REGULATIONS
OF THE RTC CUP COMPETITION
INTERNATIONAL STAGE

1.   General Provisions

1.1.   At the "RTC Cup" competitions the participants are presented with a testing area. The testing area consists of sites of varying complexity from rugged terrain to the consequences of disasters (such as earthquake, tsunami, rockslides, mud descents and the like).
The purpose of competition at such a test site is to inspire and encourage young roboteers to create robots capable of working in extreme situations, either completely replacing a human being or acting as an assistant.

1.2.   In the "RTC Cup" competition the robot must pass as many sections of the testing area as possible within the given time, performing the set tasks.

2.   Testing area

2.1.   The testing area is an automated, reconfigurable obstacle course consisting of cells that a mobile robot must be designed to get through. The general view of the possible configuration of the testing area is shown in Figure 1.

2.2.   The testing area cell is a section bounded on the perimeter with a black profile.

2.3.   A detailed description of the structure (types of obstacles and tests it contains, and their specifications) can be found in **Annex No. 1 "Description of the testing area"** of the current document.

2.4.   The configuration of the testing area changes every competition and is not communicated to the participants in advance.

2.5.   The list of obstacles and the points awarded for them are announced at least one week before the competition. Any sections may be added just before the competition.
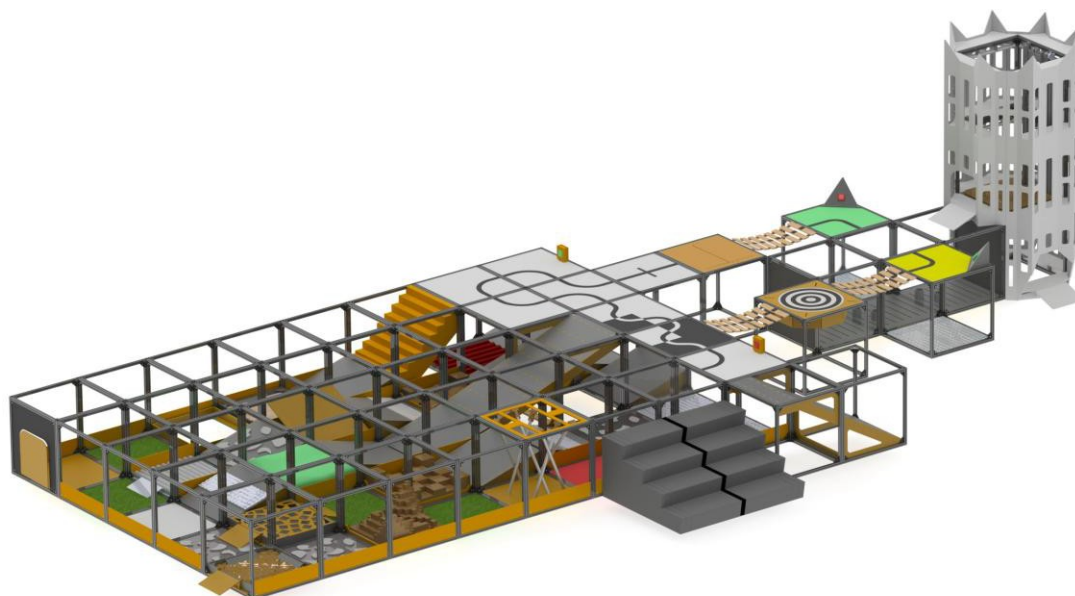
Figure 1   General view of the testing area configuration

3.   Categories

3.1.1. Competitions   are   divided into two   categories: **"Scout"** (age limit – from 7 to 14 years inclusive) and **"Extreme"** (age limit - from 7 years and older).

3.2.   In the **"Scout"** category, the robot is in the field of view of the operator, who can directly observe the robot's actions with his own eyes. The robot is controlled remotely. During one attempt, two robots (or one by the decision of the panel of judges) pass the testing area at the same time. Pairing of teams is done during drawing procedure held before the first and second attempts.

3.3.   In the **"Extreme"** category the robot is out of sight of the operator (participant), and controlled remotely, using the robot's video vision, and measuring equipment mounted on it.

One robot passes the testing area during one attempt.

