ROBOSOFT COMPETITION 2022

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SCENARIOS AND RULES[1]

DATE:

8TH APRIL 2022

VENUE:

MCEWAN HALL, THE UNIVERSITY OF EDINBURGH, SCOTLAND, UK

VERSION DATE: 06/01/2022

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

CONTENT

COMPETITION OVERVIEW

The RoboSoft Competition 2022 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 competition will be held in blended modality, so that team might participate remotely or physically.

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 elected as Team Leader (TL): only the TL can speak for the team during the competition.

The RoboSoft Competition 2022 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. Two different scenarios are proposed in this edition: a terrestrial race and a manipulation scenario. In the 2022 edition, we will explore for the first time the autonomy on our mobile robots or manipulators, to reflect the advancement Soft Robotics did over the past decade. For the manipulation scenario, teams are invited to bring a soft gripper, or the whole arm. In the former case, a robotic arm will be provided by the committee.

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 and that will clear the scenario will be considered the winner of the RoboSoft Competition 2022. Each team participates with one robot, but multiple entries of the same team with different robot designs are allowed.

OFFICIAL INFORMATION

The official information and interpretation about rules will be available on the RoboSoft 2022 website https://softroboticsconference.org/).

Rules (including this documents) and scenarios are subject to change. Please check regularly the RoboSoft 2022 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 mcalisti@lincoln.ac.uk**,** Alistair.McConnell@ed.ac.uk. For specific logistic questions, please contact Dr. McConnell Alistair.McConnell@ed.ac.uk.

VENUE AND SCHEDULE

The RoboSoft Competition 2022 will take place at McEwan Hall, Edinburgh, Scotland on **April 8th 2022.**

Figure 1: McEwan Hall

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

Day	Date	Events
1	7 April 2022	• Teams arrival and registration • Preliminary (ground) tests on the competition fields
2	8 April 2022	• Teams registration • Morning: RoboSoft Competition 2022 • Afternoon: Awards ceremony

Although the competition is scheduled only on Friday 8th, organizers will arrange preliminary ground tests for the teams, if possible. Moreover, registration for the competition will be available from April 7th. A set-up location will be provided to each team on April 8th. It will be equipped with the following minimum facilities:

- Table/work surface
- 220 V power plugs
- Internet connection (wifi)
- 1 robotic arm for a manipulation challenge (details on how to attach the gripper and programme the arm will be provided in the appendix)

Additional equipment will be evaluated by the committee upon request, however teams should be as autonomous as possible, bringing all the material they need. Teams might participate remotely, since the competition will be carried out in blended modality: 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

To ensure competent entries only, a 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 competition chairs, which will be possibly aided by experts.

To manifest your interest to participate, please visit https://softroboticsconference.org/ and fill the online form within the competition section of the Contribution tab. The form should be submitted before 28th January 2022; and it will contain a technical description of the robot and a video. Videos should be privately uploaded online, and the access should be provided with a link within the online form. The video should demonstrate the skills of the robot at the current state of development, while the technical document will summarize the expected improvements to be shown at the competition.

The acceptance notification will be on February 11th.

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

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.

It is mandatory to demonstrate the softness of the submitted entries within the technical documents. To be as inclusive as possible, we will evaluate softness either as material and/or as structural compliance, but the soft/compliant parts have to be:

- Clearly enable the function of the robot OR
- Clearly improve the capabilities of the robot

Final robots which differ significantly from the submitted entries will be disqualified.

Autonomy will not be evaluated at this stage, but please bear in mind that robots should exhibit autonomous behaviour during the competition, i.e. they could not be teleoperated. Energy autonomy is not required, thus robots could be tethered for both processing or computational purposes.

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: Locomotion (10kg) – Manipulation (3kg, subject to check of arm payload in case of gripper; 20kg in case participants will bring their own manipulator).

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.

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 2022

The RoboSoft Competition 2022 is composed of two scenarios described in detail in the next sections. 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). 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.

