Version 15.03.2024

MURC – WUURC 2024

Class: AUV

General

This document is the AUV class manual of the MURC – WUURC (Multinational Underwater Robotics Competition – World University Underwater Robot Competition). To participate in this class, participants must register **here.**

Date: July 2024
Place: Vladivostok
Number of team members: 2-10

The competition consists of three steps

- Team Spec Sheet - 10 points
- Engineering poster - 50 points
- Mission - 120 points

Vehicle requirements

- Vehicle: AUV
- Programming language: no limits
- Power: <24V, 20A
- Power source: on board
- Dimensions and weight of the robot: no more than 90x90x90 cm, <50 kg
- The robot should not be equipped with parts (sharp, piercing objects, exposed wires, etc.) that could harm the pool or team members.
- Each team performs on its own robot. Two teams are not allowed to compete on the same robot.

Weighing bonus

Vehicles weighing 50 kg will be allowed to carry out the mission. Before starting a mission, the vehicle must undergo a weighing procedure. Weighing takes place at the workstation before the start of the mission. The vehicle is weighed with all input components without taking into account the tether and the surface part (control panel, monitor, etc.). The developed vertical profiling float is not included in the device and is not weighed. The measurement will be carried out using a digital scale.

The weight bonus is calculated as follows.
50>x>40 (kg) (no points awarded)
(40-kg)*0.5 (maximum 20 points).

Team Spec Sheet

The purpose of the company spec sheet is to provide the judges with a “snapshot” of your team. It includes basic information about your team and vehicle.

Teams will receive up to 10 points for submitting a spec sheet that is one page in length, follows the file size and naming specifications, and contains all required information.

The spec sheet contents and criteria are contained in the Spec sheet scoring list on the official competition page.

Engineering poster

The purpose of the engineering poster is to present technical information about your AUV in an attractive and easy-to-use format for a wide audience. It is the promotional piece – you must not only present information about your AUV, mission program and your team, but you must also use graphics and design to publicize and “sell” (convince viewers of their value and excellence) your products and people. During the competition, the poster will be evaluated by judges representing various professions (science, robotics, marketing, etc.). While some judges will have a technical background, others will have a communications, marketing, or public relations background. In addition, there will be visitors to the competition who may not completely understand what an AUV is or how it is used.

The maximum poster size is 80x180 cm.

Use the marketing display scoring rubric posted on the official competition page as the guideline for the required components for the Engineering poster.

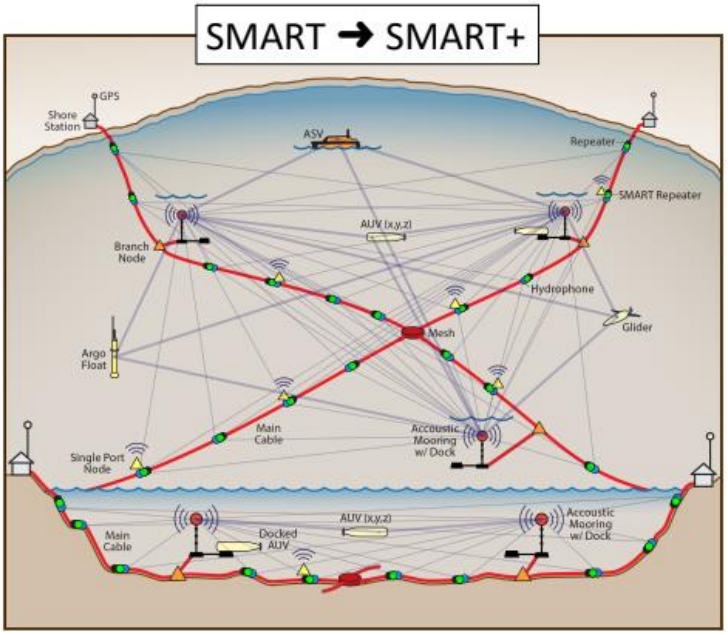
Mission

Context

Miles of submarine cable run underwater, supporting the world's communications infrastructure. However, these cables could be a way to collect data on the state of the ocean and seafloor. To implement the project to develop such “smart” cables, a Joint Task Force was created, including several UN offices. The project is called “SMART cables” (Scientific Monitoring and Reliable Telecommunications) and aims to use existing cables to collect and transmit information about the environment.[1]

One of the problems in developing a global system of “smart” cables is diagnosing the state of underwater sensors. One of the options for solving this problem is the use of AUVs (autonomous underwater vehicles), which can inspect the underwater cable and be recharged at docking stations.

