ANTA ROBOSOFT COMPETITION 2019

ROBOSOFT COMPETITION 2019

SCENARIOS AND RULES[1]

DATE:

18 APRIL 2019

VENUE:

COEX, SEOUL, KOREA

VERSION DATE: 22/01/2019

[1] The organizers can change, refine, and develop the following rules till the first day of the competition. Please visit regularly http://www.robosoft2019.org/index.html for the latest version.

CONTENT

COMPETITION OVERVIEW

The RoboSoft Competition 2019 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 2019 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. These scenarios cover some domains of soft robotics where research is particularly lively. Three different scenarios are proposed, and particularly they are terrestrial race, manipulation and wearable.

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 2019. 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 2019 website www.robosoft2019.org).

Rules (including this documents) and scenarios are subject to change. Please check regularly the RoboSoft 2019 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, yigit.menguc@oregonstate.edu, niiyama@isi.imi.i.u-tokyo.ac.jp. For specific logistic question, please contact Dr. Junghwan Byun yongsamarine@snu.ac.kr.

VENUE AND SCHEDULE

The RoboSoft Competition 2019 will take place at COEX, Seoul, Korea on **April 18th 2019.**

FIGURE 1: COEX.

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

Day	Date	Events
1	Wednesday, 17 April	• Teams arrival and registration • Preliminary (ground) tests on the competition fields
2	Thursday, 18 April	• Teams registration • Morning: RoboSoft Competition 2019 • Afternoon: Awards ceremony

Although the competition is scheduled only on Thursday 18, organizers will arrange preliminary ground tests for the teams if possible. Moreover, registration to the competition will be available from April 17. A set-up location will be provided to each team on April 18. It will be equipped with the following minimum facilities:

- Table/work surface
- 220 V power plugs
- Internet connection
- 3 robotic arms for a manipulation challenge

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 download the documents. Each submission should be composed of one video (max 5 minutes long, 5Mb) and one technical document, before February 27th. Technical document and video should be sent to m.calisti@santannapisa.it; video could be also privately uploaded online, and the access should be provided with a link in the technical document.

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. The technical committee will be supervised by the four competition chars, which will be possibly aided by experts. 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 8th.

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. Compliance of the gripper
3. Wearable
    a. Conformability on mock-up (or on subject)
    b. Torque/Force aid on mock-up (or on subject) movements

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 desirable 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 organizers 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 2019

The RoboSoft Competition 2019 is composed by three 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).
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.

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, then 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) is a novelty of the 2019 edition: a secret tile. 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 obstacles-free tiles with the function of checkpoints.

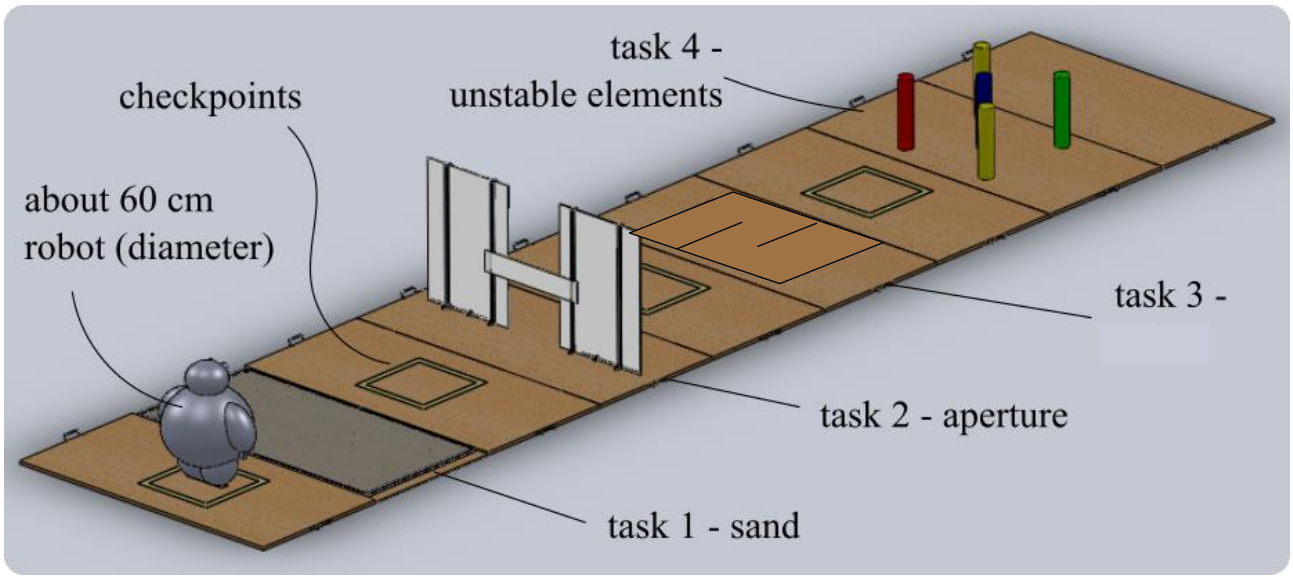

FIGURE 2: THE TERRESTRIAL RACE STARTS WITH A SAND TILE, FOLLOWED BY AN APERTURE, THEN A "SECRET" TILE, AND FINISHES WITH A TILE WITH UNSTABLE ELEMENTS.

SCENARIO DETAILS (BROKEN DOWN INTO TASKS):

- Task 1: The sand box is approximately 2 meters 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 moves 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 3. Approximately, the aperture will be a square of side s, where s should be decided by teams as follow.