For Teams that compete remotely, they should clearly show the robot's actions and the scenario. Each team will be responsible for building the obstacle course for their robot, or provide the required objects and components. Teams should explain the control algorithms of their robot: autonomous behavior could not be verified thus we will trust Teams self-statements. Clear breach of the regulation will result in a disqualification from the competition.

In this edition, teams are challenged to show the autonomous behavior of their robots: despite it is still possible to teleoperate the robot, overall points will be multiplied by 0.25 if the robot is teleoperated.

The execution of a task can be stopped at any 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 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 Scoring section.

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 small apertures and negotiate the environment to reach a target area.

DESCRIPTION:

There are three class of obstacles that competing soft robots must overcome: classical obstacles, random doors, and unstable elements (see Figure 1). The robot starts from an obstacles-free tile and should move forward toward the first set of obstacles (task 1), that comprises a sand box and a slope, representing the outside of a building. The second set (task 2) represents apertures which the robot should enter. The last obstacle tile (task 3) represents a congested, unstable environment which could collapse if the robot exerts too much force onto the structural elements. All set of tiles are separated by obstacles-free tiles with the function of checkpoints: a robot can restart the whole set by starting from the checkpoint tiles.

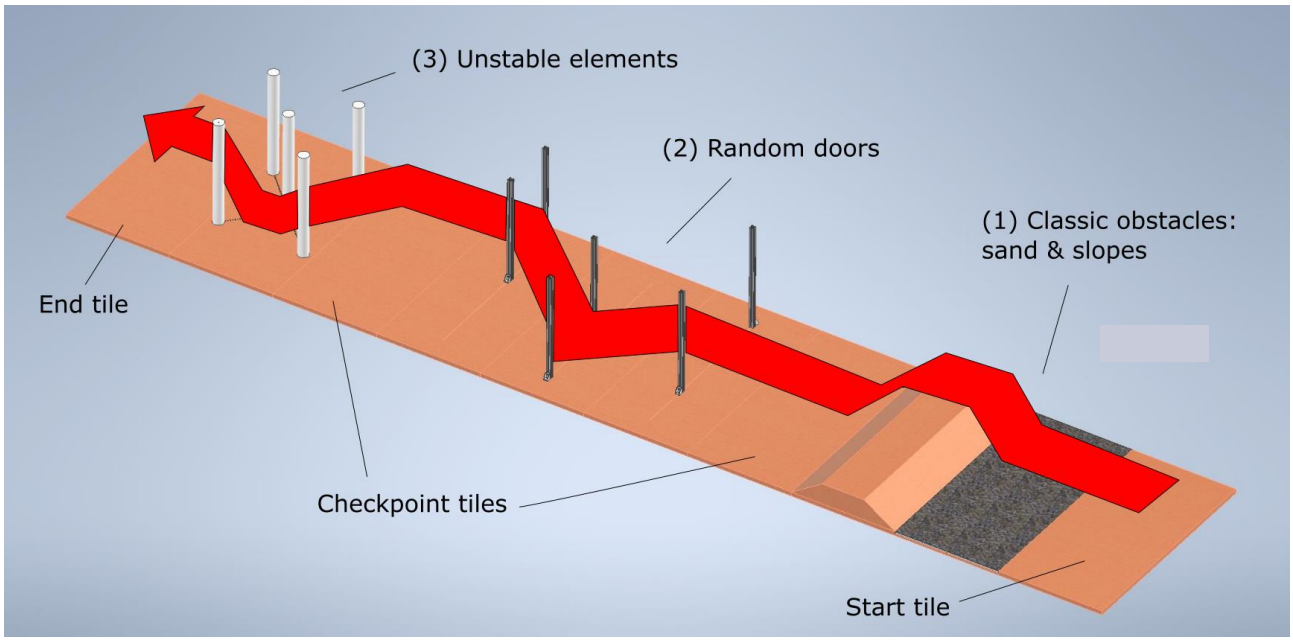


FIGURE 1: TERRESTRIAL RACE COMPRISES 3 SET OF OBSTACLES. RED ARROW SHOWS THE IDEAL PATH OF A ROBOT.

