13º IEEE Students Latin American Robotics Competition

Rules of the OPEN category

Version 1.1 – April, 2014

Petrolium Plataform

1. Introduction

The IEEE Latin American Robotics Competition proposes a challenge based on a real problem for 2014 and 2015 IEEE Open Competition. The task presented is to propose an autonomous solution for load transporting between a seaport and an oil platform. The environment is hostile and challenging, because there are several external factors that compromise the physical health of the workers/operators. The task scenario demands using autonomous robots (ground/UGV, aerial/UAV, surface/USV and underwater/UUV robots) to cross the “ocean”.

Figure 1 presents the scenario that represents the seaport, the ocean and the suspended platform. The load is presented in the form of cubes.

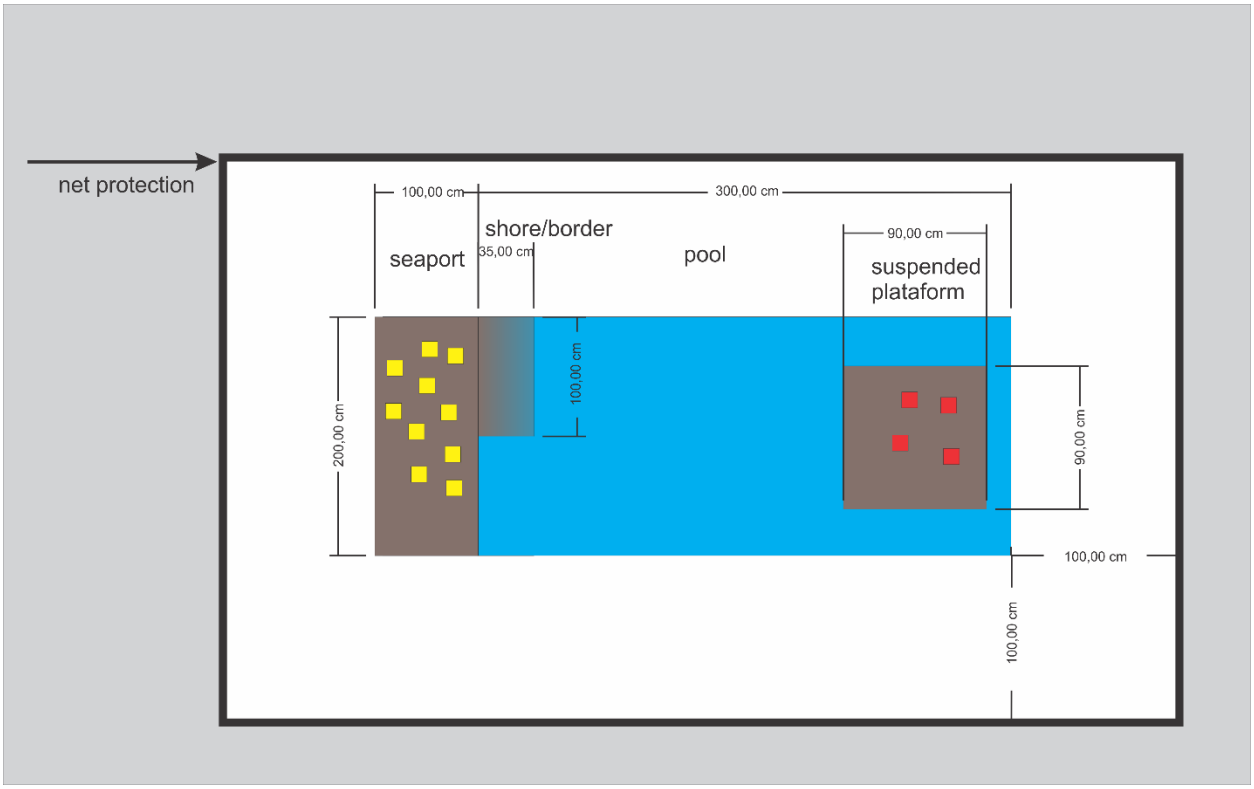


Figure 1 - IEEE LARC Open category scenario.

It is important to observe that the proposed scenario simulates a natural environment. Therefore, it is invaluable to predict some details of the problem, such as precise positions of loads in seaport. It is expected that robots will be able to deal with such troubles, despite the lack of some data.

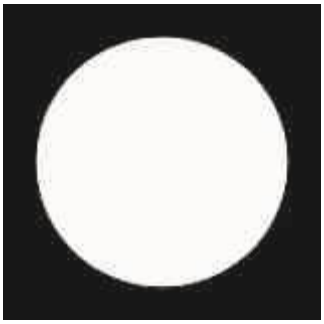
2. Objectives

The goal is to use autonomous robots (Unmanned Ground Vehicles/UGV, Unmanned Aerial Vehicles/UAV, Unmanned Surface Vehicles/USV [they can only traverse over water surface] or Unmanned Underwater Vehicle/UUV [like a submarine]) to pick cubes from the seaport, crosses ocean, and place/drop in the suspended platform, or doing a backwards operation (suspended platform -> ocean -> seaport).

The main objective is solving the load transporting task between the seaport and the oil platform using autonomous robots.
There are some identification marks presented in the environment to help the robots localization. They can be found at:

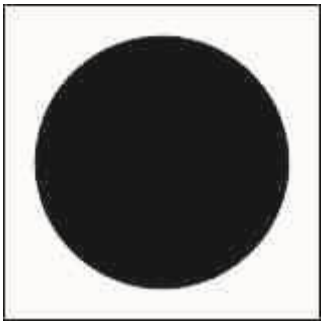
- seaport (Figure 2);
- oil platform (Figure 3);
- around the protection net (Figure 4 and Figure 5).