As part of the mission, it is necessary to inspect the underwater cable, install a marker near the damaged sensor and enter the docking station.



Work station

The station consists of a table and 2 chairs located approximately 1 meter from the pool. Pool depth 1 - 2 m (pool depth may vary depending on the competition site). The team must bring a laptop, monitors and other necessary equipment.

Time

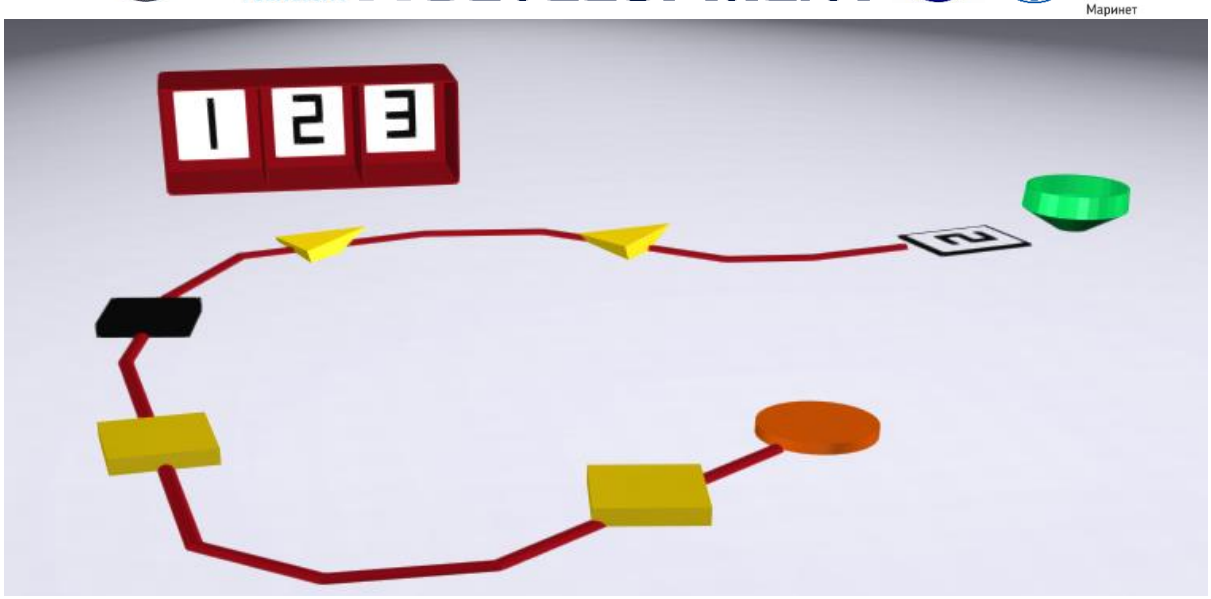
Each team will be given 2 attempts to complete the mission, each lasting 20 minutes. During an attempt, a team can do 3 launches of 5 minutes each.

Each attempt consists of three parts:

- set up at the work station - 3 minutes
- launches - 15 minutes
  The duration of one launch is no more than 5 minutes.
- break down and exit the work station - 2 minutes

Task Descriptions

At the bottom of the pool there is a red cable 50 mm thick and 10-20 m long. The docking station is a structure made of PVC pipes, consisting of 3 cubes 90 cm*90 cm. Sheets are installed on the bottom edge of each cube. On the side faces there are sheets with the cube number.



Mission scheme (Notice: color of rope can be red or black, doc-station will be red)

There are two types of figures on the cable:

- triangles - accelerometers
- squares - temperature sensors.

If the sensors are working, they are yellow; if they are broken, then they are black.