SCENARIO DETAILS (BROKEN DOWN INTO TASKS):

- Task 1: Classic obstacles.
  This set of two tiles include a sand tile, with undefined granulometry, and a slop tile. They have to be completed together or the task should be restarted from the Start tile. Points are awarded if the robot reaches the steep slope, the top of the tile, and the next checkpoint tile.
- Task 2: Random doors.
  This set of three tiles includes a "door" as large as the robot (100% nominal width, R_w, in the direction of locomotion), then with 80% and 60% of R_w. Position of the doors within the tile will be decided at the beginning of the competition. Green panels will be attached to aid visual recognition. Points are awarded by passing completely through the different doors.
- Task 4: Unstable elements.
  This 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. As in the door task, in this case the tubes will be moved to match the nominal dimension of the robot, R_w. The robot could contact the tubes but should not push them away from their original locations. Points are awarded with respect to the number of tubes dislodged when passing through them.

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.

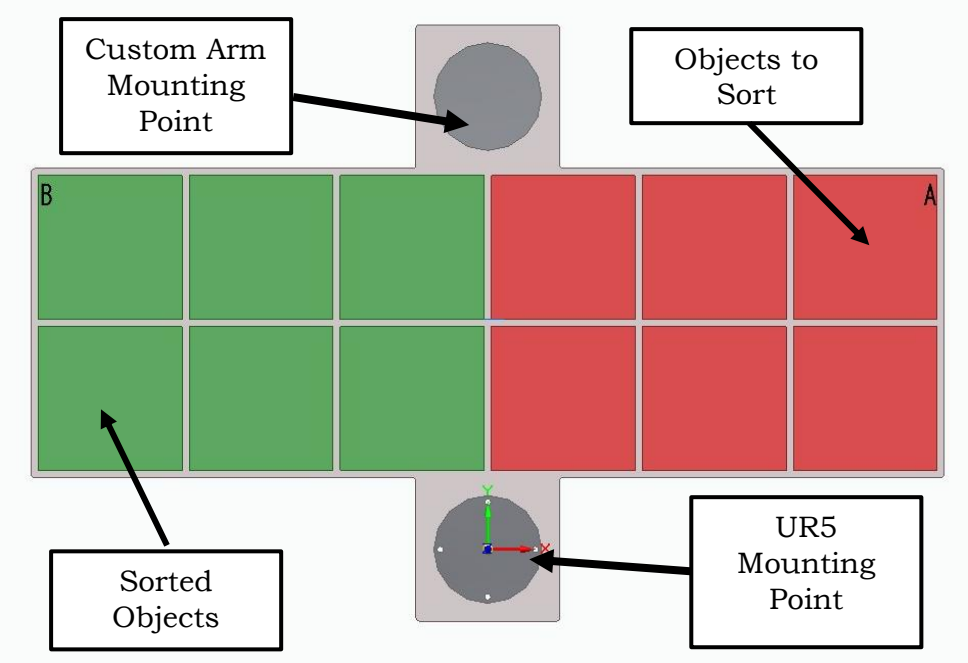
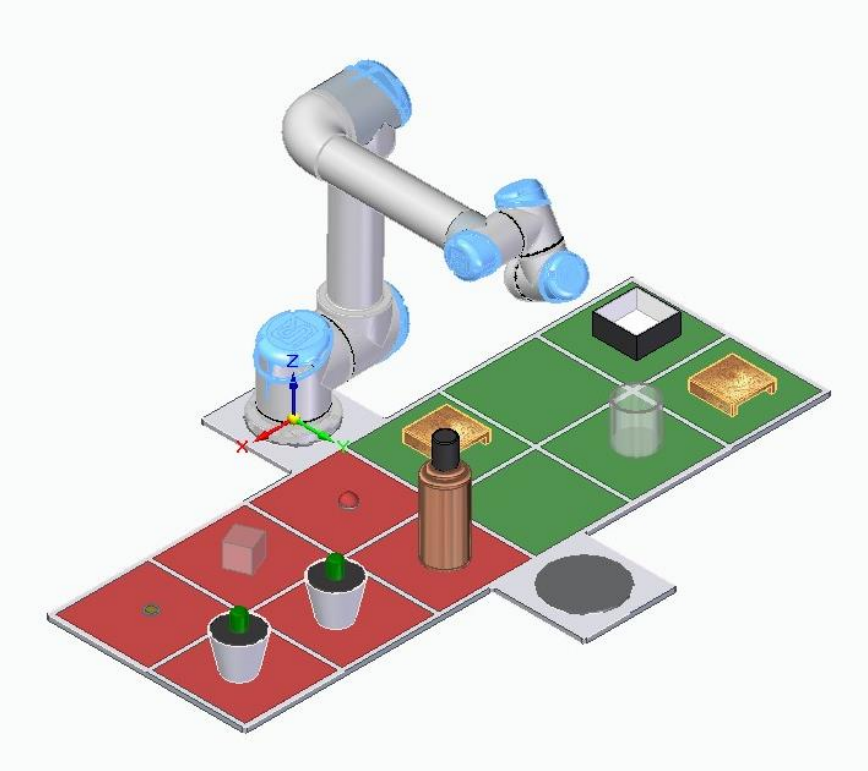


