ROBOSOFT COMPETITION 2018

ROBOSOFT COMPETITION 2018

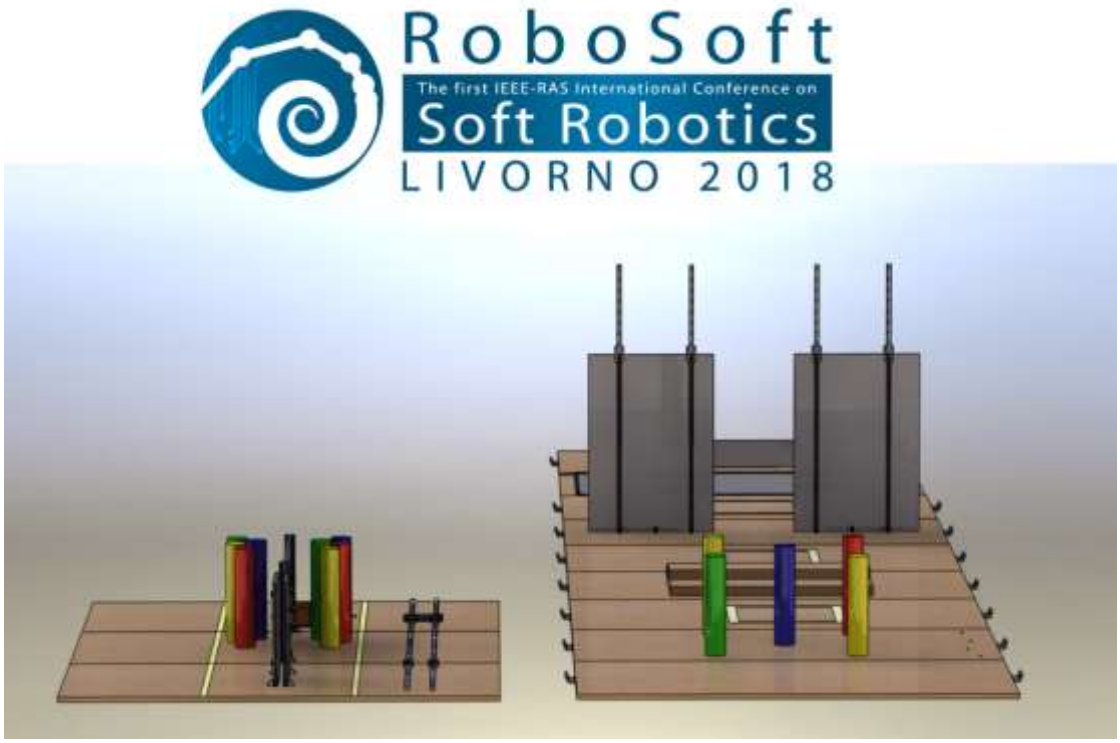
SCENARIOS AND RULES[1]

DATE:

28 APRIL 2018

VENUE:

RESEARCH CENTRE ON SEA TECHNOLOGIES AND MARINE ROBOTICS, LIVORNO, ITALY



VERSION DATE: 24/01/2018

[1] The organizers can change, refine, and develop the following rules till the first day of the competition. Please visit regularly http://www.robosoft2018.org/index.html for the latest version.

CONTENT

Competition overview 3
Venue and Schedule 4
Submission procedure 5
Technical documents and video 6
Skills to be shown in the video / evaluation criteria 6
Restrictions 7
The robosoft competition 2018 7
Terrestrial race 8
Manipulation 11
Scoring 15
Terrestrial race 15
Manipulation 16
Appendix 16

COMPETITION OVERVIEW

The RoboSoft Competition 2018 invites teams to test the design and control of their robots in challenging scenarios. The competition will showcase novelties of soft robots like resilience, body compliance, delicate contact and deformability.

The principal aim of the competition is twofold: first, to challenge state of the art soft robots; second, to push the performance of soft robots beyond the state of the art to increase their impact value.

Teams may comprise any combination of students, faculty, industrial partners, private partners or government institutions without restriction of number of participants per team. One member of the team must be designed as Team Leader (TL): only the TL can speak for the team during the competition.

The RoboSoft Competition 2018 is made of scenarios which approximate real-world robot applications. Specific parts of the scenarios require peculiar robot features which were never requested in other competitions so far, such as body shrinking, delicate contact and compliant manipulation (see Figure 1). These scenarios cover some domains of soft robotics where research is particularly lively. Two different scenarios are proposed, and particularly they are terrestrial race and manipulation.

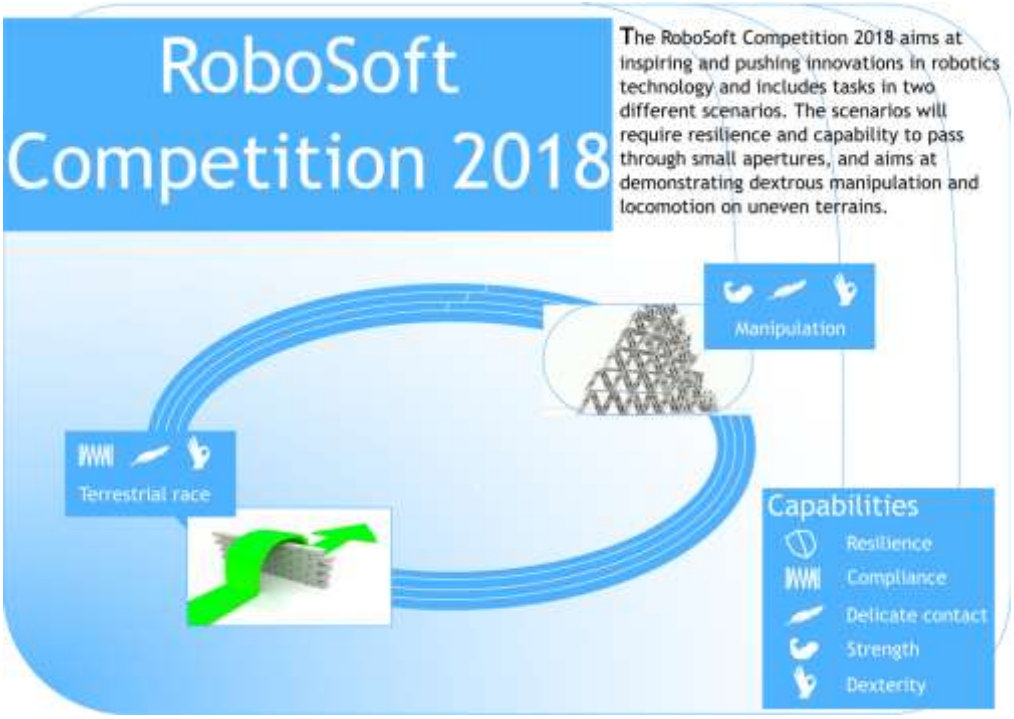


FIGURE 1: THE OVERALL AIM OF THE ROBOSOFT COMPETITION 2018 IS TO HIGHLIGHT SOFT ROBOTS FEATURES (SUCH AS RESILIENCE, COMPLIANCE AND DELICATE CONTACT) AS WELL AS TRADITIONAL ROBOTS CHARACTERISTICS (FOR EXAMPLE STRENGTH AND DEXTERITY).