10 cm



10 cm

Figure 2 - Seaport Mark



10 cm

Figure 3 - Oil Platform Mark

10 cm

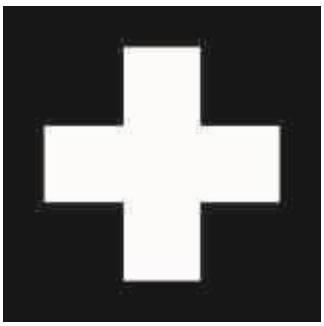


Figura 4 - Side Delimiters Marks around net protection.

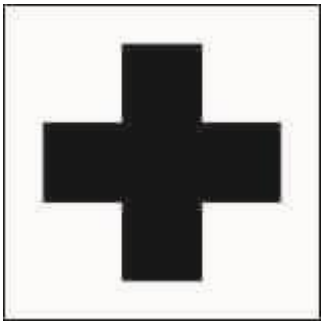


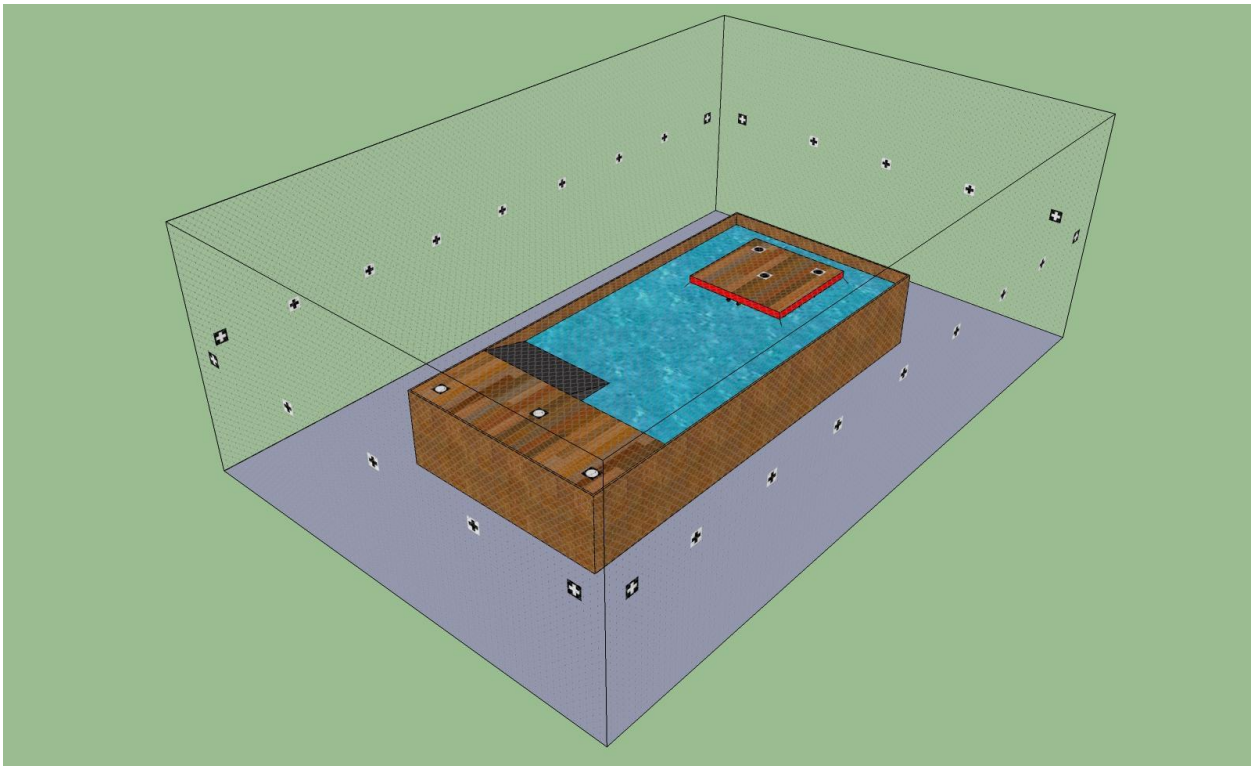
Figura 5 - Middle Marks around net protection.

The robots can cooperate among themselves to carry a cube. If a cube falls on water, the team will receive a fault. The robot can move at most two cubes at the same time. It is forbidden to launch/throw cubes, from anywhere, to transport them.