FIGURE 2: THE MANIPULATION FIELD LAYOUT NO OBJECTS



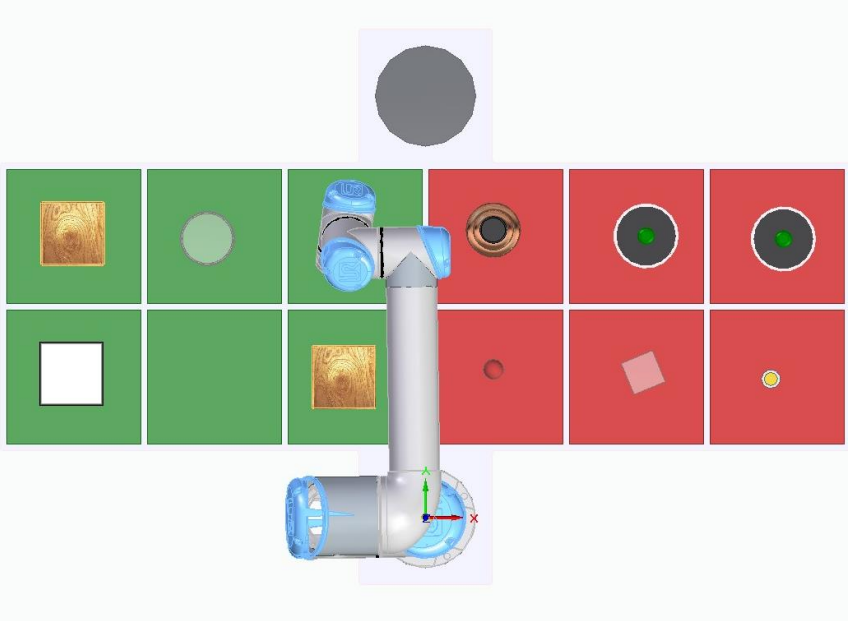


FIGURE 3: THE MANIPULATION FIELD WITH AN EXAMPLE LAYOUT

DESCRIPTION:

The scenario is structured into one classic pick and place task and two delicate object manipulation tasks. Teams have two options to cope with the tasks: in the first one, they place their robot within the manipulation space and perform the demanded tasks. In the second option, teams can attach their end-effectors to a manipulator which will be given by the organizing committee. The 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. The supplied robot is a UR5 E Series (https://www.universal-robots.com/e-series/).