4.   Requirements for a team

4.1.   A team of no more than two persons (not counting the team leader) is allowed to participate in these competitions: "Robofest", "Robofinist" and "RTC Cup:Final", in other cases - up to 4 persons is allowed. The robot can be operated by only one person.

4.2.   It is allowed to change the operator between attempts.

4.3.   The team can participate with only one robot in only one category in the

course of current competition.

4.4. It is forbidden to break and contaminate the testing area.

5.   Requirements for a robot

5.1. Robots on any elementary base that do not pose a threat to others or to the testing area may participate in the competition.

5.2. Recommended overall dimensions of the robot (according to the dimensions of obstacles in the testing area) - no more than (H x L x W) 350x400x400 mm in the starting position. After the start of the attempt, the robot can change dimensions indefinitely.

5.3. The weight of the robot should not exceed 10 kg.

5.4. The robot should have an on-board power source.

5.5. The robot is controlled wirelessly. The minimum distance between an operator and a robot is approximately 10m. In this regard, robots controlled by IR remote controls are not allowed to compete.

Figure 2   Examples of common IR remote controls

5.6. Participants are allowed to deploy a wi-fi network to control the robot during the attempt.

5.7. Before the competition attempts begin, robot training group races are held, during which participants can explore the testing area and check what tasks their robot can pass.

5.8. **Qualification:** performance of the basic passing task, which is mandatory to pass - crossing the maze threshold (43 mm) and entering the first cell.
The performance of this task is evaluated by the judges during training (pass/fail).

5.9. If the robot is unable to perform a basic task, the team is disqualified from the current attempt and waits for a break between attempts to try to qualify before the next attempt. If in this case the qualification is not passed, the team is disqualified from the competition.

5.10. **Mandatory conditions for passing an attempt**

5.10.1. For the results of an attempt to be considered, the following items shall be available and used:

- **"Scout" and "Extreme" (up to 16 years inclusive):** functional **sensors or manipulator** (successful completion of a task with the use of elements of self-containment or manipulator);

- **"Extreme" (from 17 years and older):** functional **sensors** (successful completion of a task with the use of elements of self-containment);

5.11. **Constructive prohibitions:**

5.11.1. It is prohibited to use liquid, powder, and gas substances, including as a weapon against a rival robot (for the "Scout" category).

5.11.2. Do not use flammable substances.

5.11.3. No interference in electronic equipment with frequencies greater than 100 kHz and radiated power greater than 10 mW is permitted, except for standard radio and video communications.

5.11.4. Robots that violate the above prohibitions will be disqualified from the competition.

6. Competition process

6.1. The robot must pass the testing area under the control of the operator by completing tests and performing tasks. There are beacons of different colors in the sections of the testing area, the robot should collect and place them in the appropriate color zones. Autonomous areas are traversed with the use of sensors mounted on the robot.

6.2. The robot does not have to go through each cell of the testing area. The operator can decide how to build his own route.

6.3. The competition consists of 2 attempts for each category.

6.4. One attempt takes 10 minutes.

6.5. Score of the best of two competitive attempts will be counted.

6.6. 30 minutes before the start of the attempt, the team enters the preparation zone. 10 minutes before the attempt, the operator with the robot must be in the competition area, ready to start, and notify the judges at the registration desk of his readiness.

6.7. The attempt can be **postponed** in case the participant is not ready **at least one attempt before** the attempt of the participant. Otherwise, **the postponement will be denied**.

6.8. Postponement of an attempt will result in a **penalty** for the future result of the

attempt (see Annex 2 "Points" to the current document).

6.9. An attempt may be postponed only **once**.

6.10. The team should independently monitor the schedule of attempts (the order of attempts may change depending on the appearance of postponements and disqualifications).

6.11. **Preparation for an attempt:**

A participant in the category "Scout" has 3 minutes, in the category "Extreme" - 7 minutes to prepare for the start from the moment the participant is called to the starting area (if necessary). In the "Scout" category, both participants go to the start simultaneously. After 3 minutes, the timer starts automatically for 10 minutes - time of attempt. You cannot postpone an attempt if you are not ready. The participant may start at any time from the start of the current attempt as soon as the necessary repairment is done. In case of a single participant in the testing area, if after the time allowed for preparation the robot cannot start, the team is disqualified from the attempt.