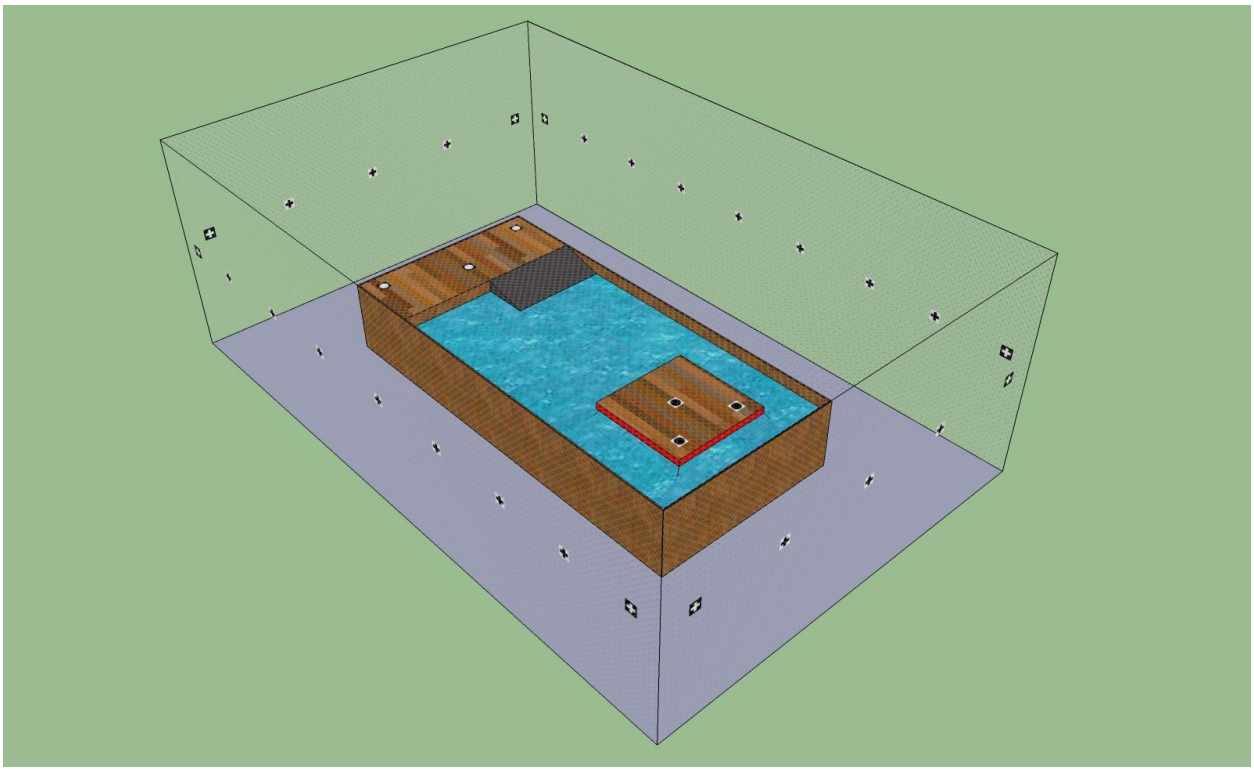
The robots must collect the red cubes, presented in the suspended platform, and carry them to the outdoor area, and carry the yellow cubes, presented in the outdoor area, and carry them to the suspended oil platform.

3. The scenario

The scenario consists of a wood tank (2.5cm thick) coated with waterproof layer, supported on the floor, with total length of 400cm, width of 200cm and height of 70cm. Half of the seaport will have a ramp/bank to help the robots to enter or leave the water. The ramp has a inclination of approximately 15^0 to reduce the effort of the robot, and also has a certain roughness (like a rubber) to increase its grip. The water level in the tank should be between 55cm and 65cm.



(a)



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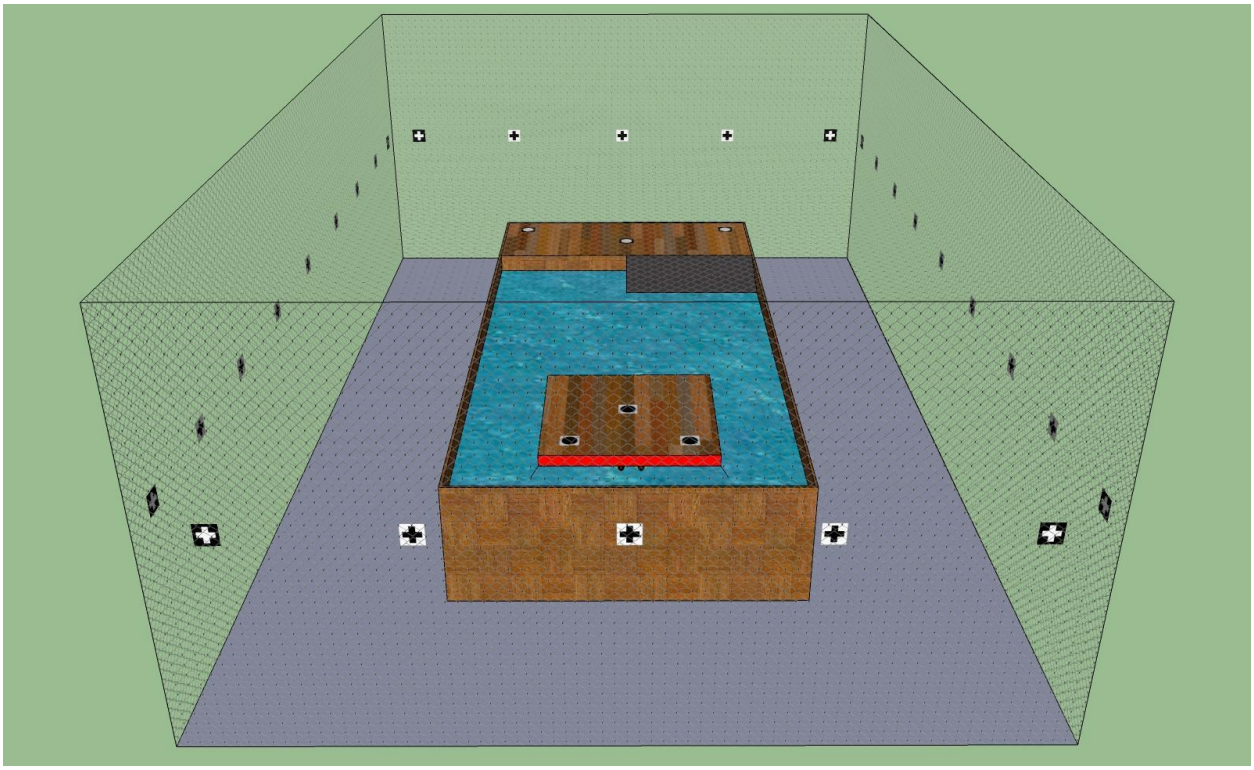

