# Singapore Robotic Games 2007

## RULE BOOK

**V 14.3**

**14 SEPTEMBER 2006**

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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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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.
2.3 Participants are required to submit a video clip or digital photographs (up to a maximum of 2MB in total file size,) of their entry to the organiser when you submit your entry for the qualifying round. See section 4 for details on pre-qualification.

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. **PRE-QUALIFICATION**

4.1 During the preliminary round, participants are required to submit a video clip (max 2 Mb), readable in standard MS Windows Media Player, of up to 2 minutes, or digital photos of their robot in performance sequence, (Max 2 MB in total) of their robot, by the closing date. (Refer to http://guppy.mpe.nus.edu.sg/srg/ for information.)

4.2 A panel will evaluate the entries based on the video clips submitted.

4.3 Results of the preliminary round will be announced on the web site 1 week before the competition.

4.4 Only qualified participants will be permitted to present their robots for the final round.

5. **JUDGING CRITERIA**

   - Degree of Innovation 20%
   - Design & Realisation 20%
   - Performance 30%
   - Content (Entertainment or Applications) 30%

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.
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 robots must be completely autonomous. It should contain the controller, power units and navigation sensors. The robot must not weigh more than 20 kg.

2.2 The maximum length and maximum width of the robot is restricted to a 0.75m x 0.75m 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.)

2.3 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 a minimum of two active, independently controllable degree of freedom. Each leg must demonstrate independent actuation with respect to other legs of the robot to realise a walking motion. An actuator that does not actively actuate the walking / hopping motion will not be considered as a controllable degree of freedom (e.g. solenoid to switch function of the motor).

2.5 The legged robot is allowed to have any number of legs, but each leg must conform to paragraph 2.4. The legs 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 true legged robot:

- Rotating wheel with spokes or 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.
- Legs that are mechanically synchronized/coordinated with it other legs to perform walking.
- Figure 1 refers to the various configurations which are and not acceptable.

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<th>Moving Beam Configuration</th>
<th>Insect Leg Configuration</th>
<th>Mammalian Leg Configuration</th>
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<tbody>
<tr>
<td>Not accepted</td>
<td>Accepted</td>
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2.6 The robot CAN ONLY use its legs for the locomotion and negotiating the obstacles. Except the feet of the legs, there should not be any other parts of the robot touching or 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-eight 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 \textbf{Starting Zone} and a 1 m \textbf{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. Each section of the track is not expected to be perfectly level and it may be slightly uneven. Track sections at the same elevation may be joined with a maximum step difference 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 2 shows a top view of an example of a competition race-track. It consists of 4 straight segments (A) (excluding the Starting and Finishing Zones) and 8 circular segments (B). The ‘obstacle’ segments will be at different elevations of 50 mm or 100 mm off the ground. The final track layout will be decided by the judges after the caging of the robots.

\begin{center}
\includegraphics[width=\textwidth]{fig2.png}
\end{center}

\textbf{Fig.2 - Sample Legged Robot Race Track}

4. \textbf{RULES OF COMPETITION}

4.1 The robot will be “caged” at 30 minutes before the start of the competition. Once the competition starts, no individual is allowed to access the robots in the “caging” area. Charging of batteries is not allowed in the caging area.

4.2 During the caging, the legged robot entries will be inspected to ensure that they conform to the legged robot specifications. Legged robots not meeting the legged robot specifications will be disqualified.

4.3 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 \textbf{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. If any parts of the robot that drop off during a run, that run time will not be counted.

4.4 The robot need not stop after crossing the finishing line.

4.5 The robot must keep within the designated track during the race. The run is void if any part of the robot touches the ground (outside side the track) or the robot fell off the track before it has fully crossed the Finishing line. Only the ‘feet’ of the legged robot are allowed to touch the track (horizontal surface). The designated feet size should proportionally be less than 1/5 in volume of the whole robot leg. If the undercarriage or any other part of the robot (except the feet) of the robot is seen to touch the track surface
while overcoming an obstacle, that run will be not be valid. It is the handler’s responsibility to ensure that the robot has sufficient ground clearance and components securely held together when moving over the track and obstacles.

4.6 When a robot approaches a step obstacle, if any part of the robot touches the vertical wall of a step, the run will not be disqualified only if the judges determine that this action does not give the robot an advantage in climbing over the step.

4.7 Each robot is given 5 minutes **Competition Time** to produce its best result (this include setup time). Team may withdraw temporarily within the 1st minute of competition and all successful runs 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 4 minutes competition time to produce its best result. (Depending on the final number of entries on the day of the competition, the judges may change the competition time for each entry.)

The request to temporarily withdraw will depend on the reasons given to the judges. Only minor repairs to the robot will be allowed (The following examples are allowed; Tightening of a loose gear/joint or re-plugging a connector. The following examples are not allowed; Change circuit boards or replace memory chips or motors or realigning the leg drive mechanism etc...) Modification of robot during competition is STRICTLY PROHIBITED.

4.8 Handlers of legged robots are allowed only one set of battery change to their robots during their competition time. The time they take to change the set of battery is taken as part of the competition time. This spare battery has to be caged beside the robot during the caging of all robot entries.

4.9 Winning is based on the shortest time to complete the FULL competition track. If all robots 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.

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

4.11 **Incentive for legged robots designs with 4 legs or less:** To encourage robot designs of 4 legs or less, their best run time during the obstacle run will be reduced by 20% over the other conventional entries. Their run time will be calculated as (actual run time x 0.8).