6.12. **Start** is located in front of the Maze entrance. In case there are two entrances, it is determined in advance where the team should start when scheduling. On the second attempt, the entrance changes to the opposite.

The robot is required to start its movement from the "start" cell indicated by the judge and move through the Maze to any other exit. You cannot go out through the fields marked as "start" and go around the maze. If the robot left the maze through the exit, it could move in and out of any cell in the future.

6.13. Once a team has passed its autonomous route (corresponding to the start), it has the right to pass another if it is not currently occupied by the other participant.

6.14. No points will be awarded for re-passing the cell.

6.15. If the robot performs autonomous actions, the participant **must** notify the judges about this at the beginning of the attempt and directly before the start of these actions. Otherwise, passing of the test will not be counted.

6.16. In the "**Scout**" category only the robot operator is allowed to be present in the testing area, the rest of the team members and the leader are behind the fence when an attempt is made.

6.17. When passing an attempt in the "**Extreme**" category, only the operator is in the booth; the other team members and the leader take places specified by the judge. If you try to talk to the operator without the permission of the judge, the team is disqualified.

6.18. Interference in control (repair) can be carried out by both the operator and any team member. After the intervention, all participants (except the "Scout" robot

operator) must leave the testing area.

6.19. Holding a rival robot in place for more than 20 seconds in any way is considered to stuck up, and both robots are moved back by the judge to the cells they had passed before, without penalties.

7. Scoring criteria

7.1. The "Scout" and "Extreme" categories are evaluated according to a single point system, but are awarded separately, as the division into categories implies different levels of complexity.

7.2. The scoring criteria for a team's performance is the number of points gained during the attempt. The best attempt from the past is counted.

7.3. Points are accrued for passing through the cells of the testing area and completing tasks. The number of points depends on the complexity level of the task.

7.4. A cell is passed if the robot entered it with the whole base and left the other end (exception - dead-end cells).

7.5. **No points** will be awarded for re-passing the cell.

7.6. A cell may or may not contain a test.

7.7. If two teams have the same number of points for the best attempt, the team that completed the attempt in less time wins. In case time is the same, the team with the highest total score of two attempts wins.

7.8. The scoring system, the table of points and conditions of passing the sections of the testing area are given in **Annex 2 "Points"** to the current document.

8. Tasks in the Manipulator category

8.1.1. To qualify for the manipulator category, the robot must perform the following tasks with any additional device capable of moving independently of the main chassis: manipulator, levers, etc.

8.1.2. If the robot performs one of the following tasks using a basic, load-bearing chassis structure (e.g. runs a button with a wheel or turn a pipe with a wheel), points will be awarded for performance, but the robot will not be qualified in the manipulator category.

8.1.3. **Opening the door** – pulling the door with the handle.

8.1.4. **Buttons** - there are three types of buttons in the testing area: the buttons in the "Capture the flag" task, the button that turns on the light in the "Fog" cell, the buttons inside the Tower on the elevator platform.

Task: press the button and turn on the light / activate the elevator.

8.2. **Pipes** – The "Pipes" task is presented in the testing area in two versions:

straight (parallel) pipes and omni (omni-directional) pipes.

Tasks: remove a pipe (pull it out of socket) and/or turn a pipe (half a turn / full turn).

8.3. **Valves** – a panel with a set of various valves in the "open" position is mounted on the wall. The valves can be lever-operated and swiveling.

Task: Turn the valve to the "closed" position.

8.4. **Debris** - silver-gray items of various sizes, shapes and weights scattered over the testing area.

Task: capture and delivery of items to the gray container.

8.5. **Ball in the trench** – standard tennis balls located in one of the two grooves of the "Trench" test.

Task: capture and delivery of ball to the second groove.

8.6. **Overturn of the robot** (see section "Overturn" Task").

8.7. **Beacons –** conventional aluminum soda cans wrapped in tape.

Task: capture and delivery of beacons to the designated area or special field (colorful cell in a small cube).

8.7.1. **General rules of beacon collection**

8.7.1.1. To be awarded points for beacon capture - the capture and lifting of the beacon must be carried out at a height of at least 20 mm, for not less than 1 second. However, this is not a requirement for being awarded delivery points, the beacon can be pushed or rolled into the designated area.

