World Robotic Sailing Championships 2012

Sailing instructions

Eligibility

The WRSC is open to teams from any organisation including private individuals, schools, colleges, universities and companies. Entry may be subject to a fee, which is still to be confirmed but will not exceed £150 per person.

Liability

All boats must be controllable by a designated human helmsman throughout all races. The responsibility for avoiding any collision and 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 resulting from a team participating in the WRSC.

Location

All competitions will take place at Cardiff Bay Yacht Club, Cardiff, UK and on the surrounding Cardiff Bay, an artificial lagoon protected from the tides. Except for a few inshore areas the entire bay is over 2 metres deep. A chart of the bay can be found online at http://www.visitmyharbour.com/viewchart.asp?chart=15942A60E9C761687

Weather

Weather in the UK can be highly variable. In September Cardiff can typically experience temperatures between 11 and 18 degrees Celsius (52-64 Fahrenheit) and rain on approximately 50% of the days. It will be extremely unlikely to get no rain during the whole of the WRSC, so bring appropriate clothing to operate in the rain. Unless visibility is severely impacted, rain will not cause events to be cancelled. All contests and races are subject to suitable sailing conditions, namely average wind speeds between 1 and 20 knots. There is no guarantee, that any or all contests will be conducted.

Scoring

For each individual contest, a boat gets a score depending on its performance. Manual control to collision with a boat or obstacle shall not count as human intervention if it is limited to minimal intervention to perform collision avoidance. Boats using some method for automatic collision avoidance and completing a contest without manual intervention to avoid a collision will be awarded 2 bonus points in the respective score. Scores will be posted on the WRSC website and a score sheet in the clubhouse.

Collisions and Rights of Way

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

Radio Frequencies

All boats and radio control or telemetry equipment must adhere to UK radio regulations and keep to legal frequencies and within legal power limits.

Tracking

All boats should attempt to transmit their position to the World Server (see http://141.83.19.17/rrMM/?page=software for source code) at an interval of between 1 and 10 seconds. Radio interference and range may at times prevent this and the World Server should not be viewed as a 100% reliable source of data. The organisers will endeavour to make the server accessible via the internet both for the purposes of viewing data and submitting positions via GSM or satellite based communications.

Classes

The World Robotic Sailing Championship is open to boats starting in either of the Microtransat, SailBot, or robotic racing MicroMagic classes. Each boat shall adhere to the rules set forth by the respective class, as summarized below. To compare results among all classes, a handicap factor based on the length of waterline (LWL) will be computed as 1 / SQRT(LWL).

Microtransat class rules

Boats must be no longer than 4 m and fully autonomous, with wind being the only means of propulsion. Boats must be clearly marked as autonomous, with highly visible markings. A means of manual intervention is required to avoid collisions.

SailBot class rules

The official SailBot rules require boats to be at most 2 m long. The maximum draft shall be 1.5 m. For further details on this class, see http://www.usna.edu/Users/naome/phmiller/SailBot/SailBot.htm

MicroMagic class rules

The MicroMagic class rules are defined as follows:

- The hull and deck must be from the Graupner kits (either MicroMagic or racingMicroMagic)
- The hull must be unmodified, while the deck layout may be changed (e.g., to add openings)
- The keel fin and rudder must be from the Graupner kits (either MicroMagic or racingMicroMagic)
- The material, shape and weight of the keel bulb may be altered, as long as it is not harmful to the environment
- The jib and main sail may not exceed the dimensions of the Graupner kit sails
- The type of rig is open, as long as the limitation regarding the sails is fulfilled and the
- boat fits into a sphere of 1 m diameter (excluding sensors / antennas mounted on the mast top)
- The boat must be human controllable throughout the races
- The boat must communicate its true GPS position to a central server at a frequency of at least 1 Hz

For further details, see http://sailing.rob.uni-luebeck.de/rrMM

Starting procedure

Unless a different method is posted during the races, the starting sequence will be defined by sound signals given 5, 4, 2 and 1 minute(s) before the start and another signal for the actual start. Additionally, a special object (StartBoat) sent by the WorldServer may also be shown / sent. After the 1 minute signal, boats must be in autonomous mode or they will incur a 50% penalty.

