; shall not stay in the goal area for more than 10 seconds otherwise the referee shall award a penalty kick to the attacking team. However, the additional team robot (other than the goalkeeper) may be allowed within the goal area provided the robot does not perform the defense or affect the play of the match. The referee shall be the judge of the situation.

6.14.6 A goalkeeper shall not hold/cover the ball for longer than 10 seconds in the goal area (2 chances) otherwise the referee shall award a free kick to the opponent team.

6.14.7 A goalkeeper shall not hold/cover the ball outside the goal area otherwise the referee shall award a free kick to the opponent team.

6.14.8 If a ball does not move for more than 10 seconds, the referee shall award a free ball to both teams.

6.15 Samples of the robot placements for various kicks are given below,
6.15.1 Free Kick – The ball shall be placed at the free kick marking by the referee. Both defending robots shall be placed along the front line of the goal area box. One of the attacking robot shall be placed behind the ball and the other shall be placed behind the robot taking the free kick. The opponent team shall place their robots first.

6.15.2 Penalty Kick – The ball shall be placed by the referee at the penalty kick marking. The defending goalkeeper robot shall be placed along the goal line. An opponent robot taking the kick shall be placed behind the ball. All other robots shall be placed in the opponent field behind the centerline. The defending team shall place their robot first. After the referee’s whistle, all robots shall wait for the penalty kicker to touch the ball before they are allowed to move freely.
6.15.3 Goal Kick – The goal kicker team can place the ball at any position within the goal area box or along the goal area box lines. The goal kicker team shall place the robot freely in the field first. The opponent team shall not place their robots beyond the free ball markings on the goal kicker’s home field.

Example: Team W gets the goal kick

6.15.6 Free Ball – There are 4 free ball placement markings provided in each quarter of the football field for which to place the ball for free ball situations, depending on which quarter the ball is in when the whistle is blown. The referee shall place the ball at the quarter’s free ball markings. The defending team shall place their robots first. Both other team robots shall be placed outside the quarter that the free ball is to be kicked.

Example: The free ball called in Area F
SCHOOLS’ ROBOTIC GAMES - SMART DELIVERY ROBOT

1. OBJECTIVE

To design and build an autonomous robot that is able to avoid obstacles and deliver objects across an open field from one base camp to another.

2. JUDGING CRITERIA

Deliver the most number of target objects to a base camp within a given time.

3. RULES AND REQUIREMENTS

3.1 The robot is to be controlled by an on-board programmable microcontroller, such as LEGO RCX, and powered by 6 AA batteries. The robot should mainly be constructed with LEGO parts and should not exceed 300 mm in length and width.

3.2 The field is of a rectangular shape with an approximate size of 2.4 m in length and 1.2 m in width. It is surrounded by two side walls of 25 mm in height and two light coloured end walls of 120 mm in height. Each end of the field serves as a base camp, which covers a zone of 300 mm from either end and marked by a base line, stretching across its full width.

3.3 Obstacles of rectangular shape, 145 mm x 125 mm and 30 mm in height, are placed at strategic locations in the field with a minimum distance of 200 mm apart.

3.4 The target objects, table tennis balls, are to be delivered one at a time.

3.5 The robot is to start from either base camp. The target object is to be loaded manually behind the base line before a delivery run. The robot should be designed to negotiate and go around the obstacles and under no circumstances should the robot be allowed to cross-over or climb-over the obstacles. On reaching the opposite camp, the robot is to cross its base line completely and unload its target object automatically. No assistance is allowed before the unloading. A maximum of two handlers are allowed to assist the robot at the base camps.

3.6 The robot is given 5 minutes to deliver as many as objects as possible. The robot may be required to perform either solo or head-to-head run, with two teams competing at the same time. Destructive strategy is not allowed.

3.7 No adjustment is allowed in the open field during the run. The robot must be brought back to the base camp 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.

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

3.9 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 delivery or the furthest distance covered for a non-delivery, of ONE final run.

3.10 Each school can submit 3 entries and no cloning (identical design) is 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.
3.11 After completing its run, the robot shall be retained for further judging and held by the organizing committee until the end of the entire competition.
VERSION NOTES (V6.2)

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 20 February 2002)

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3. Previous Revision (dated 7 November 2001)

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