World Robotic Sailing Championship 2016

Viana do Castelo, Portugal — 5 - 10 September 2016

Notice of race and preliminary version of rules
V1.0 - 26 May 2016

Introduction

The World Robotic Sailing Championship 2016 will be organized in Viana do Castelo, Portugal, from September 5th to September 9th, with 4 days of competitions and a preliminary day for setting up the team's equipment and perform free trials in the water. The World Robotic Sailing Championship will be followed by the International Robotic Sailing Conference that will be held on September 10th (Saturday).

The organizing committee invites teams from any organization, including private individuals, schools, colleges, universities and companies, to enter the competition. Each team competes with one boat and the team members can be shared among different teams. The championship will be organized by 4 contests, each one tentatively allocated to a single day.

Classes

The World Robotic Sailing Championship is open to boats propelled entirely by wind. The boats must use only the energy of the wind (and indirectly by the waves) as the propulsion force. Besides more traditional sailing rigs, the wind energy may also be used to power a propeller or a paddle-wheel using a wind turbine. The coupling wind turbine-propeller may be done either by mechanical or electrical means, providing that it is not possible to use any kind of energy stored on board to drive the propeller. The participants must be able to clearly demonstrate this to the Race Committee.

The boats may use any type of hull (mono or multi) and any type of rig, with one or more soft or rigid sails. The beam of multi-hulls should not exceed their LOA and the maximum draft should be limited to 2 m. Hydrofoils are allowed, although these appendages cannot be installed or removed manually to configure a same boat for different challenges.

The two classes considered in WRSC are:

Micro-sailboats (MS)
Small autonomous sailboats up to 1 m LOA, weighting no more than 100 kg.

Sailboats (S)
Autonomous sailboats which do not fit in the micro-sailboats category, up to 4 meters LOA and weighting no more than 300 kg.

Liability and Safety

All sailing robots must be controllable by a designated human helmsman throughout all events. The responsibility for avoiding any collision and/or damage will rest solely with the respective teams. All teams are responsible for their own safety during the event. The organizers will not assume any liability with respect to damages or personal injuries resulting from any activity of a team participating in the WRSC.

Any teams who wish to monitor their sailing robots from a RIB[1], must follow the safety instructions of the RIB driver, must provide their own personal floatation device which must be worn at all times while on the water. One person per team is guaranteed a seat in a RIB. The safety crews reserve the right to manage the fleet of support boats, and can refuse access to the support boats, in certain circumstances.

Similarly, any team member entering the docks must follow the safety instructions of the shore crew, and must provide their own personal floatation device which must be worn at all times while in the dock area. The shore captain reserves the right to refuse access to the restricted area.

Collisions and Right of Way

Autonomous boats have right of way over manually controlled boats. In the event of a potential collision, then COLREGs rules must be followed (for example, a boat on a starboard tack has right of way, etc). However, all competitors must take appropriate actions to avoid collisions and having right of way is not an acceptable excuse for allowing a collision to take place.

Scoring

The WRSC is formed by 4 contests scheduled for each day of the event: fleet race, station keeping, area scanning and obstacle avoidance. The scoring for each contest will be based on automatic tracked data to establish a ranking (1st to Nth position) that will measure the relative ability to accomplish each task. A sailboat that decides not participating in a contest, or not being able to fulfil the minimum objectives defined for each one, will be given a ranking equal to the number of sailboats registered in its category plus 1. Whenever possible the results will be posted in the Race Office at the end of each day.

Each challenge will give a prize for the first and second places in each class and the absolute winner of the World Championship will be declared the team/sailboat with the lowest sum of the rankings obtained in each competition.

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[1]RIB can be a rigid-hulled inflatable boat or other type of service/work boat

The Race Committee will determine the results from each race event based on following information:

- track data recorded by the tracking devices provided by the WRSC organization.
- In case of failure of the tracking devices, track data provided by the competing boats, as a time-stamped list of lat/lon coordinates (format below).

The competing boats should be able to provide to the organization, at the end of each day, the basic tracking data recorded from their own global navigation satellite system (e.g. GPS). This should include a timestamp and lat/lon data with not less than one track point per second. This data must be provided to the organization in one of the following formats:

- A CSV (comma-separated values) text file with three decimal integer numbers per line representing "`hhmmssdd    Lat*10`^{7} `Lon*10`^{7}". For example, the entry "`14233407,    416887091,    -88259850`" means 14h23m34s of day 7 of September, lat=41.6887091° (north) and lon = -8.8259850° (west)); 9h of recording will need approximately 1MByte of data.
- A binary file with 12-byte records representing the three 32-bit signed integers above (two's complement) in little-endian or big-endian byte order. This format will require approximately 388 KByte of data for 9h.