SCENARIO DETAILS (BROKEN DOWN INTO TASKS):

For each of the following three tasks the scenario area is made of four subspaces. Subspace Red (A) is divided into six smaller sections and contains all the initial items to be manipulated according to the relevant task. Subspace Green (B) is also split into six smaller areas and contains the goal areas for each of the tasks. The other two subsections are the robotic arm mounting sections, the top section for the arm supplied by the competition and the bottom section for any arms brought by the competitors.

- Task 1: The pick and place
  Three different objects are placed in subspace (A) and a collecting basket is in subspace (B). Objects form and material will be revealed on 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. 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.

- Task 2: Plant Problem
  Two plants are located in subspace (A) while in subspace (B) two small shelves can be found. Plant types and their base material will be revealed on the day of the competition; however their maximum dimensions and weight are reported in the appendix section. The plants should be placed on a shelf. Moving a plant from side (A) to side (B) without succeeding in placing it onto a stand will be worth zero points. If a plant is damaged during the pick and place operation, the robot will not earn any point, no matter if it manages to move the plant to the tile (B).

- Task 3: Whisky Problem – Pouring and Serving
  The Whisky problem has a bottle of "Whisky" located in subspace (A) and in subspace (B) a glass and coaster can be found. The bottle should be picked up from the table moved to the glass and a measure (dram) of whisky poured into the glass. The bottle should then be placed back safely on the table (in the empty small section) and the glass picked up and placed on a coaster.
  If the glass is damaged during the pouring or handing to the observer, the robot will not earn any points. If the whisky is spilled either during pouring or glass handling the number of points scored will be reduced.

SCORING

Points are assigned for each completed part of the task. Additional points are awarded based on the number of attempts required to complete a part of the task. All scoring methods can be seen in the score tables.

TERRESTRIAL RACE

The scoring form for the Terrestrial Race is the following:

	terrestrial						
		min	*fair*	*good*	*I*	*II*	*III*
Task1	0	3	6	12	12	6	3
Task2	0	5	10	20	20	10	5
Task3	0	4	9	18	18	9	4

Points are assigned based on completion of part of the task:

	min	*fair*	*good*
Task1	Sand tile passed	Top of the hill reached	Next Checkpoint reached
Task2	First door passed	Second door passed	Third door passed
Task3	More than one bin dislodged	One bin dislodged	No bins dislodged

The maximum score achievable is 100 (all task solved with good level, and at the first attempt). No points are assigned if is no parts of the task will be completed.

MANIPULATION

Scoring for manipulation scenario follows the same principles of the terrestrial race. The object the team will bring with them will be added in the list.

Manipulation						
	Not	Half/Fair	Full/Good	1	2	3
Task 1 – Object handled	0	6	12	12	6	3
Task 1 – Object handled	0	6	12	12	6	3
Task 1 – Object handled	0	6	12	12	6	3
Task 2 – Plant placed	0	7	14	14	7	4
Task 2 – Plant placed	0	7	14	14	7	4
Task 3 - Whisky poured	0	8	16	16	8	4
Task 3 – Whisky and glass safely placed	0	10	20	20	10	5

Manipulation			
	Not	Half	Full
Task 1 – Object handled	Objects dropped, damaged or not placed in the basket	Over half the objects are placed in the basket	All objects placed in basket
Task 2 – Plant placed	Plants damaged, dropped or not placed on shelf	One plant is placed correctly on a shelf	All plants placed correctly on shelves

	Not	Fair	Good
Task 3 - Whisky poured	The whisky is poured outside the glass, or the bottle or glass is not picked up, dropped or damaged	A measure of whisky is poured into the glass but a small spillage occurred	A measure of whisky is poured into the glass with no spillage
Task 3 – Whisky and glass safely placed	Whisky bottle or glass is dropped or damaged	One or other of the bottle or glass are placed safely and correctly	Both bottle and glass are placed successfully

APPENDIX

The information provided into this Appendix are intended to allow remote participants to replicate exactly the competition fields. Although we acknowledge that small differences might arise, remote participants should replicate with the maximum detail possible the scenarios. Likewise, the scenarios at the physical event might slightly differ from the measurements provide here.