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 and the handlers will be notified by the judges if their robot has been identified as a clone.

5.2 Clones are robots with substantially identical physical appearance and walking mechanism. As a guide, for robots not to be considered clones, there should be significantly more differences between robots than there are similarities. (shifting a battery position by a few mm or shortening a component by a few mm will still be considered as being similar). Please refer to the SRG main rules on classification of clones and procedure for appeals.

5.3 The decision of the Judges will be final when implementing the rules of the legged robot obstacle event.
LEGGED ROBOT MARATHON RACE

1. OBJECTIVE
   To design a Legged Robot to travel 6 laps 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 0.6m 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 25.4m in length (1 lap.)
   3.2 The track comprises of straight, U-turn, cross-over and circular segments connected together. Each circular segment consists of a circle quadrant of radius (with reference to the retro-reflective tape) 0.5m and 1.1m (depending on inner or outer path on the track) with respect to the longitudinal centreline of the path. The U-turn segments will have radius of xxx mm and will have poles of approximate diameter 10mm and height 120mm at the centres of the 2 semi-circular path segments at both ends of the track. The entire track is constructed with 1/4-inch plywood with circular and/or straight segments 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 segments is NOT
expected to be perfectly level and it may be uneven. Track segments 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.

Fig.1 shows the top view of a sample competition race-track. The actual competition
track which consists of a 5 to 7 curve segments, 5 to 7 straight sections and one (1)
possible crossing section. The starting position and orientation will be determined by the
judges in a random manner.

Fig. 1 The Legged Robot Race Track

4. FORMAT OF COMPETITION
4.1 The running sequence of all robot entries will be determined by drawing of lots. Every
entry robot is given 3 competition chances to produce its best result.

4.2 Each robot is to run 6 laps around the closed track, winner is determined by shortest time
to complete 6 laps.

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 Each robot is given 8 minutes to perform 3 runs, including 1 change of battery after the
first run, to produce the best run time. For change of battery, only the plugging in and
plugging out without any removal of parts is allowed, i.e. no removal of covers with
screw drivers. No cleaning of robot parts and tracks are allowed.
5.3 Robot is to start from a stationary starting position, with the extremity of the robot aligned to the start line. It has to travel along the track either by walking, running or hopping, or any other motion not identified as wheeled motion. The robot has to complete the entire competition race-track for each run.

5.4 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 to the other track, except at the cross-over segment.

If any of the above situations occurs, the participant, under instruction from the judge, must remove their robot immediately. The robot is then considered to have used up 1 of the 3 competition chances.

5.5 The race and race time both starts by the blow of a whistle. 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 Start/End line at the Start Zone after 6 laps. 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 a competition chance.

5.6 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.

5.7 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 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.

5.10 Any violation of the rules above would result in the run being invalidated.

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. It consists of three sections: a two metres long horizontal section (section A) on the ground followed by a two metres high vertical section (section B) followed by a two metres long horizontal section (section C) at the top, with each section at least 0.8 metre wide. The following tolerance will applied:

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

![Figure 1: The wall for the wall-climbing robot race](image)

2.2 The vertical wall section (Section B) will be covered with a transparent Polycarbonate sheet with thickness ranging between 10 to 15 mm. The 2 horizontal top (Section C) and bottom (Section A) walls will be covered with metal sheets having matt black surface finish.

2.3 Starting / finishing white lines will be located 0.8 metre from the edge of the horizontal section (section A and C.)

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.)
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.)

![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 shall climb up the vertical section and subsequently climb 'upside-down' to the end of the top horizontal section (section C.) When the trailing end of the robot crosses the finishing line, the robot shall climb 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-B-A.

3.3 The robot that completes the entire sequence of wall sections according to paragraph 3.2 in the least time and in accordance with all the rules wins.

3.4 All robots are to be fully autonomous and self contained with their own power supply, control and intelligence built-in within the robot itself.

3.5 No human interference is allowed after the cage-in and during the run.

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

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

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

   (b) 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; and

   (c) 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; and

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

In both cases (i) and (ii), 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.

3.8 Each team shall be given a maximum of 10 minutes to produce its best result once the robot is removed from the caging area.

3.9 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.

4. The Robots

4.1 The dimensions of each of the competing robots must not exceed 0.75 metre in length and height, and 0.6 metre in width at all times while the robot is in operation.

4.2 The weight of each of the competing robots must not exceed 10 kilograms.

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 and negotiating the wall bends.

5.3 When in doubt, the decision of the Judges will be final.
RC SUMO ROBOT 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 to operate their robots through the radio-controlled console.

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 before a match.

However, it may take any shape and size once the match begins.

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 inflammable 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
2.3.1 The radio-controlled frequencies shall only be FM 27 MHz or 2.4GHz Digital Spectrum Modulation (DSM).
2.3.2 Participants who are using FM 27MHz must be capable of operating in any of its frequency bands. Participants are allowed up to two changes in frequency bands in a game. If the robot failed to proceed after the second band change, it shall be retired from the game.

2.4 Labelling
All robots must be labeled with their team names on the front of the robot. The minimum font size is Arial 24.