Time Limits

Where time limits are set and in the event of light winds, the Race Committee may shorten the courses prior to the start, to ensure that all boats have a reasonable chance of completing it within the time limit.

Measurement units

Lat/Lon: degrees in decimals, e.g. 60.3456˚ (chart datum: WGS-84)
Distance: meters
Angles: degrees

Competitions

WRSC will be organized with 4 competitions, in a similar way to the previous WRSC editions. Depending on the number and type of participating boats, two course areas may be set in different regions, for using smaller courses for the micro-sailboats and larger regions for the sailboat class. The precise locations will be defined only a few days before the event, according to the regional short term weather forecast. The four competitions are:

Fleet race – All boats will sail together around a trapezoidal course, with legs between 100 and 300 m long. Figure 1 shows a possible location and course for the fleet race. If boats succeed completing the whole course, they will be scored by their arrival order. If not, they will be scored according to the number of marks reached in the correct order and the order of arrival to that mark. As usual in previous WRSC, the start procedure will be done manually, either by having the boats under manual control and switching to automatic control at the start sign, or by holding the boat behind the start line and releasing it at the start. If the weather conditions are favorable, up to three fleet races will be done, summing the resulting individual scoring.

Figure 1 – Fleet race: example of race course and safety region

Remote control is allowed during the course exclusively to avoid imminent collisions and for the boat with no right of way. Alternatively a collision may also be prevented by holding manually the boat with no right of way, from a support boat, ensuring that its position and

heading is maintained until the risk of collision has passed. In the case a boat gets entangled with a buoy or any other floating debris (seaweed, lines, fishing nets, etc) it can be assisted manually, as long as no advantage is given to the boat.

Minimum objective

To be considered for the scoring, a sailboat must complete at least the first leg, from the start line to the first buoy.

For safety reasons, during the fleet race the navigation area will be constrained to a region enclosing the course area and extending at least 50 m outside the waypoints defining the course. This region will be defined as a convex polygon with 4 or more vertices. Boats sailing outside that area will be disqualified. The maximum time to complete the fleet race will be set to a minimum of 30 minutes.

Station keeping – The station keeping (or *virtual anchoring*) contest will be set in a different manner of the previous editions, to better evaluate the ability of the robotic sailboats to perform a virtual anchoring task. Only a single waypoint P will be set for this competition (see figure 2). The sailing boats will have to keep navigating as close as possible to that waypoint during 5 minutes after entering a circle with a radius $R=20m$ around that waypoint. An individual score will be calculated as the minimum radius R_{min} centered in another point P_c that contains 95% of the points registered by the tracking devices, normalized to the length overall (LOA) of the boat (R_{min}/LOA). To account for the GPS error, P_c will be considered instead of P, where P_c is obtained as the average of the coordinates of all the points registered during the 5 minutes after entering the circle with a radius $R=20m$ (green dots in figure 2). To be qualified, the point P_c must be inside the red circle, regardless of the positions of the points recorded during the 5 minute period.

Figure 2 illustrates this procedure. The sailboat track is considered during 5 minutes after entering the red circle (20 m radius centered in the reference waypoint P); the average of the coordinates of all recorded track points during the 5 mins (green dots) gives point P_c; the score is calculated with the radius of the blue circle centered in P_c that contains 95% of the track points.

Minimum objective

To be scored in this contest the sailing boat must stay within the $R=20m$ circle (red circle) during the first minute after entering it; also, the final point P_c must be inside that red circle

Depending on the weather conditions, a maximum of 3 attempts may be done by each sailboat and the best score among the three attempts will be used to build the final ranking for this challenge. This contest will be done only with a minimum sustained wind of 6 knots (3 m/s).
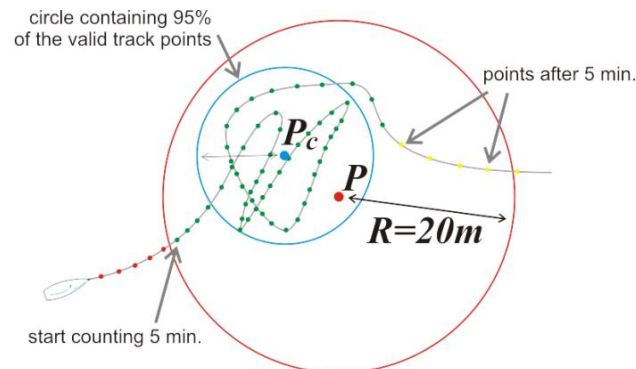
Figure 2 – Scoring procedure for the station keeping contest.