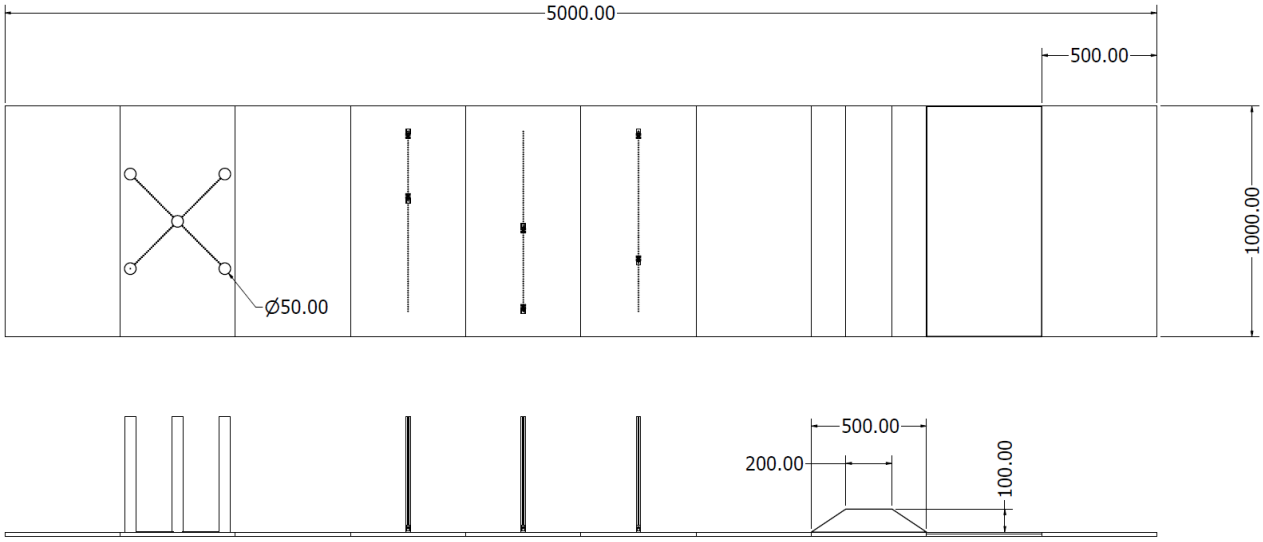


FIGURE 4: MEASUREMENTS OF THE LOCOMOTION FIELD (MM). DEPTH OF THE SAND PIT HAS TO BE AT LEAST 10MM. MAGNETS FOR THE PILLARS HAVE TO BE SIMILAR TO: SUPERMAGNETE.IT/ENG/DISC-MAGNETS-NEODYMIUM/DISC-MAGNET-5MM-1MM_S-05-01-N

Objects Specifications				
Objects	**Dimensions (mm) (Diameter x Height) (approx.)**	**Weight (kg) (approx.)**	**Material**	**Substitute**
Whisky Bottle	Ø80 x 290	0.9 (0.3 of liquid 0.6 glass)	Glass and Whisky	Spirit bottle (glass)
Whisky Glass	Ø80 x 80	0.3	Glass	Tumbler (glass)
Plant Pot	Ø60 (Base) x Ø90(Top) x 70	0.3	Pot, Soil and plant	Pot, Soil and plant
Random Objects	(Ø10 – Ø90) x (2 x 100)	0.01 - 2	Plastic, glass, organic and metal	Plastic, glass, organic and metal