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 154cm including the boundary marking.
3.2 Markings

Two red-brown color starting lines (20cm x 2cm) locate at 20cm apart at the centre of the ring. 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

The tournament shall divide the participating teams into groups of maximum 4 robots. A game consists of 3 matches. Each match shall last for 2 minutes. One point shall be given to every match winner. Zero point shall be given to a draw or a loser. If a game ends with no winner, a test of strength by the two robots immediately after the last match will be the decider.

4.2 Match Winner

A robot wins when any part of the opponent robot touches the floor.

4.3 Service Time

Participants will be given one minute of Servicing-Time before the start of their game. A maximum of two members are allowed to service their robots at a designated area under supervision. Only replacement of identical parts and batteries are allowed during the Servicing-Time.

4.4 Time Out

Each team will only be given one time-out of one minute within a game (of 3 matches). The time-out will apply after the match and only for the requesting team. Changing of battery is not allowed during the time-out.

4.5 Prohibitions – No cleaning of rings by participants.
POLE BALANCING ROBOT

1. INTRODUCTION:

The competition is among the robots, which support an inverted pendulum that is free to swing around a point with two degrees of freedom, and balance it to keep it vertical by moving the point of support along a horizontal plane.

2. ACCEPTABLE VERSIONS:

2.1 The inverted pendulum may be supported by a vehicle moving along a horizontal plane in order to keep the pole vertical. Any other innovative design, which does not violate the spirit of the competition, may be allowed at the discretion of the judges.

2.2 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 driving wheels, steering wheels, or encoder wheels, must touch the surface of balance table. It must not fall off the competition table surface during the operation.

2.3 Balancing the pendulum/pole using any form of gyroscopic principle, counter weight, or non-linear friction is not admissible.

2.4 The pole support mechanism and measurement devices should in no way restrict or hold the pole at any time.

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

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

3. POLE-SUPPORT MECHANISM AND OVERALL SIZE:

3.1 The pole is shown in Fig.1. 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 pole will be supplied by the main committee.

3.3 Due to the complex nature of pole angle measurement, the participants are allowed to use their own pole support and measurement subsystems, at this point in time.
4. FRICTION TEST:

In order to uphold the integrity of the game, the pole support should offer minimum friction to the swinging pole in all directions.

4.1. Test: 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.

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.

4.2 The test in section 4.1 will be repeated after turning the robot 90 degrees around the vertical axis and placing it on the same support.

4.3 The judges may also perform the same test at any intermediate angles to satisfy themselves that the pole has two degrees of freedom. In short, the pole should be able to move along a cone surface with the pole support as the vertex, while suffering minimum friction.

4.4. The organizers 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.
4.5. In order to further reinforce the integrity of the game, handlers of each winning robot might be asked to open up the pole support mechanism and pole angle measurement system for inspection by the judges, explain the use of each part in those systems, and answer any query that may arise.

![Diagram of Pole Balancing Robot Competition](image)

**Fig.3. Friction Test Structure**

5. **COMPETITION PLATFORM:**

5.1 The competition table is shown in Fig.4. One common competition table will be used by all competitors. The table will be horizontal with a dimension of 3 m x 1.15 m. There are three regions as shown in Fig.4. A rubber mat of 1.5 mm thickness will be used on the top of the table to improve the grip of the wheels.

6. **COMPETITION:**

6.1 The robotic vehicle would operate on the top of the platform provided. Please see Fig. 4.

6.2 The vehicle will be placed within the region A. 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.
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 40 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 25 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. Time Allowed For Each Robot**

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 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 = 0.3, 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.

**10. RUBBER MAT USED:**

10.1 Brand / Manufacturer & type: Trelleborg SBR 1.5mm - 1.5m:

10.2 Vendor  
Khong Lieng Trading Co (Pte) Ltd,  
No. 16 KIAN TECK DRIVE,  
Singapore, 628833.  
Tel: 67478555,  
Fac: 67467307  
Contact person: Eri
AUTONOMOUS ROBOT SUMO COMPETITION

1. OBJECTIVE
Participants are required to build an autonomous, self-contained mobile robot that is able to push its opponent out of the specified ring according to the tournament rules. Robot handlers are to start the robot with the press of a single button.

2. ROBOT SPECIFICATIONS

2.1 Dimensions and Weight
The size of the robots shall not exceed 20cm (length) x 20cm (width). There is no height restriction. The weight of the robot shall not exceed 3 kg.
However, it may take any shape and size once the match begins.

2.2 Restrictions on robot Design
2.2.1 The robot must not have a device that interferes with the sensor operation of its opponent. e.g. Jammer, strobe light, laser & etc.
2.2.2 Robots shall not damage the arena deliberately.
2.2.3 Robots shall not throw liquid or powder or other substances at the opponent.
2.2.4 Robots shall not employ any flammable devices as a weapon.
2.2.5 Robots should not secure itself on the ring surface by using, suction cups, diaphragms, sticky treads, glue or other such devices.
2.2.6 Projectile weapons or saw-blades are prohibited.

2.3 Robot Control
The robot shall be autonomous. No external form of control or any external intervention is allowed after the start of the match.

2.4 Labelling
All robots must be labeled with of their team names on the front of the robot. The minimum font size is Arial 24.

3. RING SPECIFICATIONS (REFER TO FIGURE 1)

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 154cm including the boundary marking.

3.2 Markings
Two red-brown color starting lines (20cm x 2cm) locate at 20cm apart at 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.

3.3 Ring Condition
The ring condition is as is and participants should design and build their robots with robustness in mind.

