Rules of OPEN category

Classifier Robots

1. Introduction

Robotics for service is centered in the design and construction of machines able to provide help directly to the members of the society, either in the house, in the companies, in the industry and in medicine. It is, without a doubt, one of the most effervescent areas in the engineering where technological big advances will surely be generated in a near future.

An application of robotics for service is inside the distribution centers helping to increase its efficiency, flexibility and speed for a dynamic, specialized and demanding society.

The objective of the distribution centers is to send products to its destination for sales as effective, quick and economic as possible. They generally consist of big areas to receive the merchandise that arrives in big volumes and organize it in small packages with several different types of merchandise, and after that, to be sent to the sale points.

The robotic distribution centers will certainly represent a competitive advantage for companies and countries. This robotic distribution centers will have robots that classify solid products, transport products and conform packages for the sale centers.

Thinking on this application, we propose to students a robotic competition where robots should demonstrated capabilities to transport and to classify products that arrive from factories and to organize them in appropriate packages to be sent to the sale points as fast as possible and with high precision.

2. The objective of the competition

In the scenario, a part of distribution center is represented, where an autonomous robot should manipulate products sent by producers and to organize them in packages that will be sent to sales points later on. The distribution center has five different types of products that will be represented by wood cubes of 50±2 [mm] of side of the following colors: red, green, cyan, magenta and yellow. Each producer sent a shipment with twelve cubes of the same color and they are organized in the area of producers. The robot should be able to differentiate color of each product, to take a cube of each color and to deposit them in a specific order in the area of sales. The correct order is the following: a cyan cube, a red cube, a yellow cube, a green cube and a magenta cube.
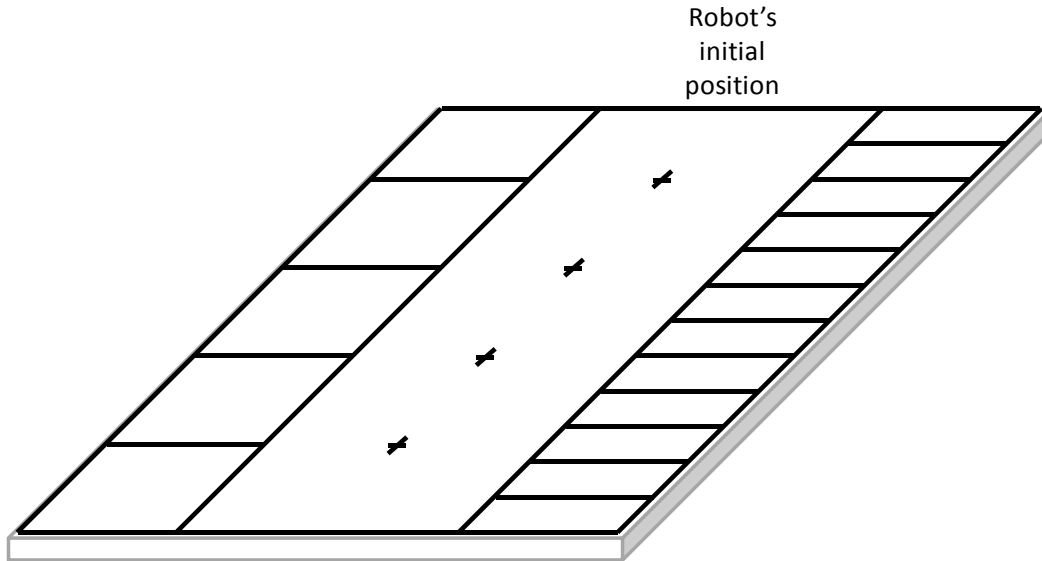
Figure 1. Scenario that represents a distribution center.

3. Specifications of the scenario

The scenario is built on white totally leveled melamine of 2400 [mm] x 2000 [mm] side. The whole external perimeter of the scenario is marked with insulating black tape, 3M brand, of 19 [mm] that will stick on the white chart of melanin (in the border).
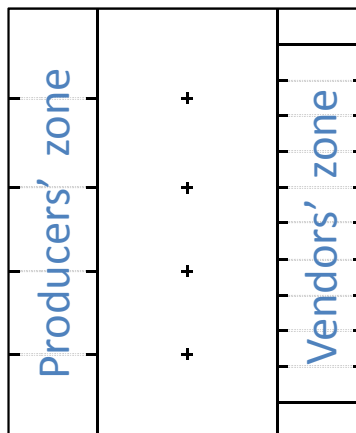

Figure 2. Definition of zones (superior view).