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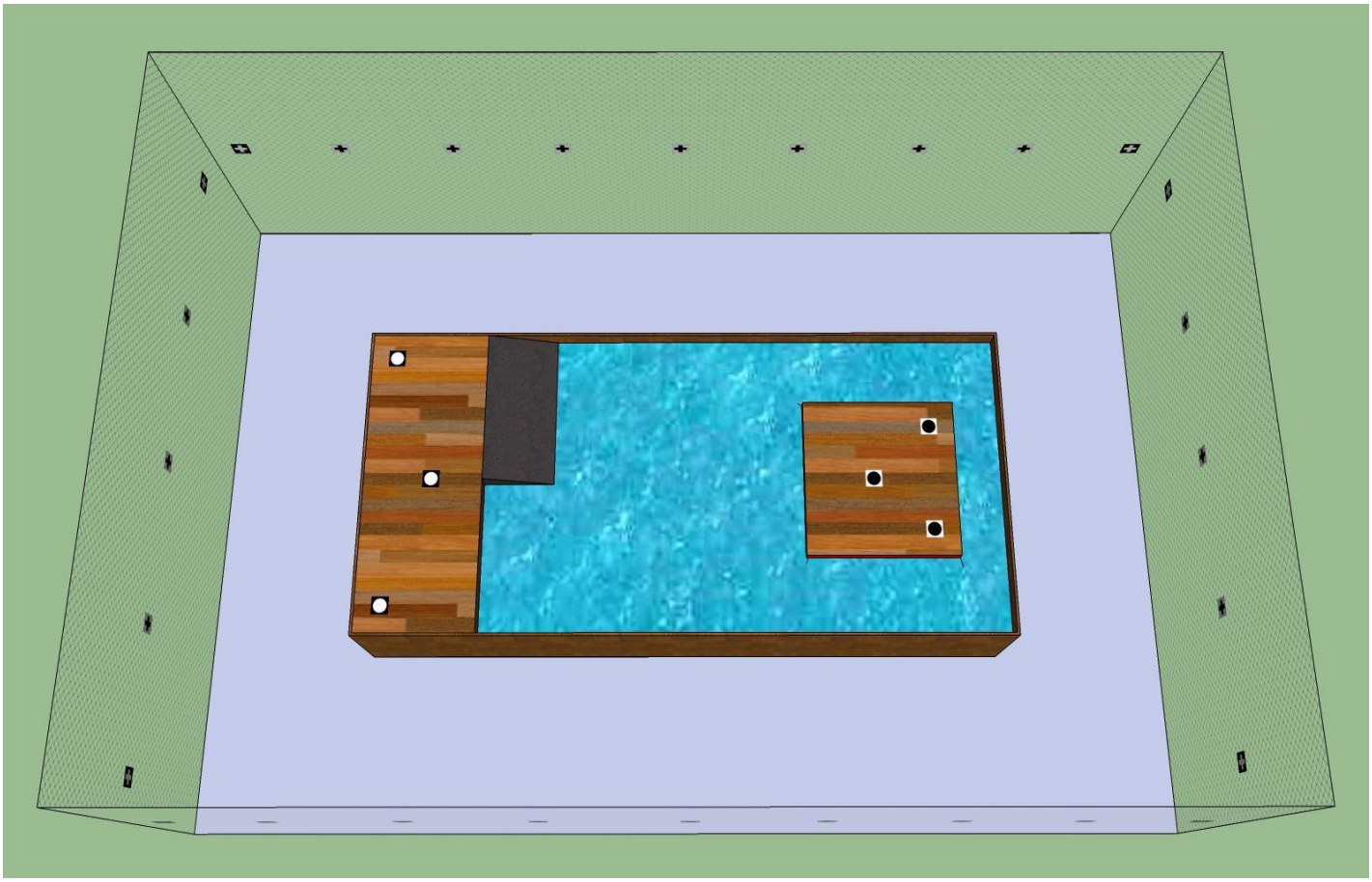
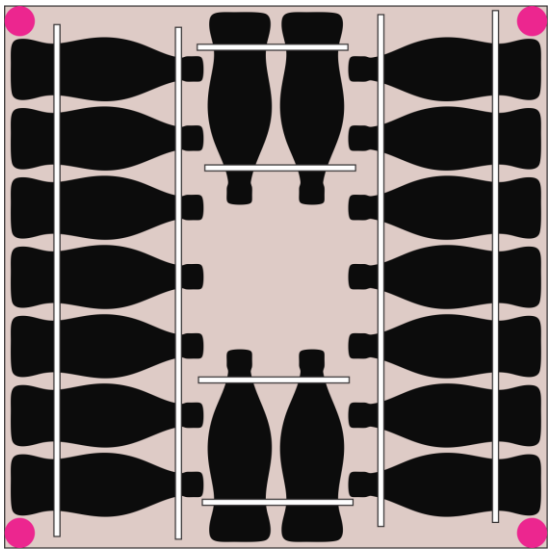