8.7.1.2. One beacon can be captured by the robot only once.

8.7.1.3. A beacon is considered to have entered the zone if it touches the zone field with any part.

8.7.1.4. If the beacon has touched a field of the corresponding color zone and left this zone, the hit is still counted.

8.7.1.5. No re-delivery of an already delivered beacon is possible.

8.7.1.6. The location and number of beacons shall be determined by the judges before the competition.

8.7.2. **Special beacons**

8.7.2.1. **Mini-tower** – a pedestal, which is a miniature copy of the tower on which a standard beacon is located.

Tasks: capture the beacon with the robot manipulator.

It is allowed to drop the beacon from the tower and further capture and/or delivery, but in this case, points are awarded for the capture of the beacon as for an ordinary beacon.

8.7.2.2. **Special beacon** – a colorful beacon located in the maze. Delivery - depending on the situation, either to the basket or in the hatch.

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8.7.2.3. **Beacon with a marker** – a black and orange beacon that has a marker inserted. There are targets glued to the wall in the same maze cell at different heights.

Task: Touch the target marker and leave a visible trace. The closer you get to the center of the hit, the more points the team is awarded.

8.7.2.4. **Autonomous (white) beacon** – a beacon, which is at the intersection of the autonomous route. Stand-alone capture of such a beacon is performed using a rangefinder, while traveling along the route. Stand-alone delivery can be made to the field with a line from one intersection to another.

The completion of the task is also counted in the Autonomy category.

8.8. All other actions with the manipulator are agreed with the panel of judges privately before the attempt.

9. Tasks in the Autonomy category

9.1. The "RTC Cup" competition includes autonomous areas in the testing area.

9.2. Before the start, the judges must be notified of the actions that the robot will perform automatically. Also, during the attempt, the participant should announce the beginning and end of the autonomous mode of the robot loudly.

9.3. The autonomous mode will only be counted after confirmation by the judges.

9.4. An autonomous action is defined as the passage of a section without operator control, necessarily by using any sensors.

9.5. Movement on encoders or timer (just "motors forward") is not considered autonomous mode.

9.6. The program and sensors may differ from the recommended ones listed below as an example.

9.7. Switching the autonomy on/off must take place remotely, and the participant must not touch the robot. In this case, the number of automatic mode switches is not limited.

9.8. During an attempt, one test can be completed either autonomously or manually, but points will then be counted **only** for passing autonomously.

9.9. **Traveling along the line** – is performed by means of a light sensor or vision system on lines (white fields, inclined lines of the maze) and bridges.

9.10. **Autonomous (white) beacon** – a beacon, which is at the intersection of the autonomous route. Stand-alone capture of such a beacon is performed using a rangefinder, while traveling along the route. Stand-alone delivery can be made to the field with a line from one intersection to another.

The completion of the task is also counted in the Manipulator category.

9.11. **Traveling inside the maze along the walls** - only on 3-cube sections that make a corner turn. The autonomy is counted if the moving along the walls of the corner cube is carried out without interruption. Methods of execution: moving along the wall using a rangefinder or a compass, gyroscope, or accelerometer, as well as vision systems.

9.12. **Autonomous capture of items and beacons** is carried out using a distance sensor or vision systems. In doing so, the robot must be turned away from the item being captured and be at least 10 cm away from it.

9.13. **Moving along a complex trajectory** (up/down stairs, passage of "ravines", "rails", "hypnosis disk", "oblique ramp-2", "logs", "fog", "hoof") along a line, using a compass, gyroscope or accelerometer, vision systems, combined methods that include the use of other sensors (e.g. a distance sensor).

9.14. **Reading a QR code by the robot** and displaying the decryption code on the screen (for "Extreme").

9.15. **Reading hazard sings by the robot** and displaying the recognized text on the screen, with the sign itself highlighted on the screen (for example, with a frame). "Extreme" tasks

9.16. **Autonomous overturn of the robot** (see section "Overturn" Task).

9.17. When performing autonomous tasks, the rule "hands off the remote control" applies - the participant must not touch the robot remote control. A touch is allowed to activate/deactivate autonomous mode.