Area scanning – The course area will be set as a "L" shape region composed by 75 squares with 20m side (forming a 100m x 50m rectangle and a 50m x 50m adjacent square - see figure 3). The challenge starts when the sailboat enters the region (at any point) and finishes when the sailboat crosses an arrival line set at a leeward position with respect to the course area, or after exhausting the maximum time allowed for this challenge. Boats will be ranked by counting first the number of squares visited and then comparing the percentage of the track points registered that are within the course area (blue line).
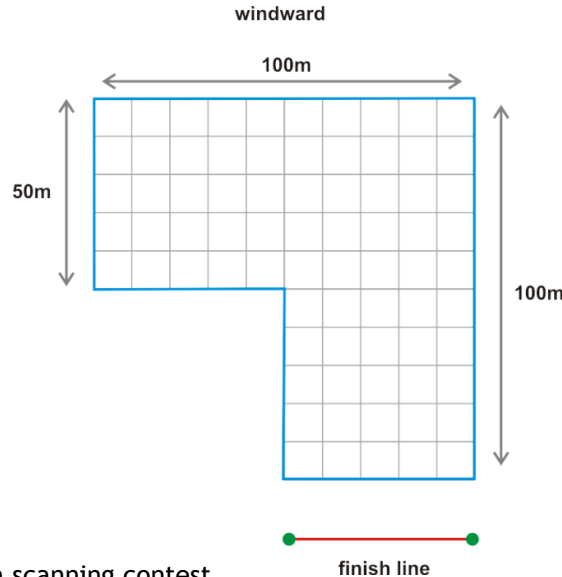

Figure 3 – Course region for the area scanning contest

Minimum objective

To be qualified in this contest, a sailboat must visit at least 20 contiguous squares within the 30 minute race time. A square is considered visited if at least one track point is registered in that square.

Collision avoidance – The collision avoidance contest will evaluate the ability of a sailing boat to deviate from an unexpected obstacle appearing in its path. The course area will be set with four waypoints forming a 150 m x 20 m rectangle, with one longest side facing windward (see figure 4). Sailboats must enter the rectangle by one of the shortest sides, keep sailing within the rectangle to the opposite short side, turning back after crossing each short side. After completing at least two legs, a physical obstacle will be placed in the course area before the sailboat turns back into its direction.
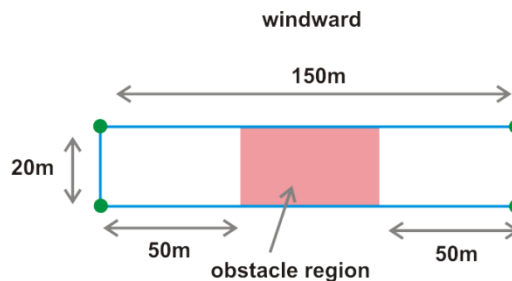

Figure 4 – Course for the obstacle avoidance contest.

The obstacle will occupy the whole 20 m of the course rectangle width and will be placed somewhere between 50m from each short side (the pink region in figure 4). The sailboat should deviate from the obstacle, not touching it, and return to the course as soon as possible and complete at least one more full leg. The "obstacle" will be made with one or two red or orange RIBs, towing a line with red or orange balloons with gaps between them not larger than 1m. After placed in position, the RIBs will do their best to keep the obstacle in place.

The sailboats will be scored according to the following table (refer to figure 5)

1. the sailboat did not initiate a maneuver to deviate from the obstacle: 0 points (red path);
2. the sailboat did start a maneuver to move away from the obstacle, but she hits the obstacle: 2 points (violet);
3. the sailboat did deviate from the obstacle not touching it, but failed to return to the course area within 5 minutes: 5 points (orange);
4. the sailboat did deviate from the obstacle not touching it and did return to the course area, but failed to complete the last full leg: 10 points (blue);
5. the sailboat succeeded completing the obstacle avoidance challenge: 15 points
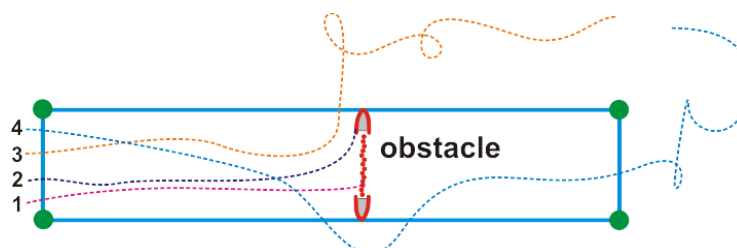
Figure 5 – The four unsuccessful cases in the obstacle avoidance contest.

To break a tie in cases 4 and 5, the number of track points outside the course area will be considered, as the percentage of the number of track points registered in the last full leg. For example, if in the last leg (from one short side to the other short side) a sailboat has recorded 100 track points and for avoiding the obstacle she registered 25 track points outside the course rectangle, she will be scored with 25 (the smaller the better).

<u>Minimum objective</u>
To be scored in this contest a sailboat must keep sailing valid legs, without crossing the long sides of the rectangle, until the obstacle is positioned.