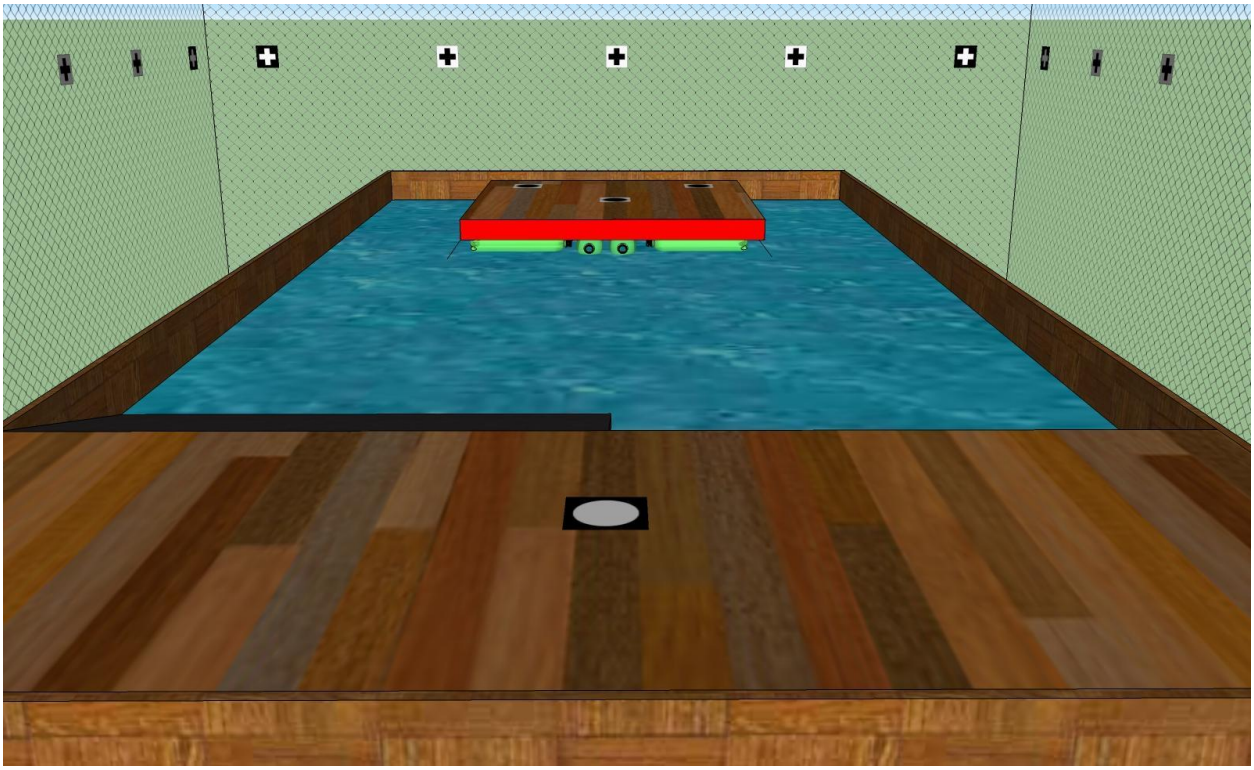
(d)

Figure 6 - 3D model scenario.

Situated in the extreme opposite side of the tank is a suspended platform (simulating the oil platform), that is located inside the water and are above water level. The oil platform is a 90cm x 90cm wood sheet, waterproof too, and its height above water level could be up to 15cm. It will use PET bottles to float, using a scheme similar to showed. For identification of the oil platform, will be attached a red tape around it.



(a)



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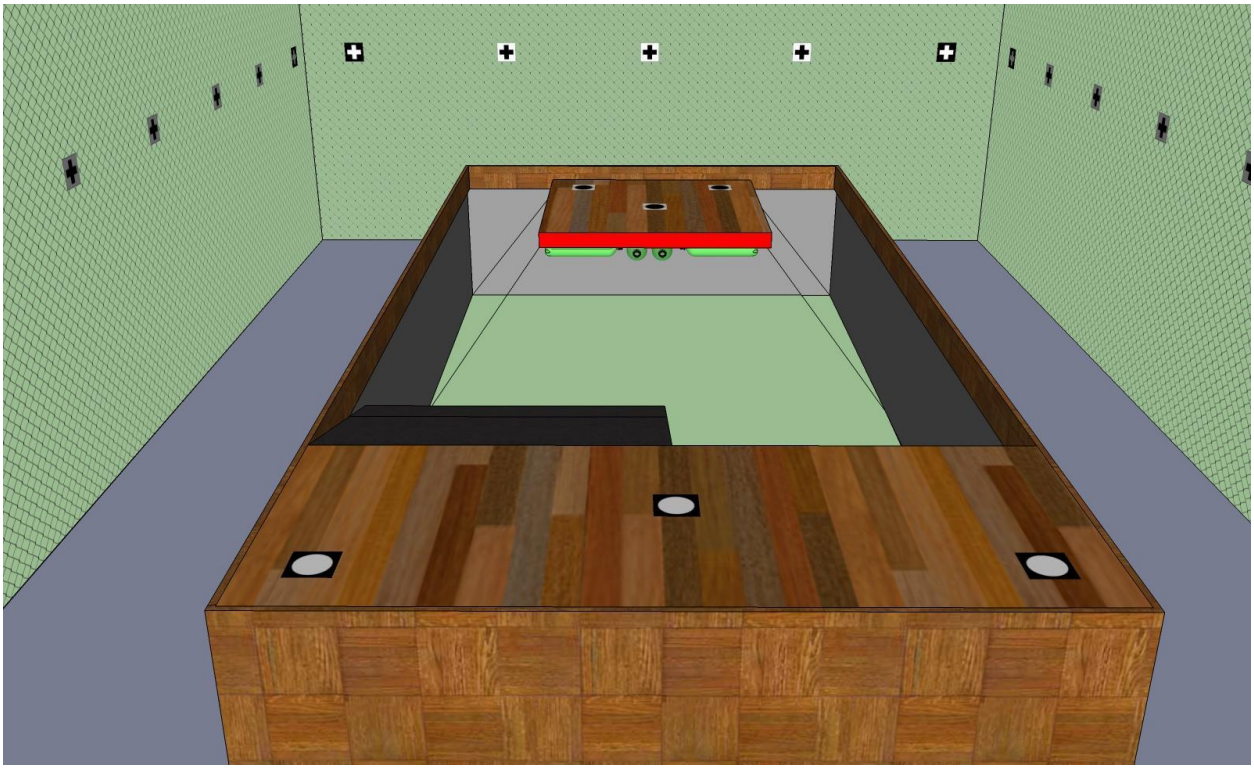