Event Descriptions

Navigation contest

The objective of the navigation contest is to evaluate a boat's ability to accurately navigate a short upwind-downwind course, all without manual intervention. At the start, the boat will cross a line between two marks (indicated as two yellow marks on the figure 1) sailing windward to a mark in approximately 20-60m distance. After rounding the mark on port, the boat shall sail between the marks (indicated in purple) again, see Figure 3. A boat sailing the described course autonomously is awarded 10 points. A boat passing in between the marks (indicated in yellow) but not in between the marks (indicated in red) indicating the start/finish line is awarded 7 points. A boat correctly rounding the windward mark is awarded 3 points.

To facilitate the contest, multiple similar courses may be set up in parallel. If time permits, there will be the chance to repeat the course with only the best score counting. Priority will be given to those boats which have made the fewest attempts.

This event must be sailed autonomously. Manual control may only be used to sail to/from the start/end of the course. Use of manual control during the event will result in a score of zero.

*Fig 1: The navigation challenge course.*
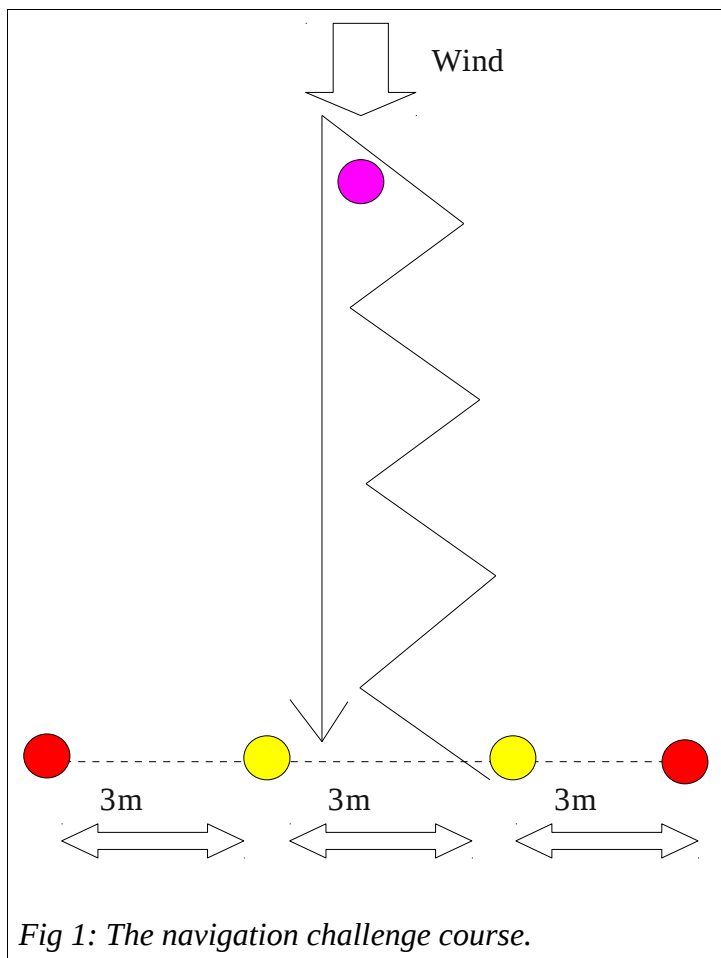
Station keeping contest

The objective of the station keeping contest is to evaluate controlled sailing in a limited region with time constraints. Each boat must start outside a 40 x 40 m box, marked by four buoys. Upon the start signal, the boat must enter the box as quickly as possible. 5 minutes after the start, the boat must leave the box as quickly as possible. Boats fulfilling the entry and exit criteria are awarded points based on the following formula:

$$p=\max(0,300 - (t_{start} - t_{enter}) - (t_{end} - t_{leave})) / 30$$

where t_{enter} is the timestamp when the boat first enters the box, t_{leave} is the timestamp when the boat first leaves the box, and t_{start} and t_{end} are the timestamps when the three hundred seconds start and end counting, respectively. All timestamps are given in seconds. To facilitate the contest, multiple similar courses may be set up in parallel.