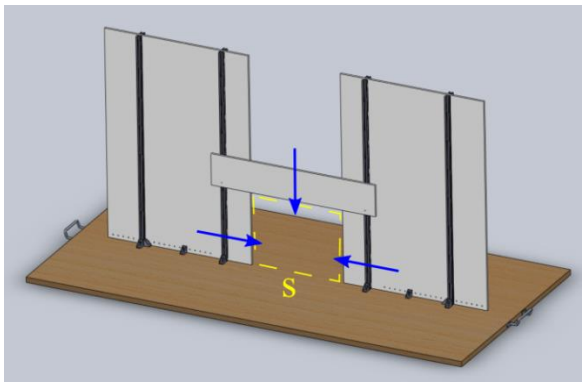

FIGURE 3: WALL TILE. BY MOVING THE PANELS, THE APERTURE WILL BE REDUCED TO MATCH ROBOT DIMENSIONS.

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: This tile represents locomotion in congested environment: it is made of "S" shaped path which requires dexterity and control of the robot. Moving through the whole path will grant all point, while performing just the first turn will give half points.
- 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 in between the tubes without dislodging them.

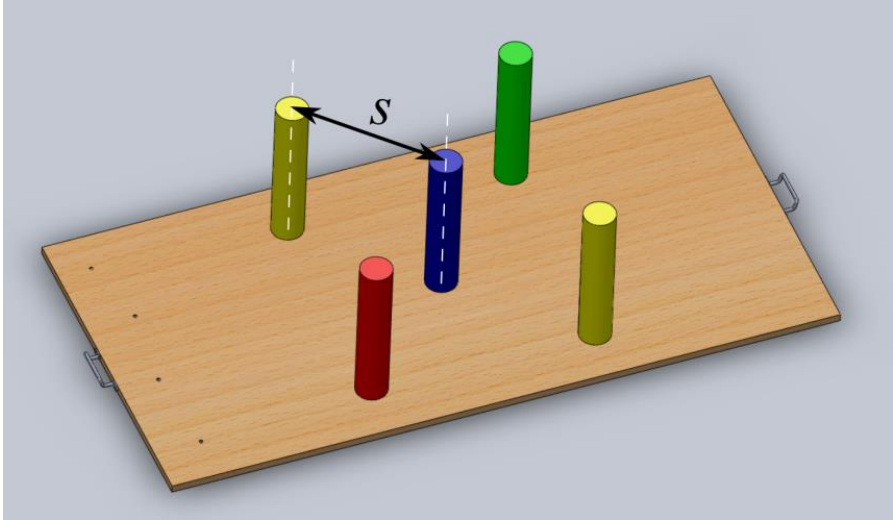

FIGURE 4: CONGESTED ENVIRONMENT TILE. THE RUBBER TUBES ARE MOVED TO MATCH ROBOT DIMENSION.

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.

In all cases, if the robot does not propel the whole body, half points will be cut from the overall score.

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. 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 a classic pick and place task. Teams have two options to cope with the tasks: in the first one, they place their robot within the manipulation space and performs the demanded tasks. In the second option, teams are allowed to attach their end-effectors to a manipulator which will be given by the organizing committee. Interface between the manipulator and the gripper should be done by the teams, and information will be disclosed as soon as possible for this option.

SCENARIO DETAILS:

- 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.

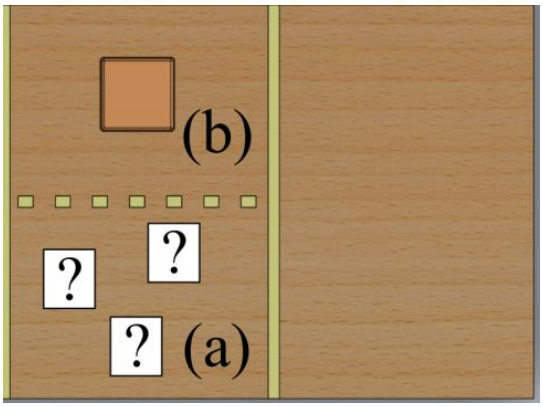

FIGURE 5: PICK AND PLACE TILE.

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 worth 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.
Each team will propose a challenging object which they consider suitable for their manipulator, and they should bring the object with them to add this item to the list of the object which will be used in the task.

TIMING:

The maximum amount of time for this trial is 10 min.

Points are awarded for each element of the task completed:

- numbers of objects correctly picked-n-placed

WEARABLE

GENERALITY

In the huge variety of applications of wearable robotics, soft robotics could play a role in rehabilitation, assistance, enhancement and many more. The competition will not be restricted to a single application, and teams can showcase their robotic solution in free demo scenario.

DESCRIPTION

The team will perform a free demo of their device, with the modality they prefer, in front of an evaluation panel. Within the demo, innovative aspects should be properly highlighted. The panel will following ask technical question on the solution presented and on the methodology used for its development.

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 -	0	1	2	0,5	0,25	0	
Task 4 - Debris	0	2	4	1	0,5	0	
Total			13,75				

FIGURE 6: 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. The total amount of points earned are the sum of the points marked in the scoring form, as in Figure 6. 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. The objet the team will bring with them will be added in the list.

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

FIGURE 7: SCORING FOR THE MANIPULATION SCENARIO. THE NUMBER OF OBJECTS WILL BE DISCLOSED DURING THE COMPETITION.

WEARABLE

Wearable competition will be subject to the evaluation of a panel of experts, which will give score based on effectiveness, reliability, innovative aspects, proposed methodology and performed demonstration.