4. GAMES RULES

4.1 Sumo Game
The tournament shall divide the participating teams into groups of maximum 4 robots.
A game consists of 3 matches. Each match shall last for 2 minutes. One point shall be given to every match winner. Zero point shall be given to a draw or a loser.
If a game ends with no winner, a test of strength by the two robots immediately after the last match will be the decider.

4.2 Match Winner
A robot wins when any part of the opponent robot touches the floor.

4.3 Time Out
Each team will only be given one time-out of one minute in a game (of 3 matches). The time-out will apply after the match and only for the requesting team. Changing of battery is not allowed during the time-out.

4.4 Service Time
Participants will be given one minute of Servicing-Time before the start of their game. A maximum of two members are allowed to service their robots at a designated area under supervision. Only replacement of identical parts and batteries are allowed during the Servicing-Time.

5. CAGING
Robots shall be inspected and caged at least 1 hour before the start of the game.

6. CLONING:
6.1 In accordance with the spirit of the competition, clones will be identified during the "caging" procedure and shall be grouped to fight against each other during the preliminary stages.
6.2 Clones are robots with substantially identical physical appearance and working principles.
6.3 When in doubt, the decision of the Judges will be final.

Figure 1
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.

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.

Figure 1: Start and Destination Points and Grid Lines for Maze
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. 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 5 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:

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

- 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 $20 + \frac{1}{60}$ of $(4 \times 60$ 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 $\frac{1}{100}$ 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 located 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 backed 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 stop 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 5 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/institutes. Each college/institute shall be limit to Four entries. 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 5 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:

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

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 \(20 + \frac{1}{60}\) of \((4 \times 60\) 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 5 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. Participants who qualify to take part in the Secondary Schools Category are strictly not allowed to take part in the Open Category. Participants from JC/ITEs may be allowed to take part in the Open Category if

- the entries are not kit sets purchased or/and subsequently modified, and
- the entries have participated and performed well in the JC/ITEs category in the same year, and
- the entries are recommended and accepted for Open Category.

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 a time limit of 5 minutes to contest on the maze. Within this time limit, the micromouse may try up to a maximum of 5 runs.

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

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

\[
\text{Search Penalty} = \frac{1}{30^{th}} \text{of the Search Time, in seconds}
\]

For example, if a micromouse, after being on the maze for 4 minutes starts a run that takes 20 seconds to reach the destination; the run will have a handicapped time score of 

\[
20 + \frac{1}{30^{th}} \text{of} \ (4 \times 60 \text{seconds}) = 28 \text{seconds.}
\]

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.

3.3.4 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 The search time shall be measured from the moment that the micromouse leaves the starting square for the first time.

3.3.6 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
Micromouse Competition

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.

3.3.7 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).

3.3.8 The handler may calibrate the sensors, if required. However the handler shall not select any strategies and enter the maze data into the micromouse. The time spent in calibration is counted towards the total given competition time of 5 minutes. Calibration is only allowed within the starting square. The micromouse is considered to have started its run if it moves out of the starting square and triggers the electronic triggering devices. Only One handler shall be allowed to operate the micromouse throughout the contest.

3.3.9 When the micromouse reaches the destination square, it may continue to navigate to other parts of the maze or make its own way back to the starting square. No manual lifting of the micromouse at the destination is allowed.

3.3.10 The handler shall not touch the micromouse while the micromouse is running in the maze unless he is given permission by the judges to do so. 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 5 minutes given. No re-scheduling of the entry due to technical problems shall be allowed.

3.3.11 An extra run is considered to be used up whenever the handler touches the micromouse.

3.3.12 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.

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. The goal is to collect and deposit equal number of the 2 different colored pellets. Points will be awarded for correctly deposited pellets and deducted for wrongly deposited pellets. Points will also be deducted for unequal number of the 2 different colored pellets deposited. The performance of each team is decided, at the end of the run time of 6 mins, by the total points accumulated. In the event that all pellets are delivered to their designated pockets before the run time of 6 mins has expired, then the shortest time taken 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](image)

2.2 The starting locations for the 2 robots must be at the 2 Start Areas. 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 matt black paint and the lines taped out with 1cm wide 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: 6742-3035, Fax: 6842-0233
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](image)

3.2 The material specification of the pellets is as follows:
- **Green** (Nyloil) RS 771-162
- **Blue** (Tuffset) RS 771-538 (RS Catalog April 2006/2007 - Pg 1693)

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 robots must be fully autonomous with their own locomotion and must receive no outside help. The robots are however free to communicate wirelessly with each other for cooperative benefits.

4.3 One robot must be designated as a “Master” and the other a “Slave”. The “Master” will command/instruct the “Slave” to move out of the Start Area at the beginning of the competition. See “Section 5 - Rules for the Contest” for further details.

4.4 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.

4.5 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 pair of colour pellets in its colour delivery area will be awarded 2 points, and each incorrect colour pellet in any pocket will have 1 point deducted from the total score. For every pellet which does not form a successful pair will have 1 point deducted from the total score. One green and one blue pellet are deemed a pair of pellets.