Each scenario is split down into tasks: points are awarded by completing partially or totally the tasks, and a scenario will be considered cleared if the robot completes all tasks. The robot that will earn the maximum overall amount of points will be considered the winner of the RoboSoft Competition 2018. Each team participates with one robot, but multiple entries of the same team with different robot designs are allowed.

A total of six awards will be handed out: First, Second and Third place for each scenario.

OFFICIAL INFORMATION

The official information and interpretation about rules will be available on the RoboSoft 2018 website www.robosoft2018.org).

Rules (including this documents) and scenarios are subject to change. Please check regularly the RoboSoft 2018 website for last updates.

In case of any question, participants are invited to read carefully this document, and for further specifications to contact the competition chairs **m.calisti@santannapisa.it**, **jamie.paik@epfl.ch**.

FIGURE 2: DEPICTION OF THE FIELD AREA[2]: ACCESS INSIDE COMPETITION SCENARIOS IS GRANTED ONLY TO THE OPERATORS AND THE JUDGES. PUBLIC SHOULD BE LOCATED OUTSIDE.

VENUE AND SCHEDULE

The RoboSoft Competition 2018 will take place at the Bagni Pancaldi (or at the Research Centre on Sea Technologies and Marine Robotics), Livorno, Italy on **April 28th 2018.**

FIGURE 3: THE RESEARCH CENTRE ON SEA TECHNOLOGIES AND MARINE ROBOTICS AND BAGNI PANCALDI VENUES. THEY ARE 5 MINUTES WALK ONE FROM THE OTHER.

[2] Image taken from: "Calisti M, Cianchetti M, Manti M, Corucci F and Laschi C (2016) Contest-Driven Soft-Robotics Boost: The RoboSoft Grand Challenge. *Front. Robot. AI* 3:55. doi: 10.3389/frobt.2016.00055"

A preliminary schedule of the competition is shown in the following table:

Day	Date	Events
1	Friday, 27 April	• Teams arrival and registration • Preliminary (ground) tests on the competition fields
2	Saturday, 28 April	• Teams registration • Morning: RoboSoft Competition 2018 • Afternoon: Awards ceremony

Although the competition is scheduled only on Saturday 28, organizers will arrange preliminary ground tests for the teams if possible. Moreover, registration to the competition will be available from April 27. A set-up location will be provided to each team on April 28. It will be equipped with the following minimum facilities:

- Table/work surface
- 220 V power plugs
- Internet connection

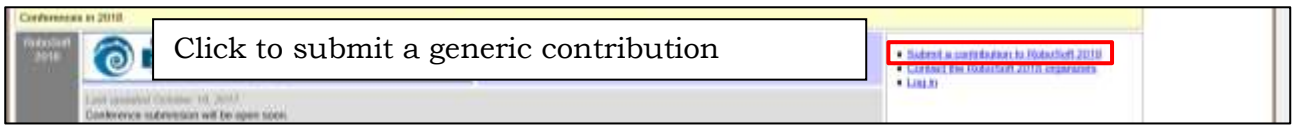
Additional equipment will be evaluated by the committee upon request, however teams should be as autonomous as possible, bringing all the material they need. Further information regarding schedule and facilities will be provided later.

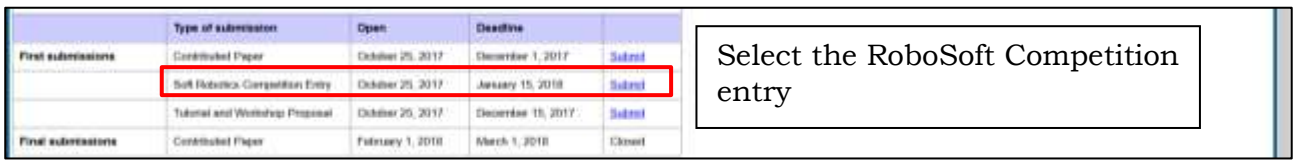
The main phases of the application procedure are reported below, along with the most important dates.