This event must be completed autonomously. Manual control maybe used to sail to/from the box before/after the event. Use of manual control during the event will result in a score of zero.

Fig 2: The course for the station keeping event.
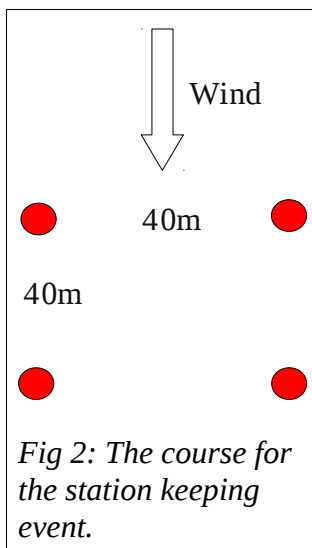
Collision avoidance contest

The collision avoidance test evaluates basic avoidance of obstacles without manual intervention. The boat shall be setup to sail on a port tack on beam-reach through two marks to round another mark and return between the two start marks (Figure 5). After a preparatory signal, no manual interaction with the boat is allowed. Shortly before the start, an obstacle will be placed on the course. The position and size of the obstacle will be available through the world server. A boat that fully autonomously and without using the world server avoids the obstacle receives 10 points. A boat that fully autonomously but based on the world server avoids the obstacle is awarded 7 points. A boat avoiding the obstacle only on the way to / from the mark is awarded 50% of the points. To facilitate the contest, multiple similar courses may be setup in parallel.

This event must be completed autonomously.

Fleet race contest

The course will consist of a triangular course, several hundred metres in length. The course length will be determined by the wind speed and sea state. The MicroMagics will be given a separate and shorter course than the other classes. A mark is considered to have been rounded once a boat is within 10 metres of it. A countdown signal will be given before the start of the race and boats shall be in autonomous mode after the 1 minute countdown signal. Remote control or manual intervention is permitted with a 50% penalty.

Each boat shall be awarded points in two categories, one for the class and one for the WRSC overall:

First, for each class points are assigned based on the sequence of finishing the race. The winning boats receives as many points as boats have registered for the class, each subsequent boat receives one point less. If two (or n more) boats have the same time to finish, both (all) receive the same number of points but the subsequent boat receives two (or n) points less. Boats in the Sailbot and Microtransat class will have their time by the square root of their LWL (waterline length). The points obtained in the class are used to establish the class winner but do not count to the overall WRSC score.

Second, all boats are ranked according to the time to finish multiplied by the root of the LWL, with the lower values indicating a better rank and the same point awarding scheme as set forth above applied based on the total number of registered boats for the WRSC. This score will be used to establish the overall fleet race ranking among all boats and count to the overall WRSC score.

Endurance and Autonomous Sensing Contest

The endurance test evaluates the power management, remote sensing capabilities and long term control of the boats.

Endurance Race

The course for the endurance contest will be set depending on the wind conditions and generally the rules for the fleet race will apply, except that the marks are rounded in the defined order until a predefined time interval after the start has ended. A mark is considered to have been rounded once a boat is within 10 metres of it. For each boat, the number of times the start-finish line has been crossed is counted to establish the total distance sailed. This distance is divided by the square root of LWL to compute the distance after rating. The boat with the longest distance will be awarded as many points as boats registered for WRSC, each subsequent boat receives one point less. If two (or n more) boats have sailed the same distance, both (all) receive the same number of points but the subsequent boat receives two (or n) points less. If physical contact between a team member and the boat is necessary (apart from avoiding a collision), the boat has to restart. The restart has to be announced to the race committee and in this case the largest number of correctly and consecutively completed courses will be counted. Batteries shall not be replaced at any time during the race.