Inside the scenario the following areas are identified:

- The producers' zone is defined by insulating black tape, 3M brand, of 19 [mm]. This area is divided inside in five sectors where products are organized one type per sector. Each sector mesures 500 [mm] x 480 [mm].

- The vendors' zone is opposite to the producers' zone. It is identified with insulating black tape, 3M brand, of 19 [mm]. This area is divided inside in twelve sectors where packages will be deposit to vendors. Each sector measures 500 [mm] x 200 [mm].

- The intermediate area or central corridor is the area between the producers' and vendors' zones. Robot begins his journey on one of four crosses marked with insulating black tape, 3M, of 19 [mm] width and 40 [mm] long.

There will be 60 wood cubes of 50±2 [mm] of side and colored; 12 of red color, 12 of green color, 12 of cyan color, 12 of yellow color and 12 of magenta color. Mentioned colors are shown in figure 3. The cubes are manufactured in solid wood. The weight of each cube is about 60 – 90 grams.
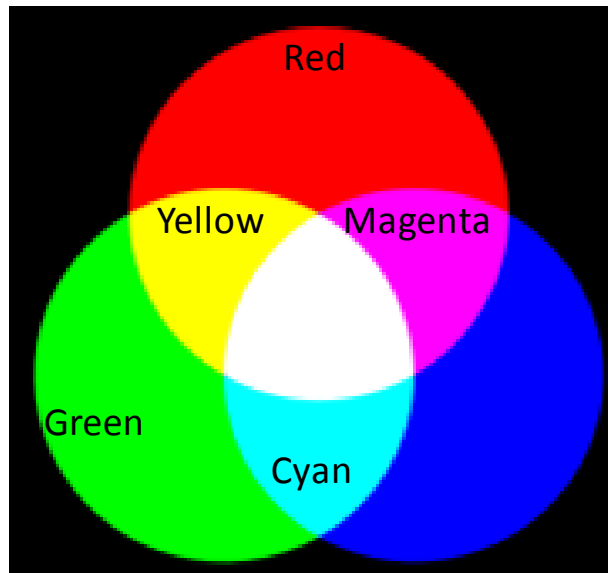

Figure 3. RGB space color with primary and secondary colors.

The cubes will be located initially in the producers' zone organized in groups of 12 and willing on-line of 4 and in three levels. Each group of products will be inside one of the sectors, in the center of sector, and all groups will be aligned in the same way as show in figure 6.
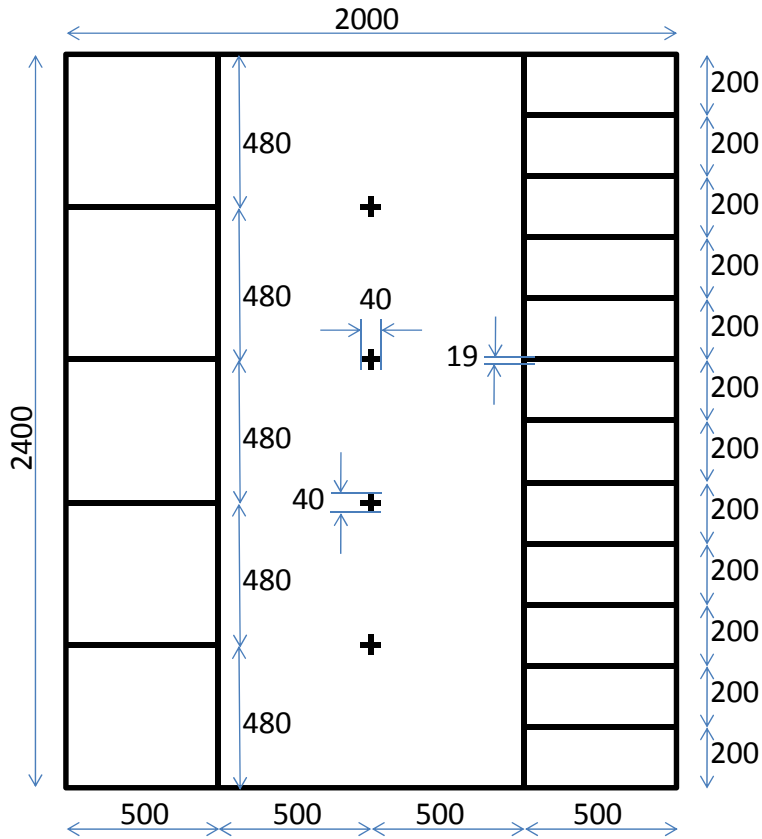
Figure 4. Dimension of the scenario in [mm].