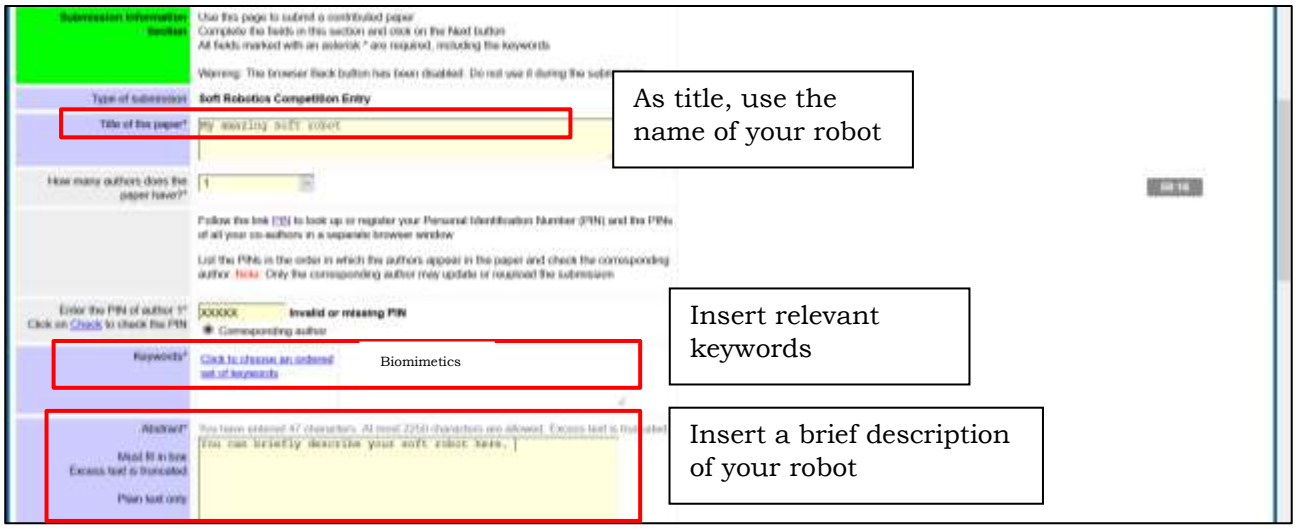
SUBMISSION PROCEDURE

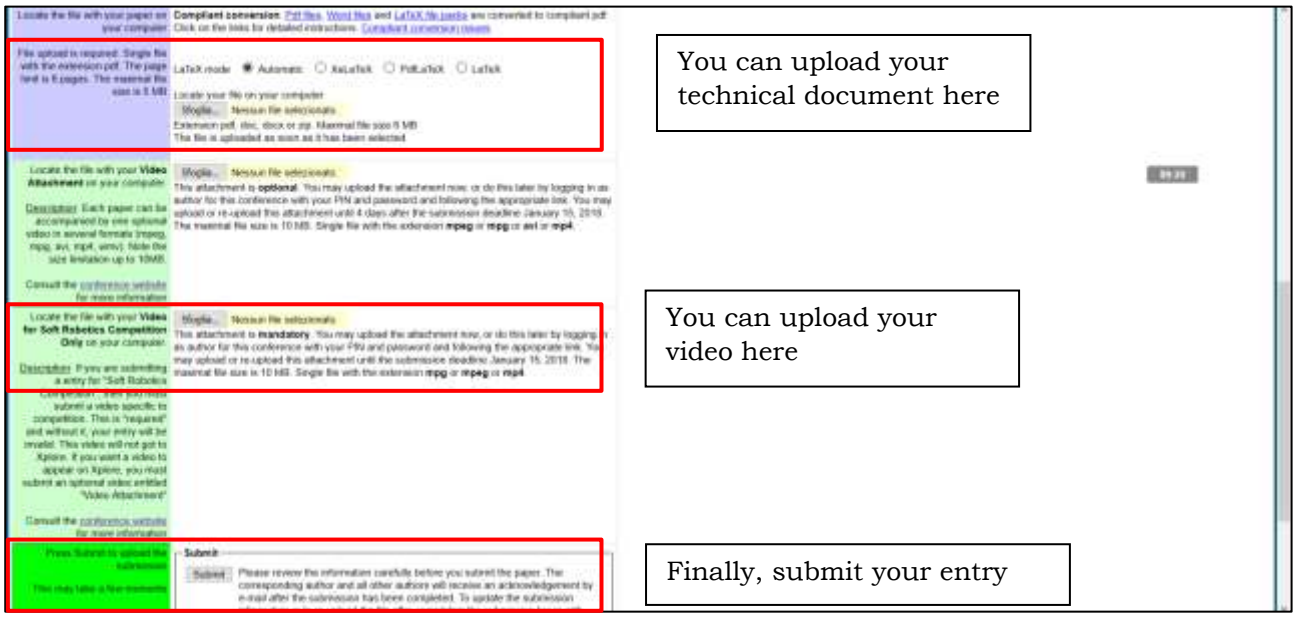
For pre-selection material submission for the competition, please visit this page and follow the instructions. Each submission should be composed of one video (max 5 minutes long) and one technical document (format can be found at the RoboSoft 2018 website http://www.robosoft2018.org/paper_submission.html).

A brief description of the step are presented hereafter:









TECHNICAL DOCUMENTS AND VIDEO

To ensure competent entries only, a pre-selection phase will take place in which a technical committee will evaluate the eligibility of each robot. Each team is invited to submit a video demonstrating the skills of the robot at the current stage of development. Each video will be accompanied by a short technical document, summarizing the current stage of development as well as expected improvements to be shown at the competition.

The acceptance notification will be on March 1st.

SKILLS TO BE SHOWN IN THE VIDEO / EVALUATION CRITERIA

Skills to be shown are directly related to scenarios and tasks: teams should demonstrate minimum capabilities of their robots allowing them to be competitive during the competition. A complete list is presented here, grouped by scenario:

1. Terrestrial race
    a. Locomotion on flat ground

   b. Passive/active body shrinking
2. Manipulation
   a. Picking of objects (by grasping, curling around, etc…)
   b. Manipulator dextrous positioning (demonstrate several poses of the robot/manipulator)

The evaluation criteria will be on a do-it base, thus a simple video demonstrating the ability to perform one of the skills listed above grants the eligibility. Although performing well in all the tasks and scenarios of the competition is the most auspicable result, you can expect that many of the opposing teams will decide/be able to tackle only a subset of the tasks/scenarios. We thus encourage teams to submit their pre-selection material even if their robots are able to show only one or few of the aforementioned skills.

RESTRICTIONS

Despite the competition is open to participants creativeness, some restrictions are required due to logistic requirements.

Robot maximum dimensions: 60x60x60 cm.

Robot maximum weight: 20 kg.

Power supply: 220V electric power supply will be provided, while other power sources will be evaluated on request. Please check the plug standard currently in use in Italy.

Robots can be either tethered or untethered, they can be teleoperated or they can have autonomous behaviour. No additional points will be awarded depending on autonomy or tethering.

Upon acceptance, teams will be required to submit a technical description of their robot to evaluate potential safety issues. Any robot considered unsafe by the judges will be disqualified.

Keep in mind that the organizer are not responsible to damage to persons or objects. Teams are responsible for all the safety requests their robot demands, or for the safety of their actions during the competition.

THE ROBOSOFT COMPETITION 2018

The RoboSoft Competition 2018 is composed by 2 scenarios described in detail in the next sections. The time to complete each scenario starts when teams are ready and the TL communicates to the judge the beginning of the trial. When a team is summoned to a certain scenario, it has 5 minutes to deploy the robot and the supporting material. If the deployment takes longer, the judge starts the countdown of the scenario time (thus the extra time needed for the deployment is deducted by the time allowed to complete the task). An example of the competition field is presented here.

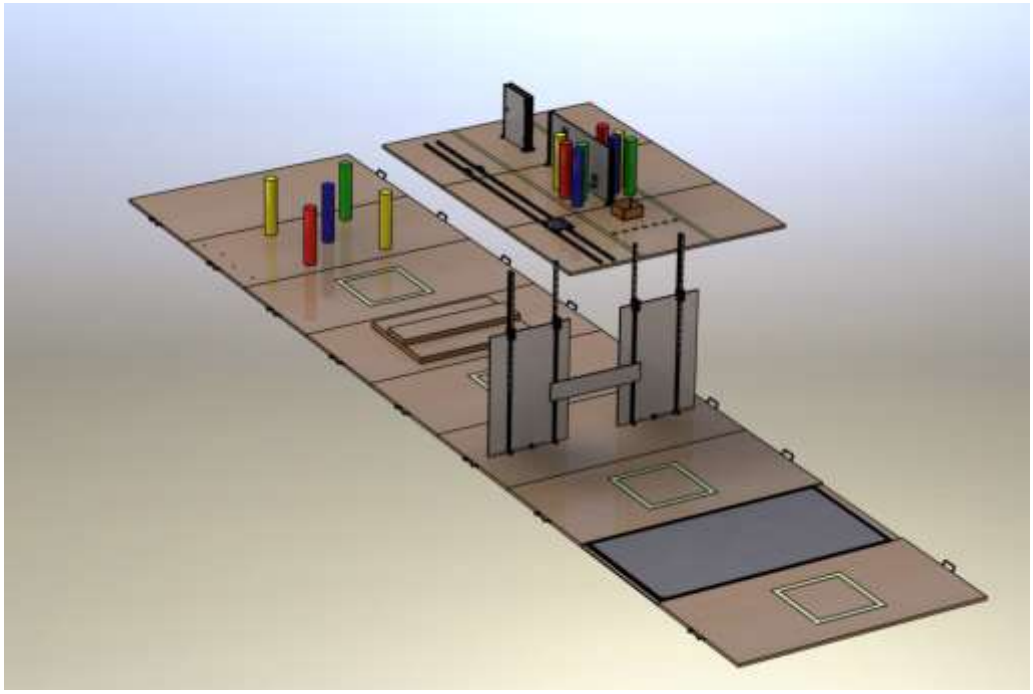


FIGURE 4: OVERALL GROUND: IT IS COMPOSED BY THE TERRESTRIAL RACE AND MANIPULATION. FINAL ARRANGEMENT OF THE SCENARIOS COULD VARY.