Example:

Blue Delivery Area: 10 Blue / 3 Green collected and deposited
Green Delivery Area: 15 Green / 1 Blue collected and deposited

Scoring:

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 successful pairs</td>
<td>20 points</td>
</tr>
<tr>
<td>3 + 1 wrong pellets</td>
<td>-4 points</td>
</tr>
<tr>
<td>5 unsuccessful pair pellets</td>
<td>-5 points</td>
</tr>
<tr>
<td>Total Score</td>
<td>11 points</td>
</tr>
</tbody>
</table>

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 robots shall be placed within the Start Areas. The “Master” robot shall be started by pressing a "start" button once by one handler under the officials' instructions. The “Master” robot will then instruct/command the “Slave” robot to start. The “Slave” robot must start immediately, failing which the “Slave” robot must then be started manually with its own “start” button. The manual starting of the “Slave” robot at the beginning of the competition will constitute 1 restart and incur a penalty of 10 points. 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 entry 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 CONTEST

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 colours. Each colour has 5 foam balls. The collected colour balls are delivered into 3 different goal-containers according to their respective colours within 6 minutes. The colour foam balls are placed 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.

Each robot has to provide a start/stop switch for the handler to commence the contest. In the case of multiple robots, the handler has to activate all the start/stop switches together. Otherwise, one of the competing robots has to provide a master start/stop switch to activate all robots. If the competing robots communicate through radio frequency (r.f.), the handler has to declare the frequency upon the submission of the entry.

Please note that no external input on selection of tactics on any robot is permitted throughout the competition. The use of external power is also not allowed.

3. COMPETITION FIELD SPECIFICATION

A 3D view of competition arena is shown in figure 1. The 2D drawings with dimensions and markings of the field, the goal-container and the tunnel are shown in figure 3, 4 and 5.
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](http://www.promostressball.com).

5. COMPETITION RULES

Figure 2 shows the competition layout. There are 8 regions where the balls will be placed. Note that these regions, which are appeared as 4x2 dotted-line matrix in the figure, will not be marked on the actual competition platform. The position of the balls will be made known only after all the participating robots are submitted. The same arrangement of balls will be used for all the participants.

![Figure 2: The Competition Layout](image)

6. COMPETITION RULES

6.1. 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.

6.2. 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.
6.3. 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.

Figure 3: The 2D Drawing of Competition field

- **Field**: the floor: Made by lauan [19], Thickness: 15mm
- **Step**: Made by lauan [19], Height: 40mm
- **Tunnel**: Made by acrylic plate, Thickness: 10mm
- **Guiding Line**: vinyl tape, Width: 19mm, Max. Error of width: ±2mm, Color: black
- **Box of Coal**: Thickness: 9mm, Made by lauan [19], Color: blue, yellow and red (painted)
- **Bucket**: plastics
- **Net**: Green Net for baseball with 40mm×40mm stitch
- **Frame of the Net**: Steel pipes (diameter is 28mm)
- **Starting Area Line**: Same with the Guiding Line
6.4. Each entry is given 5 chances of crash. 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.

6.5. For the multiple robots using r.f. communication among them, 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.

6.6. The entry shall withdraw from the competition if the entry crashes 5 times or the 6-minute competition time elapsed or the entry is dangerous to audience.

6.7. The number of color foam balls 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 deducted from the team score. If there is a tie, using the number of tennis ball retained by the robots determines the winners. If the tie still remains, using the elapsed time to complete the competition determines the winners.

6.8. 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 5-a-side football against an opponent robot team. Each robot soccer team shall setup a global vision system, which is above the football field, to keep track of their robots and ball positions. A host computer may process the vision information and send the motion commands to soccer robots through radio frequency communication.

**1. THE FOOTBALL FIELD AND THE BALL**

1.1 Football Field Dimensions

A black (non-reflective) wooden rectangular playground 220cm X 180cm in size with 5cm high and 2.5cm thick white side-walls will be used. The 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 25cm. The arc, which is part of the penalty area, will be 25cm along the goal line and 5cm perpendicular to it. The major lines/arcas (centerline, goal area borderlines and the center circle) will be white in color and 3mm in thick. The free ball (Section 13) robot positions (circles) shall be marked in gray color.

![Figure 1: Dimensions and Markings on the Playground](image)

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 areas (The region A of Figure 1) shall comprise of the area contained by the rectangle (sized 50cm X 15cm in front of the goal.)

1.5 The Penalty Area
   The penalty areas (The region B of Appendix 1) shall comprise of areas contained by the rectangle (sized 80cm X 35cm in front of the goal) and the attached arc (25cm in parallel to the goal line and 5cm perpendicular to it).

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

1.7 The Field Location
   The field shall be located indoors.

1.8 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 five robots. One of the robots can be the goalkeeper (Section 2.2.5). Three human team members, a "manager", a "coach" and a "trainer" shall only be allowed on stage. More than one host computers per team, for vision processing and location identifying can be used.

   ![Overall System](image)

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 10 different color patches, other than blue and yellow, for individual robot identification.
2.2.4 To enable infrared sensing a robot's sides should be colored light, except at regions necessarily used for robot functionality, such as those for sensors, wheels and the ball catching mechanism. The robots should wear uniforms and the size of which shall be limited to 8cm X 8cm X 8cm.

2.2.5 A robot within its own goal area (Section 1.4) shall be considered as the "goalkeeper". The goalkeeper robot shall be allowed to catch or hold the ball only when it is inside its own goal area or penalty area.

2.2.6 Each robot must be fully independent, with powering and motoring mechanisms self-contained. Only wireless communication shall be allowed for all kinds of interactions between the host computer and a robot.