9.18. All other actions with the sensors are agreed with the panel of judges privately before the attempt.

10. "Overturn" Task

10.1. The overturned robot on its side or turnedupside down comes to its initial state (stands on the "wheels").

10.2. After the overturn, the robot is able to continue moving without a repair.

10.3. The overturn is not counted if done from the vertical stand, i.e. when the robot rests on its front or rear.

10.4. Overturn points are awarded only once per attempt.

10.5. **Controlled overturn**

10.5.1. The robot performs the task without operator intervention, with the help of remote control, according to the conditions:

- If the robot performs the overturn using the manipulator or similar devices, the team is qualified in the Manipulator category.

- If the robot performs the overturn only using its basic running gear (for

example, when hit against the wall), the team is not qualified in the Manipulator category. This is also the case when the robot overturns spontaneously, without control, only due to its design (e.g. rounded body).

10.5.2.　120 points will be awarded for completion.

10.6. **Autonomous overturn**

10.6.1. The overturn is counted if the robot performs the task automatically, without operator intervention and without the use of remote control, and with the help of sensors to determine the position of the robot in space - the team is awarded in the Autonomy category.

10.6.2. 240 points will be awarded for completion.

10.6.3. Before starting an attempt, the team must warn the judge that they are going to carry out the overturn autonomously.

10.7. **Task completion options**

10.7.1. First option: the robot can start the attempt by performing this task, right on the "start" field. In this case, the robot must be tilted on its side in the starting position or turned upside down by the participant himself. The execution of the task starts after the attempt time starts.

10.7.2. To execute an autonomous overturn, the robot can be tilted on its side or manually turned upside down immediately after the "start" command. In this case, the operator can be assisted by team members.

10.7.3. Second option: the robot performs the task during the attempt. The robot can be tilted on its side or turned upside down only with the use of the remote control.

10.7.4. In both cases, if the robot is unable to complete the task and come to its initial position, the standard rules apply: the participant can take a penalty and intervene in the control (see "Penalties" section).

10.8. A judge evaluates the position of the robot (before and after the overturn).

10.9. An example of how to complete the task is shown in the video   below. According to the rules described above, it is a controlled overturn from the side, 120 points, qualification in the Manipulator category. https://www.youtube.com/watch?v=CBN5L8dGg8o&list=PLgasM8avUU wH7EjA92314qNTmbmZXkMqp&index=2&t=0s
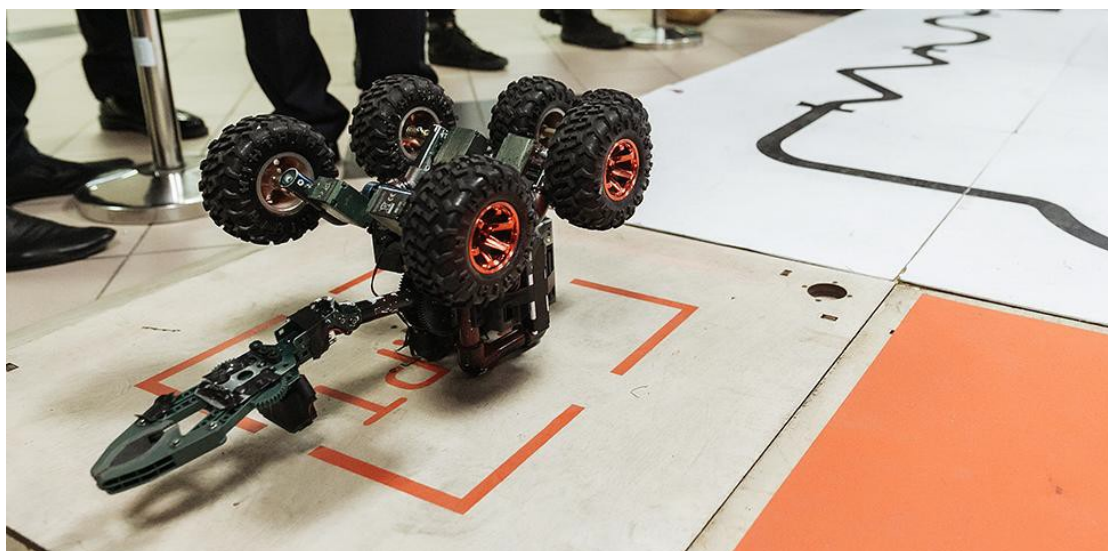
Figure 3   Overturn

11.   Penalties and timing requirements

11.1. **If an attempt is postponed,** a penalty will be charged for the future result of the attempt (see Annex 2 "Points" to the current document). An attempt may be postponed only once.