During a trial, teams will receive a maximum time slot upon which they must complete the scenario or part of it (that is completing a certain number of tasks). Depending on the scenario, they will receive additional points by taking into account specific multipliers (i.e. it is possible to tune the difficulty of some tasks to obtain additional points, as explained in the scenario details). Only two operators (one operator should be the TL himself) can participate in the trial and are allowed to operate inside the competition field, together with at least one judge who will supervise the execution of the trials.

The execution of a task can be stopped at each moment by the judges, or the TL can request to stop the trial. This can happen for safety issues or because the operators consider the robot stuck. After the TL request, the judges allow the operators to physically interact with the robot and to repositioning it in order to perform another attempt. A maximum number of three attempts for each task can be performed, after which the task is considered not completed and the robot should be moved by the operators to the next task. A fraction of the total points can be assigned to the robot in case the task is partially completed (see scenario details in the section The robosoft competition 2018).

The number of trials required to complete a task also affects the scoring, i.e. the maximum score can be earned by completing the task with the first attempt, then the score decreases at each subsequent attempt The complete scoring is reported in section Scoring.

TERRESTRIAL RACE

GENERALITY:

The robot is deployed in an environment which comprises several obstacles to be negotiated to reach, as fast as possible, the end of the scenario. This scenario simulates an urban area (comprising an unstable building) which is not accessible by humans: the

robot should be deployed far from the building, than it should go inside it passing through a small aperture and negotiate the environment to reach the end of the scenario.

DESCRIPTION:

The robot starts from an obstacles-free tile and should move forward toward the first obstacle tile (task 1) which is a sand box representing the ground outside a collapsed building. The second obstacle tile (task 2) represents an aperture of the building which the robot should enter. The third obstacle tile (task 3) represents a stair which the robot should negotiate moving upward and downward. The last obstacle tile (task 4) represents a congested, unstable environment which could collapse if the robot exerts too much force onto the structural elements. All obstacle tiles are separated by obstracles-free tiles with the function of checkpoints.

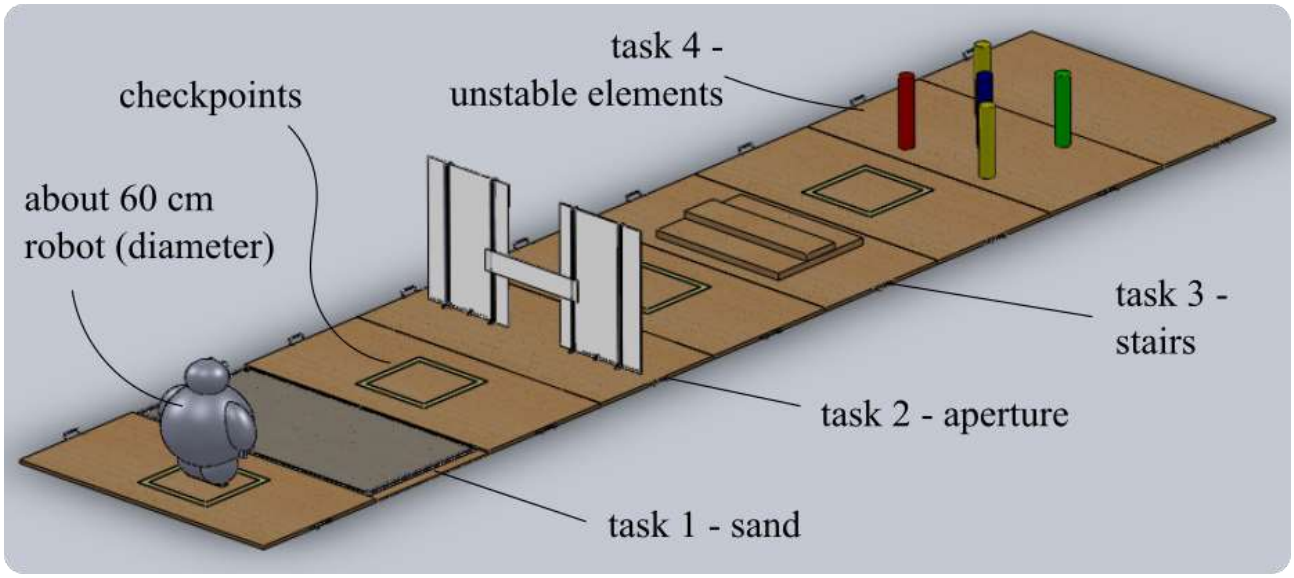


FIGURE 5: THE TERRESTRIAL RACE STARTS WITH A SAND TILE, FOLLOWED BY AN APERTURE, THEN A TILE WITH THREE STEPS AND FINISHES WITH A TILE WITH UNSTABLE ELEMENTS.

SCENARIO DETAILS (BROKEN DOWN INTO TASKS):

- Task 1: The sand box is approximately 2 meter long and 1 meter wide. It has about 1,5cm of sand with not predefined granularity. From the starting tile to the sand tile, the ground could be uneven, thus a small step of few centimeters could be required to enter into and exit from the tile. Task is considered partially solved if the robot move at least to the middle of the tile.

- Task 2: The wall tile is made of three rigid PVC elements which can be moved to reduce the aperture dimensions, see Figure 6. Approximately, the aperture will be a square of side s, where s should be decided by teams as follow.

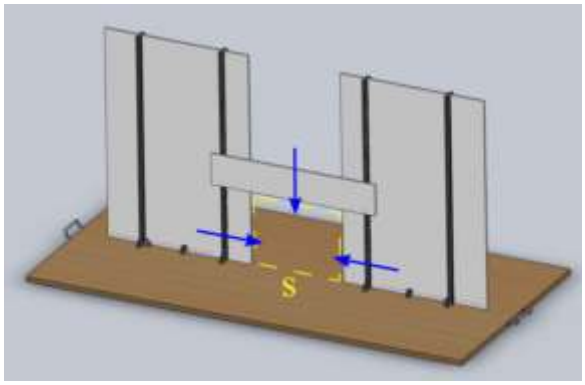


FIGURE 6: WALL TILE. BY MOVING THE PANELS, THE APERTURE WILL BE REDUCED TO MATCH ROBOT DIMENSIONS.

Prior to the competition, the nominal robot dimension, r_d, (with respect to the locomotion direction) will be declared by the TL to the judges. When starting terrestrial race, the TL should inform the judges about how challenging the aperture should be for their robot, i.e. to which extent their robot is able to squeeze (or deform), and enter apertures smaller than r_d. The more the aperture is reduced, the highest the number of points that will be awarded for negotiating this obstacle. Approximately if $s = {r_d}/{1.1}$, base points are multiplied by 1.1, if $s = {r_d}/{1.2}$ base points are multiplied by 1.2 and so on. Scoring details are reported in the next section. Notice that it is possible even to reduce the score points by *increasing* the aperture dimension, but not exceeding 70 cm. If half of the body enters the aperture but the robot gets stuck, the task is considered partially solved.

- Task 3: The stair tile represent a simple 2-step stair (step height about 5 cm) which should be negotiate moving upward and downward. This is a classic task for robot locomotion. The task is considered partially solved if the robot is at least able to climb the stair, and it is instead considered completely solved if the robot is also able to climb down reaching back the ground.
- Task 4: The unstable environment tile is made of rubber tubes held in place by magnets. Rubber tubes represent the collapsible elements of the congested environment. The robot should pass inbetween the tubes without dislodging them.