Boats may be equipped with solar panels, wind turbines or fuel cells (or other recharging technologies) to recharge their batteries on board.

Autonomous Sensing Contest

The autonomous sensing contest awards extra points for completing any of a series of challenges during the endurance race. It is designed to test the robot's ability to perform remote sensing applications which are initiated when the boat reaches a target location.

2 points for autonomously obtaining each of the following tasks at the most distant mark from the start point (location to be clarified in pre-race briefing). The initiation of the task must occur by proximity to a waypoint, you cannot simply leave a sensor recording for the entire time and extract the relevant data later on (e.g. videoing the entire race and extracting the appropriate frame as a photo of the distant mark):

- A water sample or water quality reading containing at least 2 of the following parameters: temperature, turbidity, salinity, chlorophyll content, dissolved oxygen level or the concentration of a pollutant (such as a heavy metal, fertilizer or pesticide).

- The depth of the water within 10 metres of the distant mark.

- A photograph of the distant mark, taken from no more than 10 metres away. The photo should be of sufficient resolution to easily distinguish the mark from the surrounding water. 1 additional bonus point will be awarded if this photograph can be transmitted back to shore within 5 minutes. A second additional bonus point will be awarded if this is done using a satellite data link or any other technology which works beyond line of sight with shore (NOT a mobile phone or wifi/radio modem).

- A 30 second hydrophone recording, started from the moment the boat gets within 10 metres of the distant mark.

- The wind speed at the distant mark.

- The wave height and period at the distant mark, recorded for a time of 1 minute.

- A RADAR image or LIDAR scan taken from within 10 metres of the distant mark.

2 points will also be given for providing power usage (in Watts) statistics showing the amount of power used during the race with a period of one reading every 10 seconds (or less).

Additional challenges may be added to the autonomous sensing competition if the judges and all competitors agree.

Hacker Challenge

New to this year's WRSC is the Hacker Challenge. This event requires competitors to build boats during the course of the week for a short race on the final day. It is intended to help foster collaboration between different teams and tries to embody the spirit of collaboration which has already existed at past events. Registration for this event is open from 9:00 am on day 2 (Tuesday September 18th) of the event. Each entry must consist of at least two people from at least two different teams. A new boat must be constructed as part of the challenge, this can come from any parts either of the collaborating teams have brought with them or which they borrow/build/buy during the event. Software can also be any combination of existing software from either team, existing publicly available software or newly written code. Points gained during this race will be added to all teams who collaborated. Teams intending to enter this event are encouraged to bring along spare parts which could be used to make an extra boat.

Scoring will take place in two events, a presentation of the boat and a short race.

The race will cover a small triangular course. The boat with the fastest time, will be assigned points equal to the number of boats in the hacker challenge, second place the number of boats minus one etc.

Boats are ranked according to the time to finish multiplied by the square root of the LWL. With first place being assigned a score equal to the number of boats in the hacker challenge (including boats which are not capable of sailing in the race), second place being given one less point etc.

The presentation will be worth a maximum of 10 points and will be assessing the potential of the boat to perform as a short distance racing boat. It is recognised that having been built in under a week, the boats may not completely fulfil this potential:

The following criteria will be assessed (max 2 points each):

- The hull design
- The rig design
- The software design
- The electrical systems design
- The applicability of the design to autonomous oceanography and/or ocean racing.

Document History

Date	Comments	Author
11th July 2012	Initial version, copying and adapting rules from pervious WRSC and Sailbot competitions.	Colin Sauze
16th July 2012	Removed repetition about COLREGs in collisions section	Colin Sauze