11.2. **Penalty for interference in the control:**

11.2.1. In case the operator needs to interfere in the robot's work (the robot is stuck, hung, needs to be reloaded, needs to be repaired), the team will be charged a penalty. With the next intervention, the attempt is over. The repair time is limited to 5 minutes.

11.2.2. If the robot is stuck and cannot pass a cell, at the operator's request it is lifted and moved to the point of its entry in that cell, or to the previous cell. Such an action is counted as an intervention in the control and is subject to a penalty.

11.2.3. Only the judge can lift the robot, hand it over to the participant and put it in place during the attempt.

11.2.4. During the operator's intervention in the robot's work, the time is **not stopped** by the judge.

11.2.5.   Time limit on task execution:

11.2.5.1. If the robot does not leave one cell within **2 minutes**, it is considered stuck. The participant is charged a penalty, or the attempt is over.

11.2.5.2. Outside the perimeter of the Maze and the Tower, the robot can stay no longer than 5 minutes (autonomous and coloured fields that are not in cubes are not considered part of the Maze).

11.2.5.3. If the robot is stuck/stays outside the perimeter afterwards, the countdown

time (2/5 min) starts again.

11.2.5.4. The time for executing manipulator tasks is **not limited**, except for delivery of beacons (general rules apply for delivery - no more than 2 minutes in one cell of the Maze, no more than 5 minutes - outside of the perimeter).

11.2.6.   Do not remove functional modules from the robot during repair (sensors, camera, manipulator, levers, wheels, tracks, motors). Individual small parts (clamps, tape, rubber bands, screws, and other fasteners) may be removed.

11.2.7.   Any components of the robot can be removed or replaced during the break between attempts.

11.2.8.   In case of repair, 2 minutes are counted again.

11.3. **Penalty for falling off parts:**

11.3.1. If the robot loses any part during the attempt, a penalty will be charged for each lost part, regardless of its size (debris and pieces of material, nut, beam, or entire module).

11.3.2. Any piece of the robot that is unable to move independently of it is considered a part.

11.4. **Penalty for enabling autonomous mode with a button located on the robot:**

11.3.3. Switching the autonomy on/off must take place remotely, and the participant must not touch the robot. In this case, the number of automatic mode switches is not limited.

11.3.4. A **penalty** is charged for enabling or disabling the autonomy using the button **located on the robot** (for the whole cycle: on/off). In this case, only 2 automatics on/offs are allowed.

11.5. **A penalty for tripping a mine**

11.5.1. The team is charged a penalty for running over a mine or activating a mine with any part of the robot.

11.5.2. The robot can intentionally demine by, for example, pressing an item on the mine. While doing so, the robot cannot touch the mine with any part during the mine clearance. The robot will be awarded for each cleared mine.

11.6. For **unsportsmanlike behavior** (non-compliance with moral and ethical standards, rude behavior towards other participants, organizers, and judges of the competition) punishment is disqualification by decision of the panel of judges

11.6.1. The number of penalty points is specified in Annex 2 "Points".

11.7.   The panel of judges may impose additional restrictions.

12.   Judging

12.1. At the end of the attempt, the robot operator signs the scorebook and thus accepts the results recorded therein.

12.2. The scorebook is an internal document for the competition and is used exclusively by the judges and organizers. The scorebook is not intended for use by the participants. It is forbidden to photograph or copy the scorebook.

12.3. Control and wrapping up are carried out by the panel of judges in accordance with the rules of the competition.

12.4. Discussion of the competitive process, schedule, and results of attempts with judges and organizers is carried out only with participants of teams and their leaders.

12.5. All appeals on the results are accepted in handwritten form by RTC Cup judges at the registration desk, within an hour after the results are announced (in writing in the competition area or on the competition website). On the same day, appeals are reviewed by a panel of judges, and participants receive a written reply.

12.6. All other points at issue during the competition shall be resolved on site by the panel of judges; all participants shall obey their decisions.