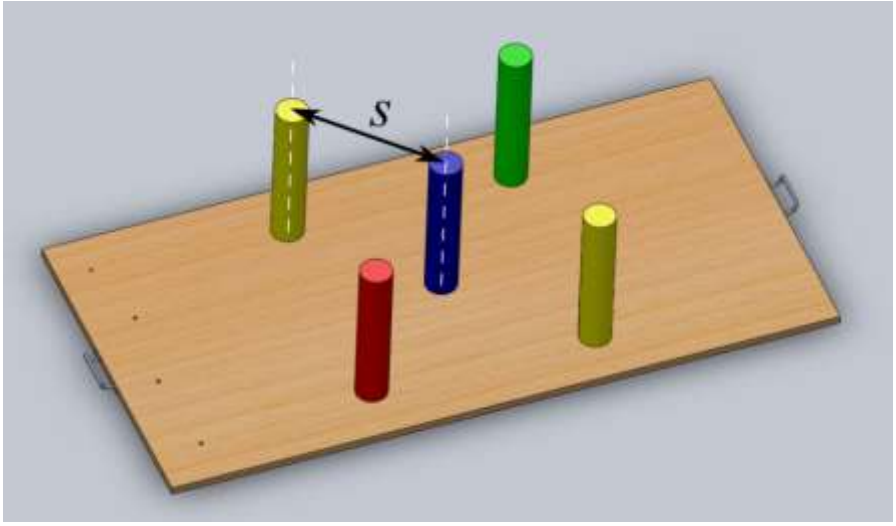


FIGURE 7: CONGESTED ENVIRONMENT TILE. THE RUBBER TUBES ARE MOVED TO MATCH ROBOT DIMENSION.

As in the wall tile, in this case the tubes should be moved to match the nominal dimension of the robot, r_d, so that the distance among the tubes, s, is approximately $s = r_d$. The robot could contact the tubes but should not push them away from their original locations. Tubes and magnets are described in the appendix section. If up to two tubes were dislodged, the task is considered partially achieved. If more than two tubes were dislodged, the task is considered not achieved. If no tubes are moved, the task is fully solved.

TIMING:

The maximum amount of time allowed for this task is 20 minutes.

GETTING POINTS:

Points are earned for the tasks:

- Negotiating the sand
- Negotiating the aperture
- Negotiating the steps
- Negotiating the unstable elements

MANIPULATION

GENERALITY:

In a structured environment, the robot should interact with several objects featuring complex shapes (possibly not known a priori) and different, possibly fragile materials, then it should move the manipulator to assume a suitable pose to apply a certain force to the object. This may represent industrial, surgical or domestic scenarios where the robot is required to manipulate particular objects or to inspect structures.

DESCRIPTION:

The scenario is structured into three tasks: pick and place of objects, arm positioning and door opening. This scenario is made of a structured environment as illustrated in Figure 7. Teams have two options to cope with the tasks: in the first one, the robot moves (thus it should be a mobile robot) toward the manipulation tiles and performs the demanded tasks. In the second option, teams are allowed to attach their robots, robotic arms or end-effectors to a linear slider (thus the robot could be also an arm-type robot).Technical specifications related to the latter option (maximum payload of the interface -connective plate- exact dimensions) are detailed in the appendix. There is no predefined order in which the tasks should be tackled. Each manipulation tile is itself a checkpoint: this means that once a task is completed or whenever the team desires, the robot could be moved from one tile to another.

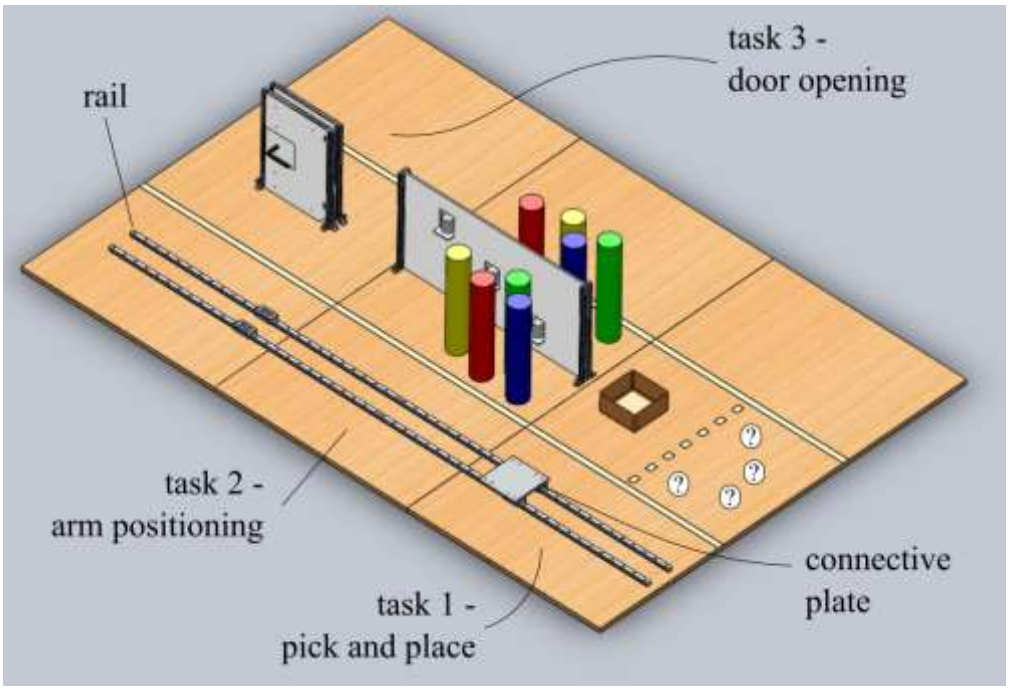


FIGURE 8: MANIPULATION SCENARIO. TASKS CAN BE APPROACHED FROM THE STRUCTURED SIDE, OR FROM THE UNSTRUCTURED ONE.

To attach the robot manipulator to the sliders, a *connecting platform* (connective plate in Figure 8) with blind holes will be provided. Each team should care of designing, bringing and fixing a *connective structure* fixing their robot to the connective platform. Two connection examples are shown in Figure 9. The connective platform is at fixed distance from the objects of the scenario: teams are free to reach the objects with their preferred connective structure.

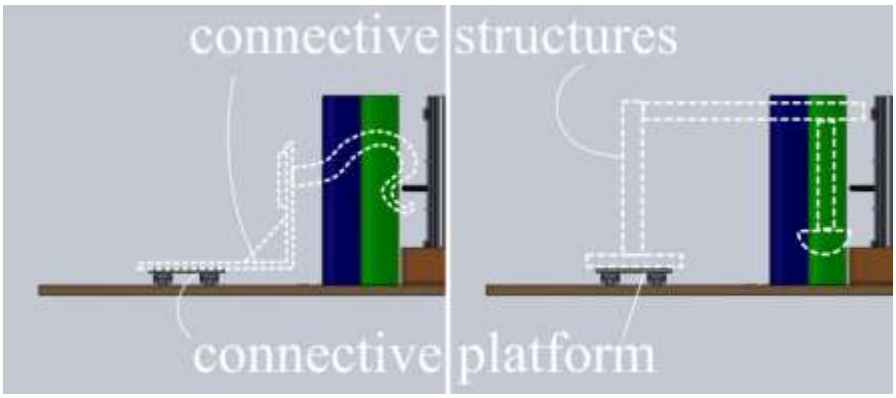


FIGURE 9: CONNECTION EXAMPLES. CONNECTIVE STRUCTURES CAN BE EITHER PASSIVE (AS IN THE LEFT FIGURE) OR ACTIVE (AS IN THE RR-ARM WITH A GRIPPER IN THE END OF THE RIGHT FIGURE).

