

WALL CLIMBING ROBOT RACE

1. OBJECTIVE

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

2. THE COMPETITION ENVIRONMENT

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

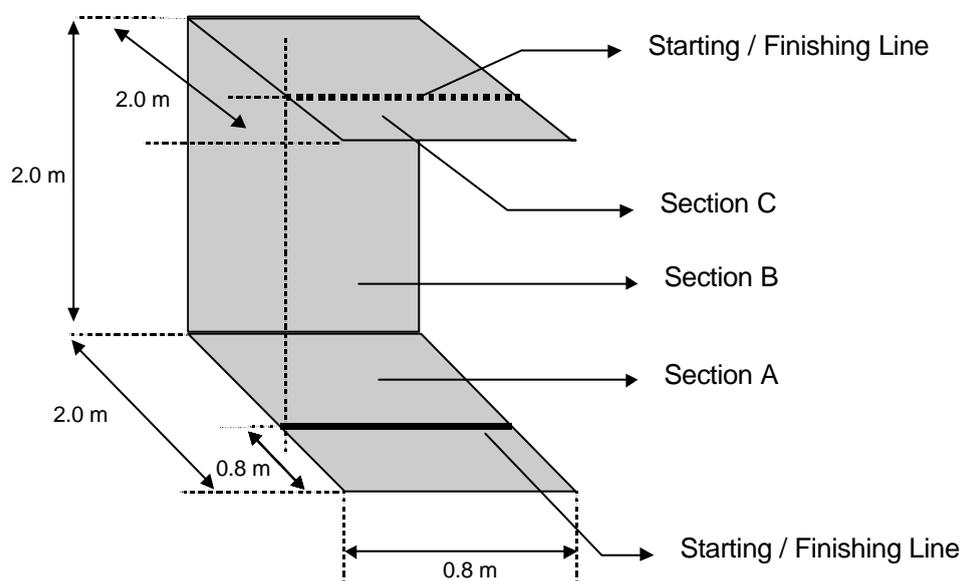


Figure 1: The wall for the wall-climbing robot race

- 2.2 The surface of the wall will be covered with mild steel sections with a thickness of at least 0.003 metres. The wall will have a matt black surface finish.
- 2.3 Starting / finishing lines will be located 0.8 metres from the beginning of the horizontal section on the ground (section A) and 0.8 metres from the end of the top horizontal section (section C). The line in section A will be used to demarcate the maximum size of the robot.
- 2.4 The supporting structure for the wall will have provision for *two* safety cables to be attached to the robot so that both cables can be used simultaneously during the race (*not* shown in Figure 1.)
- 2.5 The wall sections A and B will each have one obstacle consisting of a horizontal bar made of non-magnetic material (not shown) with 0.03 m X 0.03 m square cross-section will be placed laterally across the entire width the section. Both of these obstacles will be placed such that one of its sides is touching the wall section. Both of these obstacles will have reflective tape fully covering the exposed sides of the obstacle. The obstacle across wall section A will be placed

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

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

(a) the length of each wall section should be $2000 \text{ mm} \pm 5 \text{ mm}$.

(b) the angle formed between two adjacent wall sections should be $90^\circ \pm 0.5^\circ$.

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

3. THE COMPETITION

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

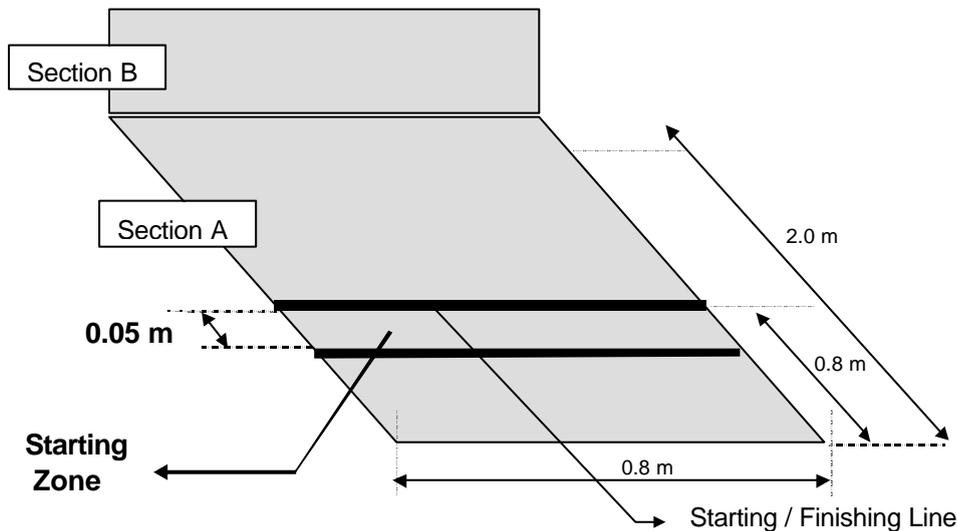


Figure 2: The starting zone for the wall-climbing robot race viewed from above wall-section A

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

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

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

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

Notes:

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

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

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

- (a) the robot touches the wall section that it is about to complete
- (b) the robot simultaneously touches both the wall section that it is about to complete as well as the next wall section in the sequence of wall sections that is consistent with its direction of travel
- (c) the robot ceases to touch the particular wall section that it is about to complete and touches the next wall section in the sequence that is consistent with its intended direction of travel.

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

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

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

- 3.7 For each team of participants, the race will begin once the participants remove their robot from the caging area. Once the race begins, each team of participants will be given a maximum of 6 minutes to produce its best result. *No* extra time will be given at the beginning for participants to set-up or prepare their robots.
- 3.8 After the race begins, any physical handling of the robot such as touching, pulling of cables or pushing of the robot during a climb will disqualify the result of that climb. However if a robot falls off while climbing the wall, using the safety cables to break the fall of the robot is allowed and the result of the climb will be determined as specified in paragraph 3.3 & 3.4 above.

4. THE ROBOTS

- 4.1 The dimensions of each of the competing robots must *not* exceed 0.75 metres in length and height, and 0.6 metres in width *at all times* while the robot is in operation. For non-autonomous designs these dimensions apply for the mobile or climbing part of the robot only.
- 4.2 The weight of each of the competing robots must *not* exceed 10 kilograms. For non-autonomous designs this weight restriction applies to the mobile or climbing part of the robot only.
- 4.3 Competing robots must not have parts removed or added to them during the competition except for replacement of batteries or for repairs essential to the operation of the robot. The competing robots are not allowed to discard any part of their chassis during operation. The competing robots must not use chemical or combustion power methods.
- 4.4 The competing robots must not damage the competition environment including the wall and its supporting structure and the sensors in any way.
- 4.5 The competing robots must not endanger the judges and the spectators in any way. All competing robots must be firmly secured with two safety cables at all times during operation.
- 4.6 A robot will be disqualified during the competition if it endangers the judges, the participants or the spectators in any way during the competition, or if it damages the competition environment. Alternatively a robot may be banned from competing if, in the opinion of the judges, it is likely to pose a safety hazard or cause damage to the competition environment.

5. CLONING

- 5.1 In accordance with the spirit of the competition, clones among the winning entries will only be awarded one prize. Clones will be identified during the "caging" procedure.
- 5.2 Clones will be identified by the working principles of the whole robotic system, such as the sequence of operations during the crossing of obstacles and negotiating the wall bends.
- 5.3 When in doubt, the decision of the Judges will be final.