The robot's task is to organize packages of five cubes of different colors and to place them inside the sectors of the vendors' zone. The packages should be formed of a cube of each color. Vendors need that cubes are placed in the following order: cyan, red, yellow, green, and magenta, as is shown in figure 5. It is possible to give to vendors the cube packages organized in another order but that will have a penalization.

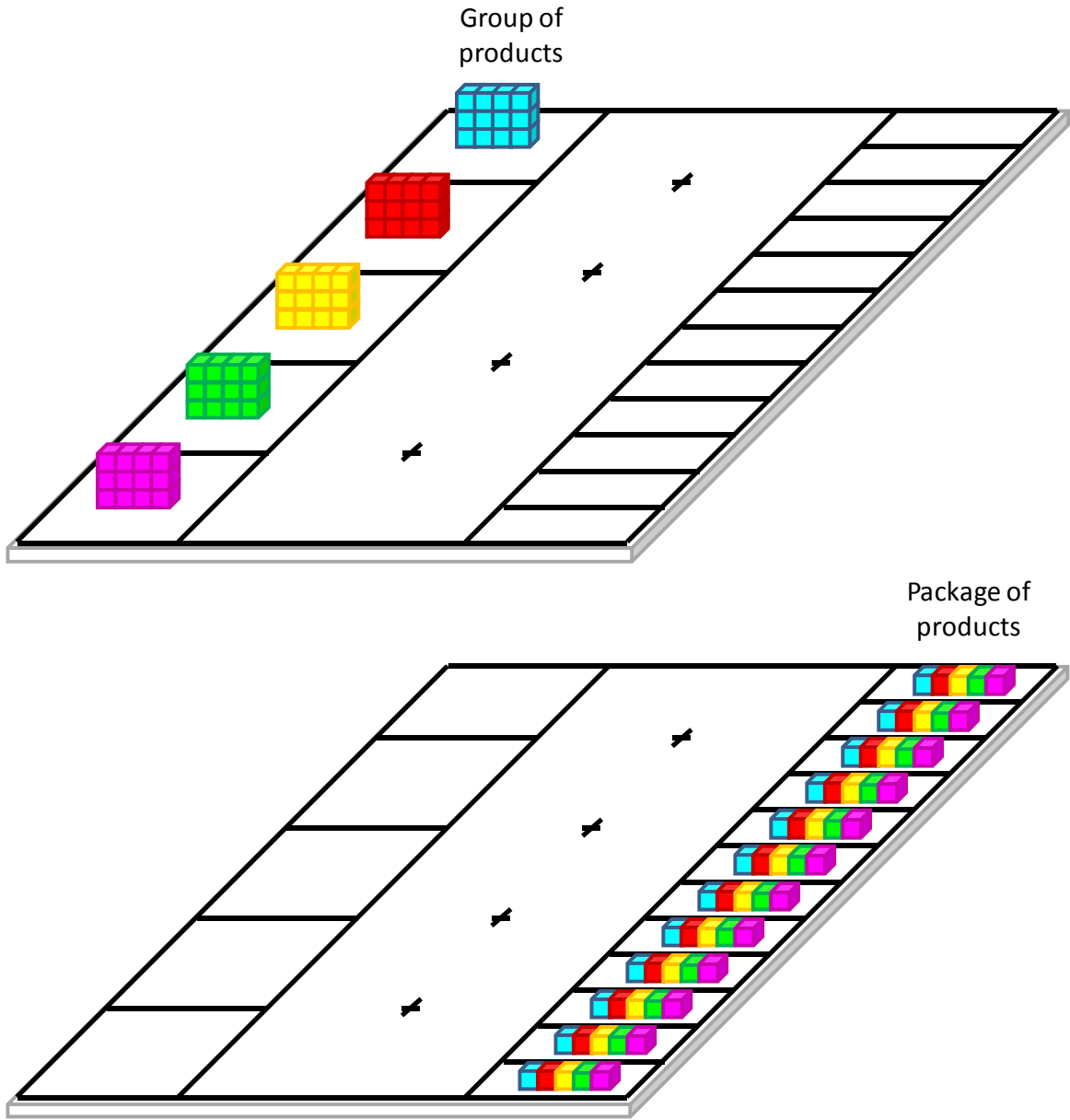Figure 5. Requested order of cubes in each package.