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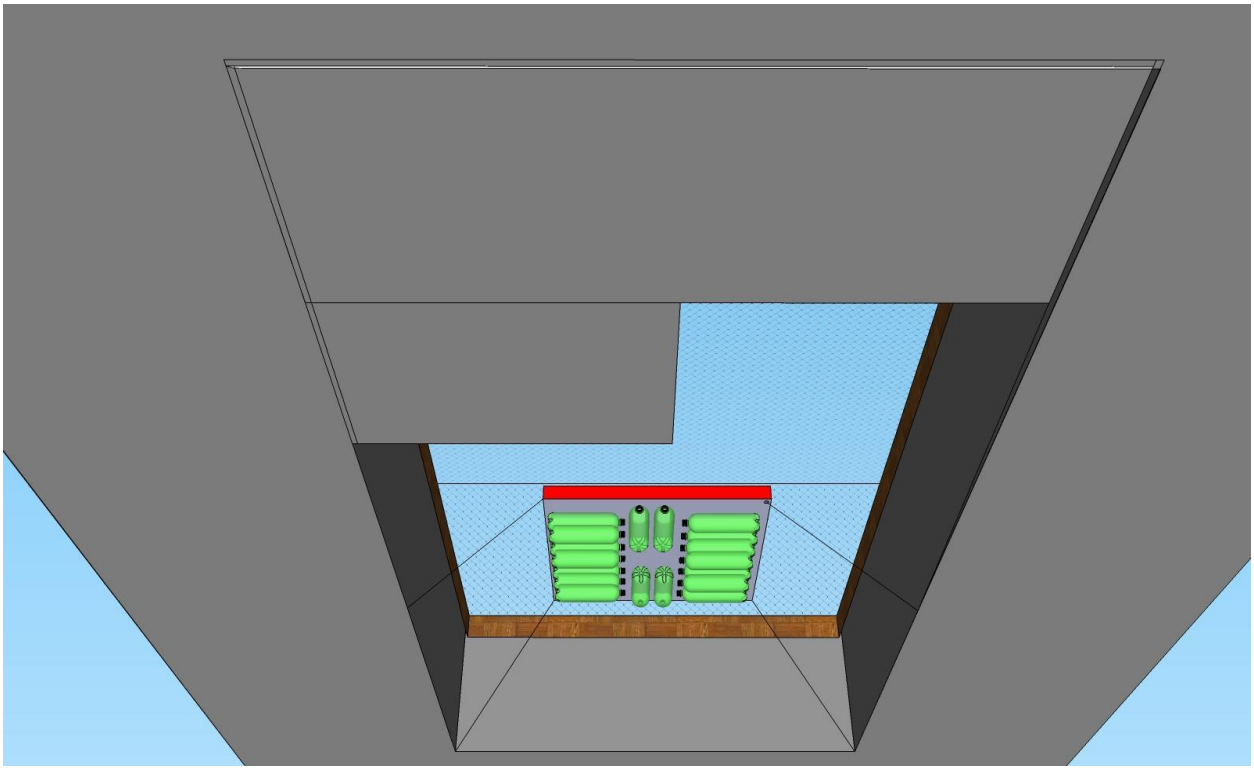


(d)

Figure 7 - Example of Pet Bottle Scheme that can be used to create a floating platform

There will be a protection net involving the environment to avoid accidents, for example, in case an aerial robot loses control. The protection net will have a maximum height of 2m in relation to the ground.

There will be identification marks on the seaport and on the oil platform. The cubes must not cover these identification marks in order to avoid localization problems.