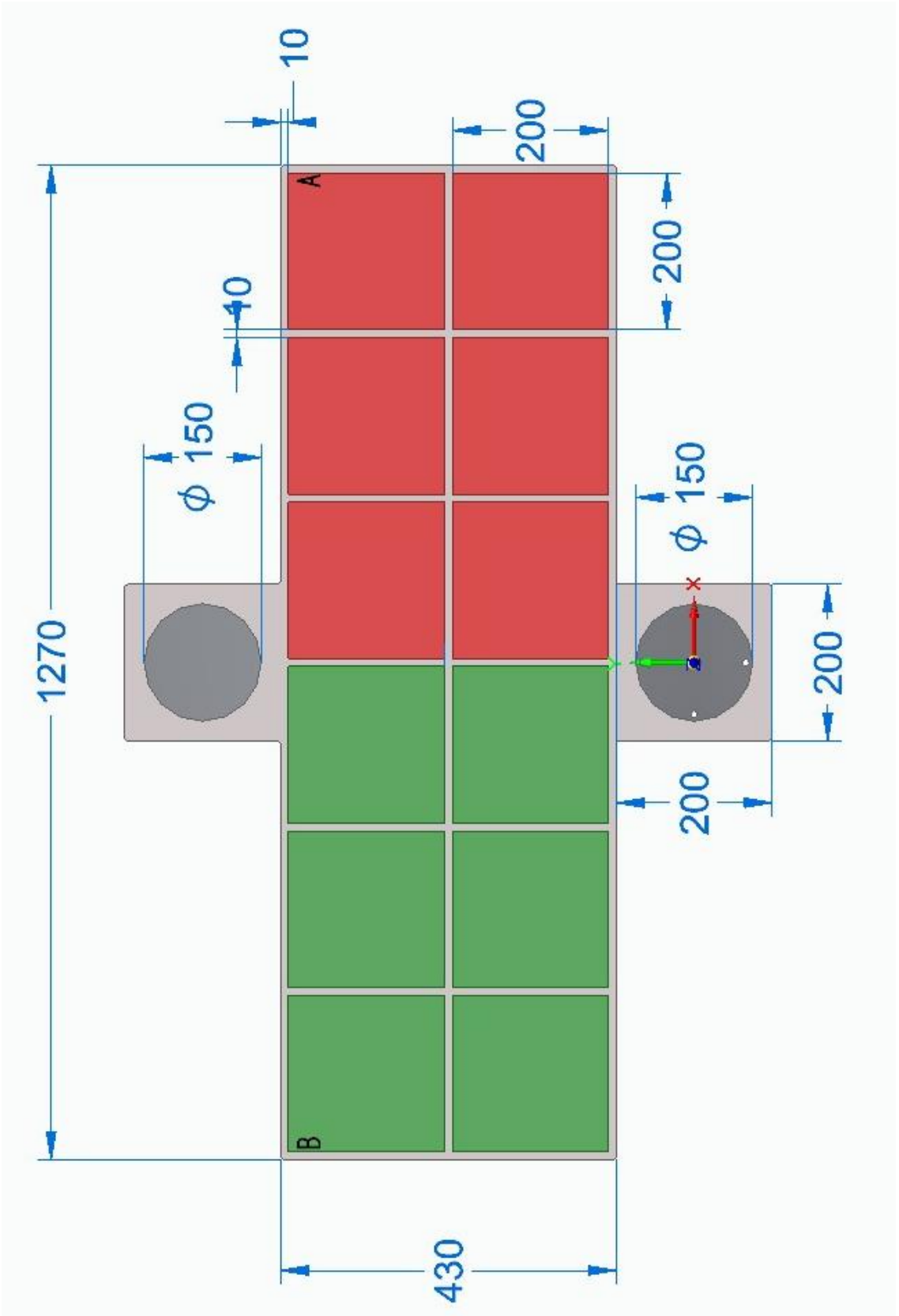


FIGURE 5: THE MANIPULATION FIELD FULLY DIMENSIONED