SCENARIO DETAILS (BROKEN DOWN INTO TASKS):

- Task 1: The pick and place tile is made of two subspaces, one (a) where the objects (four different ones) are placed and the other (b) where the collecting basket is lodged. Objects form and material will be revealed the day of the competition, however their maximum dimensions and weight are reported in the appendix section. Also fragile objects (glass-like or similar) could be presented.

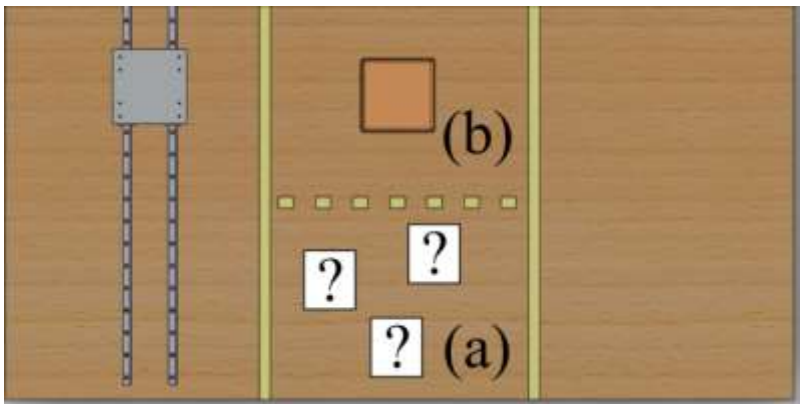


FIGURE 10: PICK AND PLACE TILE.

The objects should be collected inside the basket. Moving an object from side (a) to side (b) without succeeding in placing it into the basket worths a fraction of the points that will be earned with a correct placing inside the basket. If an object is damaged during the pick and place operation, the robot will not earn any point, no matter if it manages to move the object to the tile (b) or even placing the object into the basket.

- Task 2: In the positioning scenario, robots should demonstrate their dexterity by reaching three cans placed in a wall. The tile features three different lanes, from (i) to (iii). Robots should reach the cans by starting from a frontal position with respect to the can they have to touch. This is to prevent that a robot starts from lane (i) and touches the can of line (ii), avoiding the corresponding rubber tube.

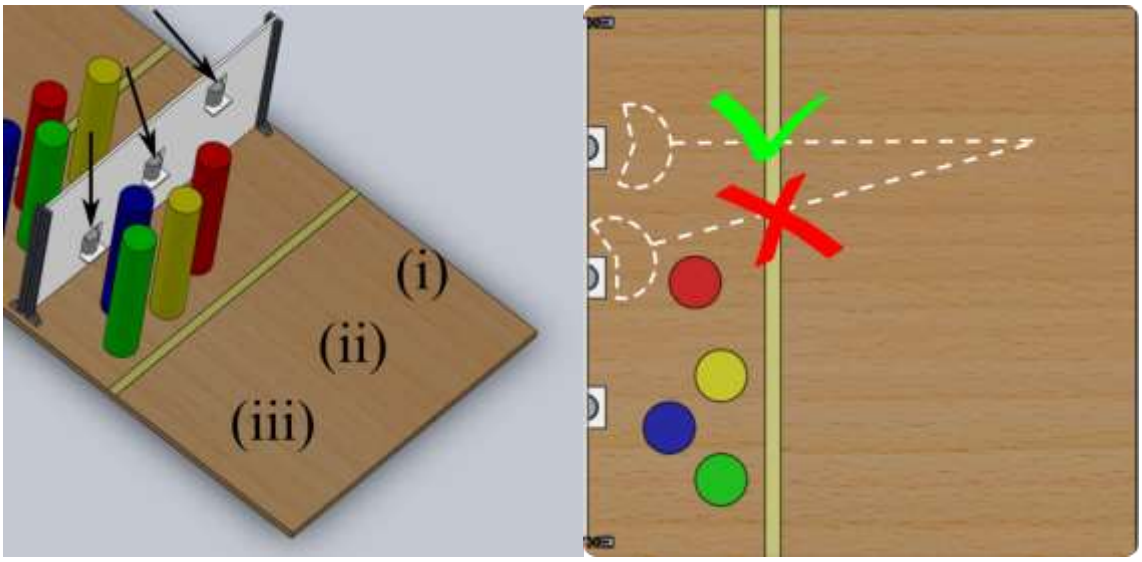


FIGURE 11: LANES OF THE POSITIONING SCENARIO. ON THE RIGHT, ALLOWED AND NOT ALLOWED PATH FOR THE MANIPULATORS.

The first lane (i) is the simplest one, as the robot can freely elongate to touch the can without the need to avoid any obstacle. In the second one (ii), a fixed rubber tube is placed between the can and the robot, thus that a low degree of dexterity is required by the manipulator. Finally in lane (iii) there are three rubber tubes between the can and the robot. The aim is to increase the difficulty of the task depending on the lane that is negotiated. If a manipulator passes the tubes but does not hit the can, the task is considered partially accomplished.

- Task 3: The door tile is made of a small door with an horizontal handle placed at mid height. Despite the apparent simplicity of the task, it requires coordination and strength both to achieve a stable grasp of the handle as well as during the opening maneuver. The task is considered completely solved if the handle is turned and door opened. Task is considered partially completed if the handle is rotated but door is not opened.

TIMING:

The maximum amount of time for this trial is 20 min.

Points are awarded for each element of the task completed:

- numbers of objects correctly picked-n-placed
- numbers of can reached
- door opened

SCORING

Points are assigned for each task completed in each scenario. Each task can be evaluated as totally completed, partially completed, or not completed at all. Additional points are awarded for completing the scenario with a minimum amount of trials. Structured evaluation forms are provided to the judges to ease the score evaluation, see the following Scoring forms.

In the scoring sheet, the first column is the score awarded for not completing the task, second column is the score awarded for partially completing the task and third column is the score for totally completing the task. Third, fourth and fifth columns indicate scores for completing a task in the first, second or third attempt respectively.

TERRESTRIAL RACE

The scoring form for the Terrestrial Race is the following:

Terrestrial Race							
	not	half	full	1°	2°	3°	*m*
Task 1 - Sand	0	0,5	1	0,25	0,125	0	
Task 2 - Aperture	0	2	4	1	0,5	0	x
Task 3 - Stair	0	1	2	0,5	0,25	0	
Task 4 - Debris	0	2	4	1	0,5	0	
Total			13,75				

FIGURE 12: SCORING FORM FOR THE TERRESTRIAL RACE

Points are awarded for the four tasks described before. Additional points are awarded by completing the tasks in the first, second or third trial. Multiplying factors are applied depending on the aperture decrease/increase.