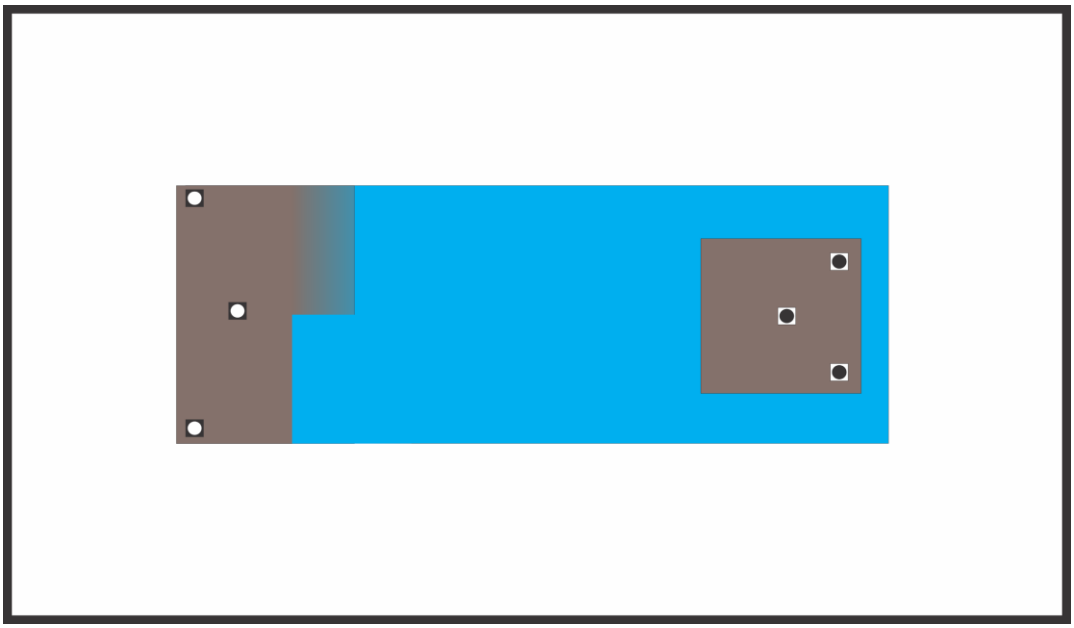
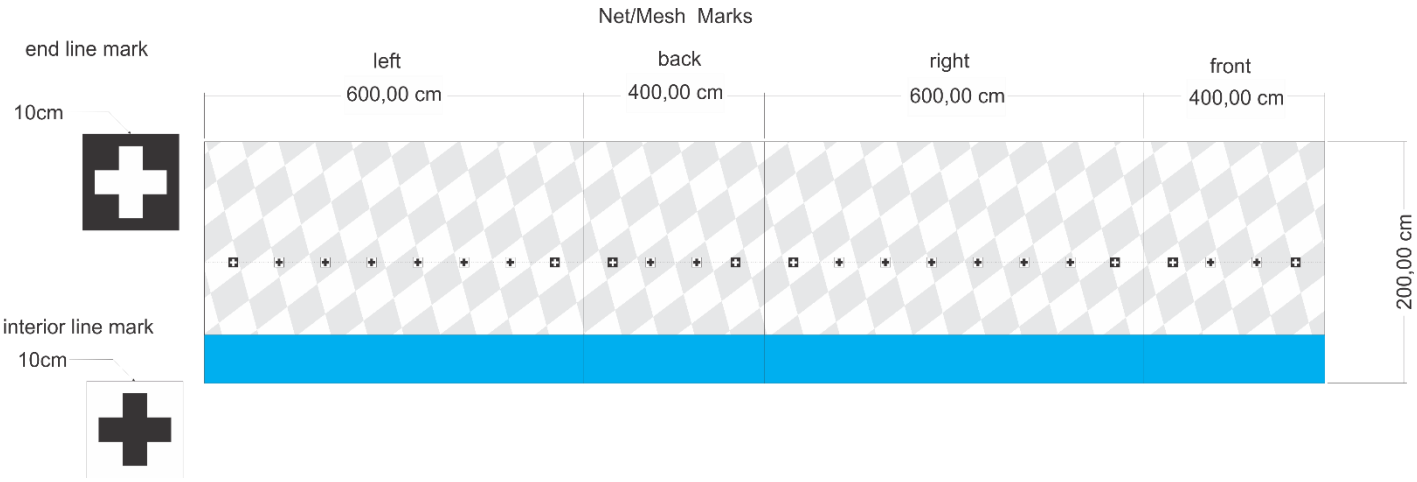


Figure 8 - identification marks of the seaport and of the suspended platform, respectively. The identification mark is a square with an edge of 10cm.

There will be other identification marks to identify the corners and sides of the screen protector:



(a)

Figure 9 - Position of the identification marks to mark the corners and sides, respectively.

Adding marks or signals of any kind to the environment besides the preexisting ones will not be allowed.

There will be 10 yellow cubes randomly distributed in the seaport and 4 red cubes randomly positioned on the oil platform. Each cube is approximately 5cm edge and weighs up to 100g.

About cubes:

- Can’t be wet;
- Can't fall out of the tank.
- Can be transported over, above and under water;
- Cubes can’t be thrown.

4. Lighting conditions

The environment can be placed inside a gymnasium or on a patio outdoors. Thus, some parts of the scene can be exposed to direct sunlight. Therefore, robots should be able to see in any conditions of interior / exterior lighting and then robots must be calibrated by team members for the lighting conditions of the scene at the time of testing. Since the competition began, the teams will play in the conditions of the scenario without discussing or making any complaint.

5. The robot

The robot must be autonomous mobile, able to move through the scenario and achieve his goals without human intervention, without any communication with a computer, cell phone or any external device. The robot needs to process the data obtained from its sensors in a onboard processor. Robots can be air, water or land type. The use of more than 2 robots of any kind will be permitted. The sum of their total weight of all robots of a team should not exceed 10 kg and all of them, simultaneously, must fit inside a cube of 60cm of edges before match starts.

Below is the list of compatible characteristics on measures of robots :
- The size of each robot can not exceed a cube of 60 cm edge early in the match.
- The robot (or robots) must be initialized just by pushing a single button in any round of the competition.
- External communication with any device other than robots of the same team is prohibited.
- The scenario can not be changed by any robot.
- Teams will be disqualified from the competition if their robot violate any of the above restrictions.
- Robots must start on seaport (touching it – outside or inside the water). Aerial robots can start above seaport (as def1 below).

6. Rules

As soon as the competition starts, all teams must leave the robots in a “waiting area”, a space designed by the competition commission outside the task environment. The robots can be withdrawn from this area during the competition and in the end of each round. All teams will have the same time limit for robot adjustments. The moment when each team will compete will be randomly chosen, and only in this moment, a team member can withdraw a robot from the waiting area.

While in the waiting area, the robots cannot be modified. Any hardware or programming changes will only be allowed once to all contestants in the end of a round.

Important Definitions:

Def1. Touching a platform or the seaport: A robot will be considered touching the seaport or plataform only in the cases below

1 – If any part of the robot touches any part of the seaport/plataform out of the water.

2 – If more than 80% and 90% of the robot´s body are above the seaport/plataform, stable for some seconds, in a distance that any grasp, arm or stick of the robot would be able to catch a block or able to reach a distance very close to the seaport/plataform.

Def2. Be at a Seaport or Plataform: A robot is considered at seaport (or platform) if it is touching any part of seaport (or platform)

Def3. Complete Travelling: A travelling is considered complete if a robot is at seaport (Def2) and move to the plataform and touches it (Def1) or if the robot is at plataform (Def2) and moves to the seaport and touches it (Def1)**.**

Def4. Stalled Robot: Stalls are situations where at least one part of any robot does not have a linear displacement of more than 15 cm in 1 minute.