Group of
products

Package of
products

Figure 6. Initial situation (top), desired final situation (below).

4. The conditions of illumination

The local committee will provide interior uniform illumination during the whole day and with an approximate intensity of 1000 [lux]. Nevertheless, the participant teams should come prepared to calibrate their robots based on the local conditions of illumination. The local committee will carry out all possible actions to reduce to the maximum the effects of shadows and natural illumination; however these factors cannot be completely eliminated. Consequently, it is very recommended that the participant robots were designed to be immune to variations of illumination. Once the competitions have begun, the teams will play under the existent conditions of illumination without discussions or complains.

5. The robot

The robot should be a mobile, totally autonomous device, that is, it should be able to move through the scenario and to complete the objectives without human intervention, without communication with external computers and only using the devices that robots have.

Robot has no restrictions of materials, mechanical parts, and electronic components, being able to have a limitless quantity of pieces, sensors, actuators and processors prefabricated or made by hand.

The restrictions that robot should respect are:

- During all competition, the initial configuration of robot must remain in a cube of 300mm of side. Then the robot can autonomously deploy any kind of griper, arm or mechanical extension to take, manipulate or transport cubes.
- Robot should not communicate in any way with external devices.
- Robot should not deteriorate the scenario.
- Robot should have a unique starting button that is used in all the competition. In this way, it will make sure that the information used by the robot is obtained by its own sensors and not the observed from the members of the team.
- Only one robot can be on the scenario at a time. It is not allow robots that can split in two or more robots during a round.

Break any of the previous restrictions is disqualification condition.

6. The rules of the competition

Once initiate the competition process, all the participant teams will leave their robots in the space assigned by the organization, in view of all and they will only be able to move it from this delimitation at the moment to compete and once concluded the round. This assures that all the teams have the same amount of time to adjust their robots.

When all the robots are in the space assigned by the organization, all representatives of teams will participate in the riffle of location of the groups of products (cubes) in the producers' zone and later on they will participate in the riffle of the order of participation of team's robots.

During the riffle and during whole round, no member of teams would be able to modify their robot in any manner. Robot's changes and reprogramming will only be allowed after round has concluded for all participants.

The judges will announce, in order, the name of participant team and they will assign him an initial position (one of four marks in the central corridor) and orientation for their robot. The start point and orientation of robot are defined by raffle.

The robot will begin the test on assigned mark and every time team members call a restart.

When the robot begins his attempt nobody can touch it, otherwise it will be considered as a team restart.

Each robot will have a maximum of two restarts per round. When it is restarted, all the cubes are placed in their initial positions, but without stopping the clock.

If the robot presents a mechanical evident problem and if the judges authorize it, the participant team can fix it, the test is restarted and clock won't stop. It is considered as mechanical evident problem, for example, the detachment of a piece, problems with a motor, troubles with a sensor, battery ran out, or any difficulty not associated to a wrong design or due to a bad programming that impedes their normal operation and that it can be repaired to the interior of the scenario quickly.

The robot cannot leave the scenario; otherwise the robot must restart. It is considered that the robot leave the scenario if a robot's wheels enters in contact with the outlying lines of scenario. If the robot abandons the scenario, the members of the team will be able to manipulate their robot but it will be considered as a restart, and clock won't stop.