Mission

- The vehicle starts above the red circle in front of the cable. The vehicle needs to inspect the cable (walk along it).
- If the vehicle detects a working temperature sensor, it must touch this sensor and turn on green LEDs. If the vehicle detects a working accelerometer, it should turn 360 degrees and turn on green LEDs.
- If the vehicle detects a broken sensor (black square), then it throws the marker on it and red LEDs turn on.
- At the end of the cable there is a table with a number and a platform with a beacon.
- In the pool, in a random place, there is a docking station with an acoustic pinger.
- The vehicle must identify the number on the table.
- Then the vehicle must take the beacon from the platform and take it to the docking station
- The beacon must be placed on any free floor of the docking station.
- Mooring is carried out on the floor indicated on the table.
- The device can be moored together with the beacon. In this case, the team receives fewer points.
- Beacon simulated by PPR Tee 20 mm

- The team makes the marker themselves and brings it with them to the workstation. (max.size - 7*7*7 cm)

Starting conditions

- The team should prepare a mission program file and name it **mission_team_name** (for example, mission_mur.py). It is prohibited to use programs with a different name.
- The number of sensors on the field is fixed and equal to 5. The position of the sensors is determined randomly before the start by the judge. There is also one broken (black) sensor on the field. This mission set up is used for all teams during one attempt. After all teams have completed the first attempt, the judge determines the placement of sensors for the second attempt.
- The location of the docking station is determined by the judge before the start of the attempt and remains the same throughout one attempt.
- Before starting, the robot must be on the surface of the water in the starting area. It is possible to start the program using mechanical switches, via wireless networks, as well as by launching the program directly on a laptop.
- The robot is launched from a square frame 90x90 cm.
- Before launch, the team can orient their device in the frame in any way they want.
- Under the frame at the bottom of the pool there is a red circle with a diameter of 25 cm. The depth of the field is set on the day of the competition and does not change throughout the entire competition day.

Competition rules and scoring

Mission Scoring

1. Working sensors detected - **up to 40 points**.
   1.1. **5 points for each** - when detecting a sensor, the AUV turned on the correct color indication, but did not perform the correct maneuver (turned on the green LEDs if the sensor was working) or performed the correct maneuver without turning on the light indication.
   1.2. **10 points for each** - when the sensor was detected, the AUV turned on the correct color indication and performed the correct maneuver (turned on the green LEDs, touched the sensor - if it was a square, turned 360 if it was a triangle).
2. Broken sensor detected - **up to 20 points.**
   2.1. **5 points** - the sensor is detected and the red color indication is turned on.
   2.2. **20 points** - the sensor is detected, the red color indication is turned on, the marker is thrown.
3. The vehicle follows the cable - **15 points.**
   The step is completed if the AUV detected all five sensors (performed actions on them, including incorrect ones).
4. Installation of a beacon - **up to 15 points.**
   4.1 The beacon has been removed from the platform - **5 points.**

4.2. The beacon is installed on a free floor of the docking station - **15 points.**
Free floor - the floor of the docking station on which the AUV is not located.
4.3. The beacon is installed on the apparatus mooring floor - **5 points.**

5. Docking station detected - **15 points**
   The step is completed if the device has reached the docking station.
6. Mooring at a docking station - **up to 15 points.**
   6.1. The AUV entered the docking station on the wrong floor - **5 points.**
   or
   6.2. The AUV entered the docking station on its floor - **15 points.**
   The criterion is met if the AUV is completely moored into the docking station and no part of it goes beyond.

Total: 120 points

Ending the launch

The launch is stopped fails in the following situations:

Standard situations:

- The vehicle entered the docking station;
- The vehicle floated to the surface, that is, any part of the robot appeared above the water inside the frame.

Emergency situations:

- The maximum launch time has expired;
- The captain asks the judge to complete the launch;

Critical situations:

- The vehicle has violated other requirements described in the rules;
- The participant has violated other requirements described in the rules.