2.2.7 The robots are allowed to equip with arms, legs, etc., but they must comply with the size restrictions (Section 2.2.1) even after the appendages fully expanded. None of the robots, except the single designated goalkeeper, shall be allowed to catch or hold the ball such that more than 30% of the ball is out of view either from the top or from the sides. (See Figure 3.)

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 have to be moved after the side change at halftime. If both teams wish to keep their cameras over and above the center circle of the playground, they shall be placed side by side, equidistant from the centerline and as close to each other as possible. The location of the overhead camera or sensor system should be at a height of 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.

6. **GAME COMMENCEMENT**

6.1 Before the commencement of a game, either the team color (blue/yellow) or the ball shall be decided by the toss of a coin. The team that wins the toss shall be allowed to choose either their robot's identification color (blue/yellow) or the ball. The team who receives the ball shall be allowed to opt for their carrier frequency band as well.

6.2 At the commencement of the game, the attacking team will be allowed to position their robots freely in their own area and within the center circle. Then the defending team can place their robots freely in their own area except within the center circle.

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 Section 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 Section 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 is not there for defense or if it does not directly affect the play of the game. The referee shall judge the penalty-kick situation when the additional robot in the goal area is not there for defense or if it does not directly affect the play of the game. The referee shall judge the penalty-kick situation.

8.5 It is referred to as handling, as judged by the referee, when a robot other than the goalkeeper catches the ball. It is also considered as handling, if a robot firmly attaches itself to the ball such a way that no other robot is allowed to manipulate the ball.

8.6 The goalkeeper robot should kick out the ball from its goal area (defined in Section 1.4) within 10 seconds. The failure to do so will be penalized by giving a penalty kick to the opposite team.

8.7 Giving a goal kick to the team of the goalkeeper will penalize the intentional blocking of a goalkeeper in its goal area.
8.8 Only the referee and one of the human members of a team (manager, coach or trainer) shall be allowed to touch the robots. The award of a penalty-kick shall penalize touching the robots without the referee's permission.

8.9 A penalty kick is awarded against a team whenever three robots of the opponent team are all together staying inside the penalty area while the ball is in play. (Only the robot whose 50% or more of the body enters the penalty area should be considered as staying inside the penalty area). In case a robot crosses through its own penalty area without intention of defense, this robot shall not be considered as staying inside the penalty area.

9. **PLAY INTERRUPTIONS**

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

9.1 A robot has to be changed.

9.2 A robot has fallen in such a way as to block the goal.

9.3 A goal is scored or a foul occurs.

9.4 Referee calls goal kick (Section 12) or free-ball (Section 13).

10. **FREE KICK (SEE FIGURE 4)**

When a defender robot intentionally pushes an opponent robot, a free kick will be given to the opposite team (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 two defending robots are allowed to be placed at the leftmost and rightmost sides in touch with the front goal area line. With the referee's whistle all robots can start moving freely.

11. **PENALTY KICK (SEE FIGURE 5)**

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

11.1.1 Defending with more than 1 robot in goal area (Sec. 8.4.)

11.1.2 Failure on the part of a goalkeeper to kick out the ball from its goal area within 10 seconds (Sec. 8.6.)
11.1.3 When any one of the human members touches the robots without the referee's permission, while the game is in progress (Sec. 8.8.)

11.1.4 Three robots of one team stay inside their own penalty area (see Section 8.9).

11.2 When the referee calls a penalty-kick, the ball will be placed at the relevant penalty kick position (PK) on the playground (Figure 1). The robot taking the kick shall be placed behind the ball. While facing a penalty kick one of the sides of the goalkeeper must be in touch with the goal line. The goalkeeper 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.)
12.1.3 When an opponent robot intentionally blocks the goalkeeper in its goal area (section 8.7.)
12.1.4 When the goalkeeper catches the ball with its appendages (if any) in its own goal area.
12.1.5 When a stale-mate occurs in the goal area for 10 seconds.
12.2 During goal kick only the goalkeeper will be allowed within the goal area and the ball can be placed any-where within the goal area. Other robots of the team shall be placed out-side the goal area during goal kick. The attacking team will get preference in position-ing their robots any-where on the play-ground, but it must be as per Section 8.3. The defending team can then place its robots within their own side of the play-ground. The game shall restart with the referee's whistle.

13. **FREE BALL (SEE FIGURE 7)**

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

13.2 When a free-ball is called within any quarter of the playground, the ball will be placed at the relevant free ball position (FB) (Figure 1). One robot per team will be placed at locations 25cm apart from the ball position in the longi-tudinal direction of the playground. Other robots (of both teams) can be placed freely outside the quarter where the free-ball is being called, but with the rule that, the defending team will get their preference in position-ing their robots. The game shall resume when the referee gives the signal and all robots may then move freely.
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 a can of weight 200g OR 300g and to return to the starting box before unloading.

2. JUDGING CRITERIA

The robot which has the highest accumulated weights of all the collected “cans” within the stipulated time of FOUR minutes is the winner.

3. RULES AND REQUIREMENTS

3.1 The robot is to be controlled by an on-board programmable microcontroller and powered by 6 AA batteries or its equivalent of 9V (6 x 1.5V). The robot should not exceed 25 cm in length and width.