About restarting: The clock will be stopped, the scenarios configuration will be reset by the judge and his assistants, the score will be reset to zero and the team will be penalized with **-30 points** due to restarting. The team has 5 minutes to restore the robot(s) to compete. It is not allow to change the robot programming or leave the competition area. There will be permitted at most two restarts. The idling time will not be accounted on the total time, but the time used up to the restarting will be added to the total time.

About penalties: The clock will not be stopped, the robots must continue its activities, the environment will not be reset and the score will not be restored. The robot will receive a score penalty for any task failure.

In case of restarts or penalties:

Restarting cases:

- If any team member touches any robot or any environment element without the judge's authorization;
- If any robot presents evident mechanical problems and the judges have previously allowed the team to restart the robots. Evident mechanical problems are motor, tire,

sensor, arm, propeller, wing detaching, a battery discharged. In general, any unexpected malfunctioning not related to bad project designing that can be quickly repaired;
- If any robot is unable to move (stall) in the environment and the judges have previously allowed the team to restart the robots.
- If any robot hits the protection net and such collision results in any damage to the robot and the judges have previously allowed the team to restart the robots;
- If any robot is visibly out of control and the judges have previously allowed the team to restart the robots.

Penalties will be given when:

- A cube falls on water **[-15 points]**
- A cube falls off the tank **[-15 points]**
- A wet cube **[-5 points]**
- More than two cubes are being loaded at once **[-5 points for each extra cube]**
- If all robots of a team stay stalled (even at platform or seaport) for more than 1 minute, the team is forced to restart.
- If no robots are trying to perform the task deliberately for 2 minutes, the team is forced to restart.
- Each restart will penalize a team with an absolute score of -30 points. Any restarting round demands a team to restart with -30 points (thirty negative points).

Scores:

- Each yellow cube on oil platform OR red cube on seaport **[+10 points]**
- If task has been completed in less than 20 minutes **[+3 points for each entire minute left]**
- To move first yellow cube to oil platform OR red cube to seaport in the first 3 minutes after the beginning of the round of after a restarting **[+20 points]**
- To move first yellow cube to oil platform AND first red cube to seaport in the first 5 minutes after the beginning of the round or after a restarting **[+20 points]**
- Each cube is gently placed on seaport (red cube) or platform (yellow cube) without being dropped or dropped lower than 1 cm **[+2 points]**
- Travelling from seaport to platform, without touching pool border or protection net, while loading at least one yellow cube **[+5 for each travel, 10 travels at most will be considered].**
- Travelling from platform to seaport, without touching pool border or protection net, while loading at least one yellow cube **[+5 for each travel, 10 travels at most will be considered]**

The score given to each transported cube is valid once the robot places it in the specified area (red cubes on the seaport, yellow cubes on the oil platform). Thrown cubes won't be considered

(except if they are dropped by an aerial robot above corresponding area).

About a round's end:
The round ends when one of the following criteria are met:

- All the yellow cubes are in the suspended platform and all the red cubes are in the seaport;
- When 20 minutes have elapsed;
- If a third restart is required.
- A team member can ask for mission aborting. If a team aborts the mission, the team will receive their points at that time and the round´s time will be reset to 20 minutes. Aborting can be asked only in the following conditions:
    - There is no more cubes to be transported
    - At any moment after one restarting at least.

TieBreaker:
If two teams receives the same final score, the following topics, showed in order of importance, can be used to eliminate the tie:

1 – Time to finish all rounds (sum of all times) (the less the merrier)

2 – Time elapsed to successfully transport the first yellow cube after the beginning of the round or after a restarting (use the best one of all valid rounds) (the less the merrier)

3 – The number of yellow cubes at the plataform (use the best one of all valid rounds) (the more the merrier)

4 – The number of red cubes at the seaport (use the best one of all valid rounds) (the more the merrier)

5 – A new round with only 10 minutes.

A team will be qualified or win based on the score of its robots. If two or more teams tie with an even score during the qualifying round up to fourth position, all the teams in the same situation will pass to the final round. If two or more teams tie with an even score during the final round an extra round will be held immediately following the final round for those ones.

Any special situation related to rules or scores will be analyzed by the judges and organizers of the IEEE LARC Open category, that will give a honest and unbiased verdict.

7. Announcements and rounds

An announcement with an hour of antecedence will be given for starting tests and the exact hour the robot must be in the waiting area. This time may be used by the teams to adjust the robots. There will be a qualifying and a final round.

Qualifying round:

- All registered teams may participate;

- Each team can have two tries to do the task, according to the rules presented in Section 6;
- Judges will generate random positioning for the cubes;
- The four teams with the highest scores will qualify to the Final Round.

Final:

- Only the qualified teams may participate;
- Each team will have at least two rounds;
- Judges will generate random positioning for the cubes;
- The first, second and third places of the IEEE LARC Open category will be awarded.

8. Registration

In order to participate the IEEE Open competition, a team of up to 6 people from any institution must be made. The team members must be students or former students that have finished their studies in at most two years. The teams must be registered in the website. The registered team list will be announced in the LARC website. It is required during registration to present a technical report using the IEEE template. This report must describe the robots' conception, construction and programming. After the competition, the winners will briefly present their robots to the other teams. The report must be sent through the event website. Failure in presenting this document will deny participation of the team in the competition, once it is important to the teaching, development, and knowledge transferring between contestants. All teams participating the IEEE Open competition will receive a participation certificate. In addition, the teams classified in the first three places will receive a winner certificate.

9. The jury

The jury will be composed of experts in robotics. One of them could be a competition organizer, and the remaining two guests. The names of the judges will be announced before the competition.

10. On extraordinary situations during competition

Any extraordinary situation regarding rules or the score will be considered by the judges and the organizers of the Open category and they will issue a verdict with honesty and impartiality.