Conducting the competition

1. Competition organizers are preparing a schedule for training in the pool. Each team must undergo a technical inspection of robots to ensure compliance with the requirements.
2. Each team carries out debugging of the robot and training launches according to the schedule.
3. In the final, each team will be given 2 attempts. A team can perform 3 launches in one attempt. The duration of one launch is 5 minutes.
4. The judge calls the teams according to the established schedule.
5. At the beginning, a team member must show the judge a file with a program for completing the mission. The file should be named mission_team (for example, mission_mur.py).

6. If a team uses a file with a different name to complete a mission, then the judge has the right not to count the attempt.
7. Between attempts, teams will be given time to debug the device, within which they can make changes to the program.

Rules

1. The vehicle can enter the docking station only if the “vehicle follows the cable” criterion is met.
2. If the vehicle did not identify one sensor, but correctly oriented itself along the cable and continued moving, then the launch continues.
3. As soon as the vehicle enters the docking station, the judge stops the timer and the launch is completed, the points and time for completing the mission are recorded.
4. If the vehicle floats up, the judge stops the timer and the launch is considered completed, the points are recorded and the maximum time of the launch is set. The captain can complete the launch earlier and the maximum time of the launch is recorded.
5. If time runs out during a launch, the points earned up to that point and the maximum time are recorded.
6. The vehicle in the pool can only be launched by one team member, who is located at the edge of the pool. Before starting, the vehicle must be in the water in the starting area. A team member located at the edge of the pool must hold the robot. After the judge has given the start and timed it, the team member can start the program.
7. During the attempts, the assistant makes a video recording. If, after the judge has completed the score sheet, the team does not agree with the points awarded, they must inform the judge before signing the score sheet. After this, the video recording of the team's last attempt is reviewed and re-evaluated.
8. At the end of the attempt, the team captain must review the score sheet and sign. Once the evaluation sheet has been signed, appeals will not be accepted.
9. The result of the attempt is the best of three launches.

Determination of final rating

- In the final, the winners are determined by the number of points. The best attempt and the time taken to complete this attempt are counted. If the teams have the same number of points, then the second attempt are taken into account.
- If 3 or fewer teams participate in the final, if a team scores 0 points in two attempts, then the team will not be awarded a prize.

Props description

The start area should be located at the edge of the pool and is a frame of 90x90 cm.

Composition and characteristics of the props (you can download printable layouts from the link: https://drive.google.com/drive/folders/1IzG3nOndhu9swWwJacRyu5uvWtdKUOor?usp=sharing)

№	Type	Color and material	Linear dimensions	Location
1	Frame	Made from polypropylene pipes d20mm. White color.	L x W: 90x90 cm	Located on the surface of the pool above the red circle.
2	Rope	red or black	D50 mm Length 10-20 m	At the bottom of the pool
3	Plaque with a circle (1 piece)	Red circle on a white background. It can be cut from both floating materials (in this case it is necessary to attach a weight to the reverse side) and non-buoyant ones. Materials: alucobond, acrylic, PVC, banner fabric, iron.	Diameter: 25cm. Square size 40*40 cm	Located at the bottom of the pool under the starting frame
4	Sensors	2 squares, 2 yellow triangles. On stands made of PPR pipes d20mm.	L x W: 20x20 cm	They are installed on the rope in any way (4 figures are located on the rope at the same time).

5	Broken sensor (black)	Black square. Mounted on stands made of PPR pipes d20mm.		One sensor is located in any part of the rope.
6	Tables with numbers (at the bottom)	Plates with numbers 1,2,3. They are printed on a banner, glued to sheet material (not buoyant) and weighted.		
	Number plates (for docking station)	plates with numbers 1,2,3. They are printed on a banner and glued onto sheet material to the back walls of the docking station.	L x W: 30x30 cm	
7	Dock station	Made from polypropylene pipes d20mm. Fomax sheets are attached to the lower faces of the cubes. On the back wall of the cubes there are signs with numbers 1,2,3	L x W: 40x40x40 cm	

Examples of rope.
https://sport-setka.ru/kanaty/kanat-dlya-lazanya/
https://forma-sporta.com/goods-642/
https://clck.ru/37ZCud