The cubes should be manipulated and transported by the robot from producers' to vendors' zone, but they won't be able to place or forget a cube in the central area or in an area of another product otherwise it will be penalized with 10 points. To consider a package of cubes is "deposited" it should:
- form a group of five cubes of different color, no matter the order of colors,
- be perfectly aligned among them,
- be placed inside a sector of the vendors' zone. Inside means that no cube is in contact with the black line.

If a package is "deposited", 100 points are scored. But, if cubes of a package are placed in the "correct order", 300 points are scored instead of 100 points. The correct order is specified in the figure 5. Contrary, packages are "bad deposited" if they stand out of the sector where they were placed, been not five cubes of different colors, or been cubes misaligned inside the same sector.

Cubes should be place ones next others in horizontal way. The cubes can't be place ones over the others as a tower. One point will be scored

It is considered that test had concluded if meets one of following conditions:
- If time reach the maximum of the test (5 minutes).
- If competitors decide to stop their participation, being responsibility of each team the amount of point scored and the time stops. The competitors cannot stop their participation if the robot has accumulated zero points.
- If robot accumulates three restarts.
- If robot places all the packages in the vendors' zone.

The first and main criteria to determine the winner is the highest score. If a tie exists then the second criteria is the smallest time archived. In the case that two (or more) teams end up with the same score and time, then another test will be carried out. If a tie exists during the development of the final round, it will be made an extra test immediately to define the 1st, 2nd and 3rd place.

Any consideration or exception will be considered by judges and organizers.

7. The evaluation form and the assigned score

The assigned scores will depend on the area and activity that robot is carrying out.

- A point will be assigned by each cube that is placed inside the vendors' zone without evaluating if it is, or not, aligned inside the sector. A cube is inside if is not touching the black line.
- 100 points or 300 point (but not both) will be assigned depending on package.
  - o 100 point will be assigned by each package of five cubes "deposited" in a sector of vendors' zone, but they don't respect the correct order.
  - o 300 points will be assigned by each package of five cubes "deposited" in a sector of vendors' zone and in the correct order, as mentioned in figure 5.
- Each restart is penalized with 10 less points. Each round has maximum two restarts.
- To forget a cube in the central area will be penalized with 10 points.
- To place a cube of a product in another sector of the producers' zone will be penalized with 10 points. This rule is also applied, if a robot accidentally left a cube fall down and it bounces outside of the sector that corresponds to it.