3.2 The field (Figure 1) is of a rectangular shape with an approximate size of 176 cm by 144 cm, and is constructed using the proprietary Plegofield (www.plegofield.com). There is a black path (on white background) leading to FIVE separate paths, at the end of which a “can” could be pre-loaded on one of these five rocker arms (Figure 2). There is also a starting box measuring 25 cm by 25 cm at one end of the field where the robot would start and finish.

3.3 The robot should be designed to negotiate and follow the black path. Obstacles would be placed randomly by the judges just before competition commences to prevent robot from taking “short cut” to reach the “can”. Other fixed obstacles (Figure 3) are placed near the end of each path. Two cans, one 200g and another 300g, are loaded randomly on the rockers. Upon reaching the end of path, the robot has to collect ONE of the two “cans”. Robot should make contact with the rocker arm to dis-lodge the “can” onto its receptacle. Robot must then carry the “can” (off the ground), and bring it back to the starting box. Upon reaching the finishing position (when any part of the robot body touches the starting box outline) the “can” is unloaded by the handler and robot repositioned within the starting box to start the next run to collect the next “can”. The uncollected “can” will be removed and another two “cans” (one 200g and 300g cans) will be placed randomly on any two of the 5 available positions by the judge during the time the robot makes its return run. Only one “can” is to be collected for each run and 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 “can” on the field in the course of its run. The robot is to start from the starting position and the 2 “cans” will be placed on any rocker arms by the judge.

3.5 The robot is given four minutes to collect as many cans (of either weighs) as possible.

3.6 No adjustment is allowed in the open field during the run. The robot must be brought back to the starting box 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.

3.7 Permission may be granted for 1 recess (10 minutes) and it carries a penalty of 2 minutes on the competition time.
3.8 In the event of a tie, **the robot that collect the heaviest “can” first will be ranked highest.** If there is still a tie, the robot with the least number of aborted runs during the game will be ranked next. On further tie, the rank will be determined by either the shortest time for a successful collection of the heaviest can or the furthest distance covered for a non-delivery, of ONE final run.

3.9 Each school could 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.

3.10 All robots shall be caged at the beginning of the competition and will be returned only at end of the entire competition.
FAQ (Frequently Asked Questions)

1. Must we use only Lego parts. Can we use parts from other sources?

*There is no restriction on parts used.*
2. How many motors are allowed?
   *No limits on number of motors used. However, you are limited in the use of maximum 9 V (6 x 1.5V) battery source.*

3. How many sensors are allowed?
   *No restriction on number of sensors used.*

4. Are we allowed to use other microprocessors beside the RCX and other type of sensors supplied with Lego Mindstorm?
   *There are no restrictions microprocessor and sensors used.*

5. Can my robot collect more than one can at a time?
   *No, robot can only collect one can at one time.*

6. What brand is the can drink?
   *We use Jia Jia Herbal Tea cans.*

7. What is filled inside the can to make its weight 200g and 300g?
   *Beans.*

8. Will there be a practice run?
   *Due to constrain in the venue, we could only set up the track on the actual day. We might consider allowing practice time one to two hours before event commences.*

9. Are we allowed to measure the light sensor values so that we can program it on our robot before caging?
   *Please do so during practice runs, usually few hours before the event.*

10. What does caging mean?
    *Only participating robots need to be caged in a common area before the start of competition. Caged robot will only be released back to the students until the end of the whole competition.*

11. Can I take back my robot if I know I have no chance of winning any medal?
    *Usually you are not allowed to take back your robot till the end of the competition. However, we understand that some school need to leave early as the bus is waiting etc. In that case, we allow early return of robots provided all the teams from the same school have completed their runs and are out of contention for any medals.*

12. Must the entire robot start behind the starting line or can some parts of the robot be in front of the line such as the light sensor?
    *The entire robot including sensors, arm etc need to be behind the starting red line.*

13. Must the robot follow the line strictly. Can we just program the robot to go straight without following the line.
    *Robot must follow the line to reach the “can” as there are obstacle placed randomly everywhere and robot will not be able to take any short-cut.*

14. Is flash photography allowed during the runs?
    *Flash is not allowed as flash might effect the light sensors.*

15. Are we allowed to wipe the playing field with a dry cloth before starting the run?
    *Yes, but please inform the judges first to get his/her permission.*
UNDERWATER ROBOT COMPETITION

1. OBJECTIVE

Underwater vehicles are vital to port & harbour security, naval and scientific exploration, underwater cleaning etc. This fun-filled and challenging competition aims to introduce students to this fascinating world so that they can explore career opportunities in this field. The competition will spur interest and promote education in this area and motivate young and aspiring engineers and scientists to further pursue this field.

The competition aims at the following long term goals

- Address shortage of skilled individuals to support advanced marine engineering in Singapore
- Reach more students & get them interested in the industry. Help students develop the skills to support marine engineering early on through fun filled activities
- Complement & expand educators’ knowledge and expertise in this field

2. BRIEF DESCRIPTION OF MISSION

2.1 The team of contestants have to design and build a remote operative vehicle (ROV) or an autonomous underwater vehicle (AUV).

2.2 The mission involves the picking up of as many objects (cargoes, one at a time) from the middle section of the tank and dropping them in baskets at either ends of the tank. At the end of each run the number of objects in each basket ideally should be equal. For ROV’s, each pair (one in each basket) gets four (4) points and remaining unpaired objects in the basket get one point each. For AUV’s, they shall be awarded double the points for ROV’s, as well as a bonus of two (2) points on condition that the robot(s) deliver(s) at least one (1) object into the basket.