Terrestrial Race								
	not	half	full	1°	2°	3°	m	
Task 1 -Sand								1,25
Task 2 -Aperture							1,1	2,75
Task 3 - Stair								1,25
Task 4 - Debris								0
Time	x							
Total			5,25					

FIGURE 13: EXAMPLE OF A FILLED-IN SCORING FORM

The total amount of points earned are the sum of the points marked in the scoring form, as in Figure 12. A filled-in scoring form is presented in Figure 13: on sand, the robot completely achieved the task (+1 point) in the first trial (+0.25 point), see partial on the left of 1.25 points. On aperture task, it partially completed the task (+2 points) in the second attempt (+0.5 point) with a multiplier of 1.1, thus the partial score is 2.75. By adding scores achieved in the other tasks a final score of 5.25 is obtained. Completion time is reported and will be evaluated when there is a same score.

MANIPULATION

Scoring for manipulation and underwater scenarios follows the same principles of the terrestrial race.

Manipulation						
	not	half	full	1°	2°	3°
Task 1 - Object 1 hanlded	0	0,5	1	0,25	0,125	0
Task 1 - Object 2 hanlded	0	0,5	1	0,25	0,125	0
Task 1 - Object 3 hanlded	0	1	1	0,25	0,125	0
Task 1 - Object 4 hanlded	0	1	1	0,25	0,125	0
Task 2 - Can 1 reached	0	0,5	1	0,25	0,125	0
Task 2 - Can 2 reached	0	0,75	1,5	0,375	0,1875	0
Task 2 - Can 3 reached	0	1	2	0,5	0,25	0
Task 3 - Door opened	0	1,5	3	0,75	0,375	0
Total			14,375			

FIGURE 14: SCORING FOR THE MANIPULATION SCENARIO

APPENDIX

Appendix reports the list of material that will be used to build the scenarios, the approximate dimensions and other details regarding the competition field. This is to increase the understanding of the scenarios and also to allow the teams to reproduce scenarios or parts of them. As for all the part of this rule book, also this part can be subject to modification, even if this is not envisaged by the organizers. Additionally, all CAD of the scenario will be available for download, inspection, or usage by the team. Readers should be aware that the organizers do not take the responsibility of small discrepancies among the CAD and the actual scenarios. Please also note that some of the CAD models are from third parts, which own the rights on them.

Approximate dimensions of the fields are presented in the following drawings, which provide a broad understanding of the scenario size. Essential components to build and assembly the scenarios are provided hereafter. Scenarios are made of commercial components, so that each participant can easily buy them and check features of interest (weight, adhesion force, maximum payload, ect.). This is to allow participants to replicate scenarios (or part of them) in simulation or physically. Although the organizers are trying to be more specific as possible, be aware that modifications to the proposed implementations, due to logistics, are conceivable. Clarification about rules are also reported.

TERRESTRIAL SCENARIO

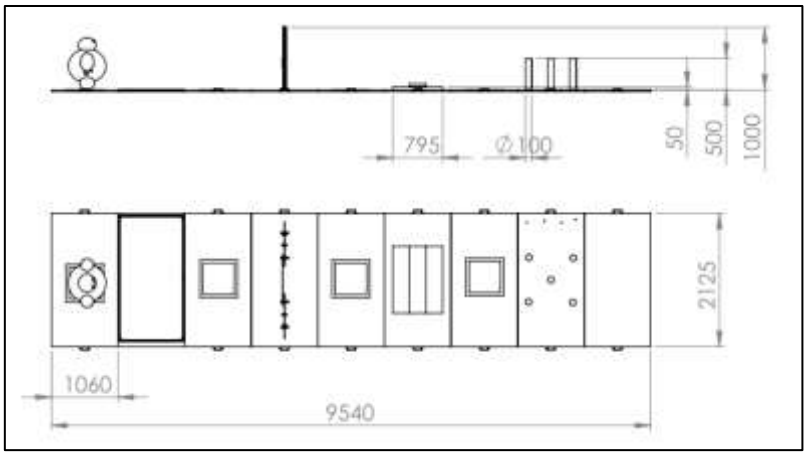


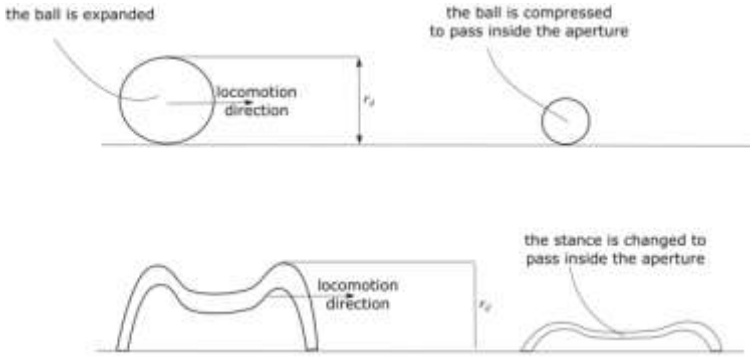
FIGURE 15: TERRESTRIAL RACE DRAWING. SCALING 1:75. MEASURES IN MM.

The material of the floor will be wood: our plan is to use a commercially available tile (Leroy Merlin, ID OBJ 35198730 http://www.leroymerlin.it/ricerca?q=35198730). Steps for the stair tile will be obtained from the same wood plate. All structural components (sand and aperture tiles) will be made of MISUMI aluminium frame, HFS5-2020-1000[3] and HFS5-2020-1000. The sand tile could be slightly uneven with respect to the previous one, however the maximum high of the step should be lesser than 40mm. The dimension of the sand is intentionally unspecified (it could range from fine sand to a few millimetres granules). Tubes of the debris tile will be foam noodles from Decathlon http://www.decathlon.it/noodle-di-schiuma-120cm-id_8216134.html. We plan to connect tubes to the ground with FE-S-10-03 magnets from supermagnete.it http://www.supermagnete.it/eng/disc-magnets-ferrite/disc-magnet-diameter-10mm-height-3mm-ferrite-y35-no-coating_FE-S-10-03. This is the attaching force that participant should consider. Teams should keep in mind that a force applied radially with respect to the axis of the tube can translate the noodle in another position where magnetic force will be reduced.

Aperture tile needs more specification with respect to the nominal robot dimension. This is a critical measure which is interesting because it highlights deformability of soft robots, but also it is complex because could be extremely qualitative. We try to make it as fair and quantitative as possible by using these considerations: teams will declare the locomotion direction of their robots, and we use the frontal projection with respect to the robot direction. The maximum dimension of the frontal section will be used as r_d. Robots will be evaluated in one of the stance (if robots are able of multi-modal locomotion) used for locomotion, decide by the teams, and robots are allowed to change stance to enter the aperture. Judge will supervise and approve the participants evaluation, to ensure the fairness of the comparison among different robots. Teams should consider that due to the soft robots variability this evaluation could be extremely complex: in case of discrepancies among participant and judge evaluations, the latter one will be used for the calculation of the points.

[3] Important notice: product codes are referred to the Italian suppliers. Other countries' suppliers can provide a different code for the same product, so check carefully specifications.

Here we report two examples, which illustrates actual soft robots, to explain the concept. The first one is the JSEL[4] robot, that I depict as a ball, the second is a lateral view of a pneumatic legged robot[5].