In the figure 7 some possible cases are shown and how they should be scored.
a) It has three cubes but only two are inside the sector. The score is 2 points.
b) It has four aligned cubes inside the sector. So, score is 4 points.
c) It has five cubes of different colors inside sector but one of them is misaligned. It can't be considered as a package "deposited", so the score is 5 points.
d) Package is composed by five cubes of different colors, but some cubes are misaligned with regard to other cubes although all are inside the sector. It isn't a package "deposited" then only 5 points are scored.
e) Two cubes of package stand out of the sector (touch the black line) although the five cubes are aligned. So, 3 points are scored. Package is not "deposited".
f) Some cubes are separate with regard to other although all are inside the sector. Only 5 points are scored. The package isn't "deposited".
g) The package has five cubes of different color and they are aligned inside the sector. The package is considered as "deposited" nevertheless don't has correct color sequence. So, 105 points are scored.
h) Two packages are placed inside sector, one on floor and the other over the first. Only the package on the floor will be considered. Because package on the floor has the correct color sequence, 305 point will be scored. No points will be earned with cubes of second package.
i) The package is "deposited" and has correct color order. The score is 305 points.
j) The package of cubes is "deposited" inside the sector although the whole package is 180 degree rotated. The sequence of color is correct. So a score of 305 point will be assigned.
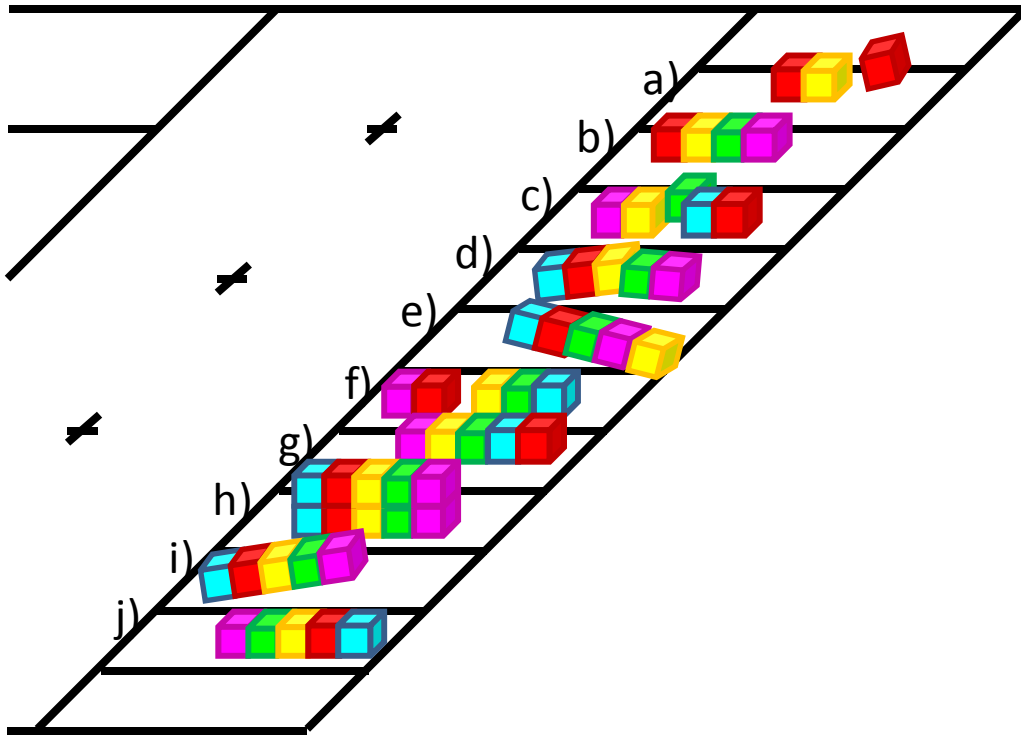
Figure 7. Examples of correct and incorrect placement of packages.

8. The execution of the tests and the rounds

Before beginning the rounds, competitors will be warned in advance for final calibrations. If judges consider necessary to give more time to teams for calibration for reasons of brightness, they will given only one extra minute to each team before their test.

Two types of rounds exist, classificatory and finals:

Classificatory rounds:

- All teams registered in LARC 2010OPEN category participate.
- It has four rounds per team. Judges can vary this number depending on number of participant teams and total amount of time to do the classificatory rounds.
- The maximum time per team to carry out the test is 5 minutes.
- Each team can restart its robot twice in a round. For each restart a penalization of 10 points is scored and the time won't stop.
- The best score in the four rounds will be taken into account to decide on participate teams in the final. The best five teams will classify.
- If a tie on scores happens, the criterion is the smaller time.
- Each team has maximum one minute to show up in the scenario, after that, the time of competition will begin to run.

Final rounds:

- The best five places of the classificatory rounds will participate.
- It consists of three rounds.
- The maximum time for team to carry out the test is 5 minutes.
- Each team can restart its robot twice per round. For each restart a penalization of 10 points will be scored and time won't stop.
- The best scores in the three rounds will be taken into account to determine the 1st, 2nd and 3rd places.
- If a tie happening, a fourth round will be disputed among the teams tied to define that place.
- Each team has one minute to show up in the scenario, after that, the time of competition will begin to run.

9. Requirements to participate in the competition

The way to participate in the Competition Robotics LARC 2010 OPEN category is to form a group of (up to) 4 people, which should be students of any educational institution of any country.

It is a requirement for participation, the delivery of a document where it is described the development and operation of participant robot (TDP – Team Description Paper) in IEEE format. After the end of competitions, winners will briefly present their robot to other teams. The no presentation of this document will impede the participation of team, because it is important for the development and evolution of knowledge of participants.

10. The Jury

The jury will be compound for one person of organizes of competition and one person of local committee that will know the present rules. The names of these two people will be announced in the days of the competition.

11. About extraordinary situations during the competitions

In case of an extraordinary situation with regard to the rules or the score, the judges and the Organizers of the Competition will analyze the conditions of the case and they will decide inside the possible biggest impartiality.