2.3 While doing so they would have to maneuver through window frames which will be non magnetic on either sides of the tank. Hitting the windows will cause the team to lose points.

3. TANK SPECIFICATIONS

3.1 The game will be played in a L-shaped tank of dimension: 1425mm x 1425mm x 500mm. The tank has a glass of 12.5 mm thickness. See Figure 1 for details.

3.2 There shall be two rectangular window frames, 20mm thickness, one on each sections of the tank 50mm from the ends of the tank. See Figure 2 for detailed dimensions.

3.3 The centre section of the tank will have a bump which is 12.5mm in height.

3.4 In the central area of the tank there shall be a cargo holder containing 16 objects arranged in a grid. See Figure 1 layout.

3.5 The cargo holder will be a square of 100mm sides with the sixteen objects arranged in a grid. The cargo holder will be made from a non-magnetic material. See Figure 3.

3.6 The cargo to be lifted will be nuts as shown in Figure 4. The nuts will be ferromagnetic and weigh between 20g to 30g.

3.7 A black tape, 5cm thick, will run through the centre of the tank and on both sides of the tank at a height of 20cm from the bottom.
3.8 There are two basket areas at both ends of the tank. There will be a barrier of about 2cm in height separating the basket from the rest of the tank.

Figure 1: Tank Dimensions (in mm)
4. **ROBOT SPECIFICATIONS**

4.1 The robot should at the start of competition fit in a box of 30cm (width) x 30cm (length) x 30cm (height). Any vehicle found violating the dimensions shall be disqualified immediately.

Figure 2: Rectangular Window Dimensions (in mm)

![Rectangular Window Dimensions](image)

Figure 3: Cargo Holder Dimensions (in mm)

![Isometric view of Cargo Holder with cargoes](image)
4.2 During any attempts, the vehicle should not exceed 40cm in any one dimension. This specification however does not prevent the initial vehicle from splitting up into multiple parts as long as the above conditions are satisfied. The later condition above would then apply to each completely disconnected part. However, at the start of the competition, the vehicle must be assembled as a single unit.

![Diagram of cargo dimensions](image)

Figure 4: Cargo Dimensions (in mm)

4.3 In case of AUV’s, the method of wall sensing is at the discretion of the builder. However, the AUV must not exert a force on any wall of the tank likely to cause damage.

4.4 Wheeled or legged machines running on the tank bottom surface will not be allowed. Any other method of propulsion is at the discretion of the builder, provided that the power source is non-polluting. Use of any kind of explosive material is prohibited. Nothing may be deposited off by the machine in the tank.

5. Judging Criteria

5.1 For non-autonomous robots, points shall be awarded in the following manner:
   5.1.1 4 points for each pair of objects (one in each basket.)
   5.1.2 1 point for any unpaired object left in either basket.

5.2 For autonomous robots, the points scheme shall be as follows:
   5.2.1 2 bonus points for autonomous vehicles if it drops at least one object.
   5.2.2 8 points for each pair of objects (one in each basket.)
   5.2.3 2 point for any unpaired object left in either basket.

5.3 The time for the first cargo to be dropped will also be recorded, and shall be used as a tie-breaker.

5.4 Penalties shall be imposed for the following:
   5.4.1 Touch penalty - 2 points will be deducted if any part of the robot, including the cargo, touches any part of the window frame during one pass through it.
   5.4.2 There is no penalty for hitting the tank walls otherwise.

6. Rules for Competition

6.1 Each team will be given a competition time of 20 minutes, inclusive of setup time. Each robot is given a maximum of 3 attempts within the competition time, each attempt is limited to a maximum of 6 minutes.

6.2 Robots shall start from either end of the competition tank. The starting line shall be 40 cm from either edge of the tank, and the robots may not be placed beyond this line at the start. Once team has chosen the starting end, all attempts shall proceed from the same position.
6.3 The attempt with maximum points will be considered as the team’s final score. And the time recorded for the first cargo drop for the chosen attempt shall be used as tie breaker.

6.4 Any objections or appeals on discrepancies on points awarded must be raised within 5 minutes after the team completes its competition attempts and its points displayed on the official results board. Objections/appeals should be submitted in the official appeals form available at the Reception Counter to the event chairperson. No further appeals and objections shall be entertained after the given window.

6.5 Judges decision is final and binding to all.

6.6 All robots will be caged half an hour before competition starts and would be checked for safety and cloning. Robots found to be of unsafe nature shall be disallowed.

6.7 The objects have to clearly fall within the basket. Objects on the basket barrier shall not be counted.

6.8 Any dropped object outside the cargo holder or basket will be considered out of play.

6.9 Each vehicle can lift only one object at a time. However while picking up objects within the cargo area, if multiple objects are picked, excess objects can be dropped back without penalty. In other words the vehicle should be carrying only one object once it is out of the cargo area. If multiple objects are carried at one time out of the cargo area, all of them will be considered out of play.

6.10 Only two handlers are allowed in the competition arena for each team and only one remote controller is allowed in case of an ROV.

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.

Figure 5: Isometric view of Competition Setup
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.
**VERSION NOTES (V14.3)**

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 14 SEPTEMBER 2006)**

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<td>Added Cloning rule.</td>
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3. **PREVIOUS REVISION (DATED 1 SEPTEMBER 2006)**

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4. **PREVIOUS REVISION (DATED 10 MAY 2006)**

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