It is extremely important that participants keep in mind that the aperture will be a square, so that the reduction will affect two orthogonal dimensions.

MANIPULATION SCENARIO

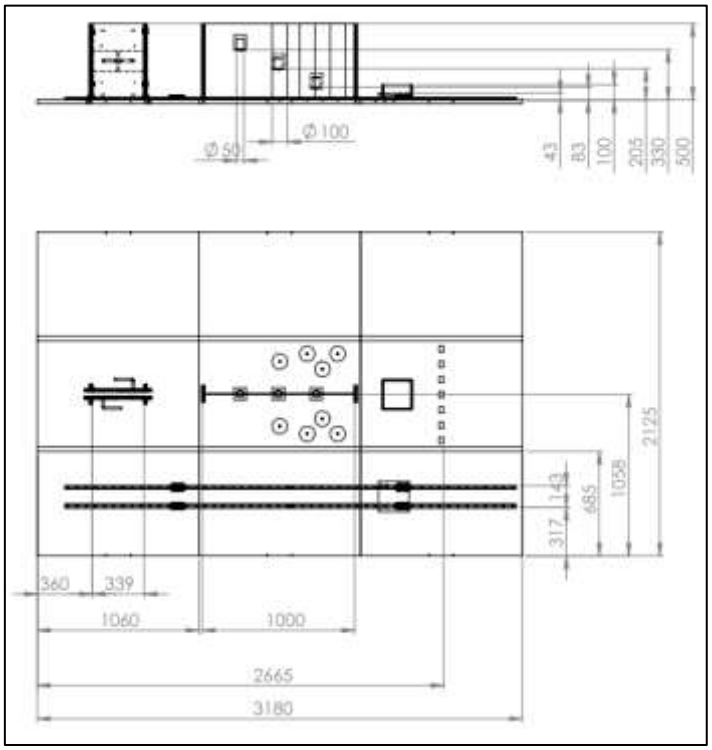
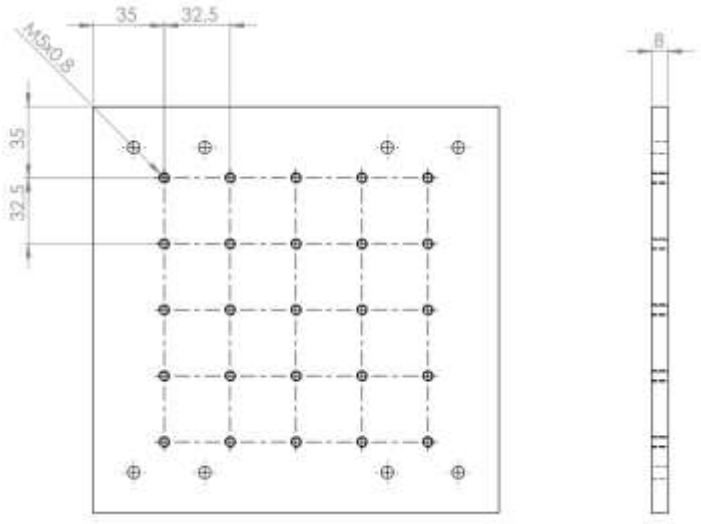


FIGURE 16: MANIPULATION DRAWING. SCALING 1:25. MEASURES IN MM.

[4] Steltz, E.; Mozeika, A.; Rodenberg, N.; Brown, E.; Jaeger, H.M., "JSEL: Jamming Skin Enabled Locomotion," in *Intelligent Robots and Systems, 2009. IROS 2009. IEEE/RSJ International Conference on* , vol., no., pp.5672-5677, 10-15

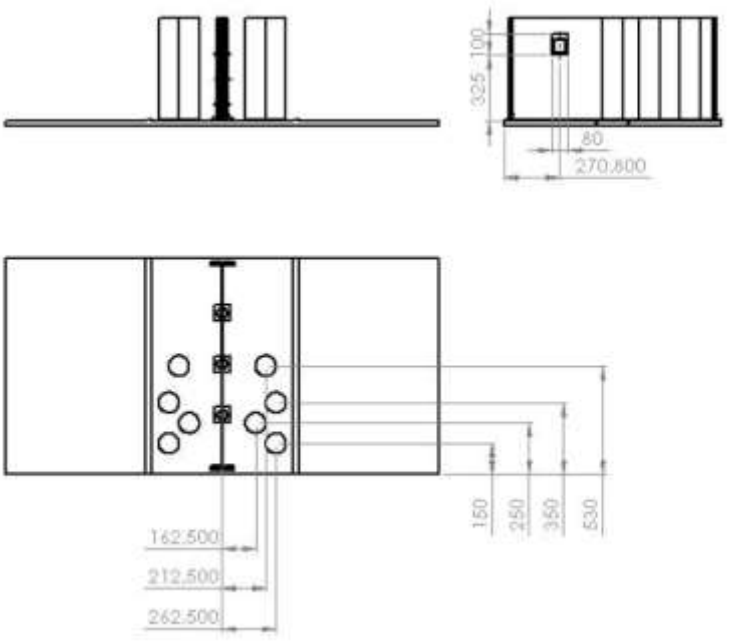
[5] Ansari, Y., Shoushtari, A.L., Cacucciolo, V., Cianchetti, M., Laschi, C., *Dynamic walking with a soft limb robot*, LNCS, 2015

The material of the floor will be wood: our plan is to use a commercially available tile (Leroy Merlin, ID OBJ 35198730 http://www.leroymerlin.it/ricerca?q=35198730). All structural components will be made of MISUMI aluminium frame, HFS5-2020-1000[6] and HFS5-2020-1000. The rail and slider are commercial components from MISUMI, SXR33-1480. The connecting platform will be attached to the sliders and will have several holes to attach the other structures. Maximum dimensions of the plate are 200x200mm. A grid of M5 holes is provided to attach the arms (and/or structures) to the sliders. Larger holes (8 external holes on the edge of the platform) are used to attach the platform to the sliders, so consider just the grid. Please keep in mind the overall payload and the other specifications of the sliders. Exact positioning of the holes are reported in the following schema, dimensions in mm.



The objects to be collected will have a maximum weight of 1Kg and will be contained in a bounding box (a cube) of approximately 100mm side, but shape, materials and positions will be revealed the day of the challenge. Collecting basket will be box-like containers with dimensions of 200x200x100mm. The robot is supposed to go through the tubes in lane (iii) of task2. Passing on the side is allowed in lane (ii). Tubes will be foam noodles from Decathlon http://www.decathlon.it/noodle-di-schiuma-120cm-id_8216134.html that will be fixed to the ground. Here a detailed drawing of the positions. Dimensions in mm.

[6] Important notice: product codes are referred to the Italian suppliers. Other countries' suppliers can provide a different code for the same product, so check carefully specifications.



In the task3, the door should be pulled (the other direction is blocked), but consider that required angle of opening is very small. To score points, it is sufficient that the door is opened of 5° (basically the handle is rotated and the door is slightly opened). Here the main objective is to demonstrate that manipulators can simultaneously apply a torque to the environment and have a certain degree of dexterity. About the torque to be applied, we plan to use a commercial locker/handle, again from Leroy Merlin, so you can take as a reference those handles/lockers.