ROBOtics Learning for empowering the new GENerations of EU Innovators

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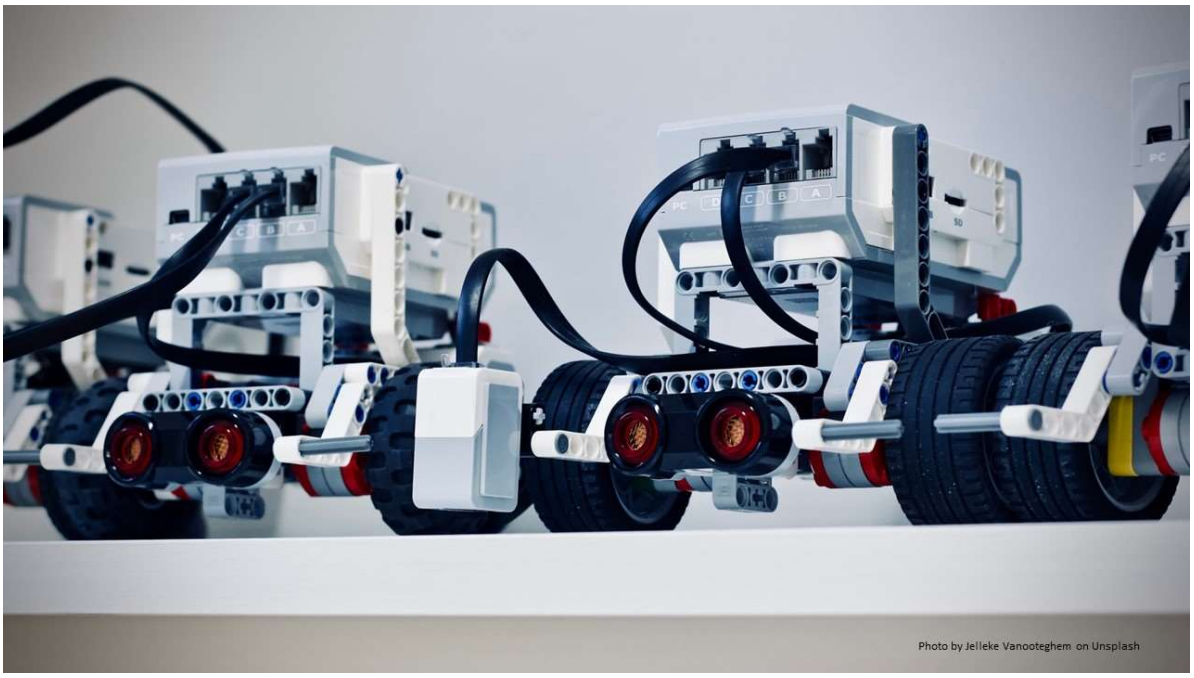

ROBOGENIUS Contest methodology

Full version

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Introduction

The contest methodology created under the Erasmus+ KA2 strategic partnership project "*Robotics Learning for empowering the new Generation of EU innovators*" is designed to provide a framework for the organisation of a robotics competition at pre-university level. The contest methodology has as a main goal to prepare learners for mechatronic national and/or international contests organised with mixed teams from secondary to tertiary education. Therefore, the contest organiser can adapt the provided framework according to his/her needs and specific objectives.

The contest is an opportunity for learners to apply the knowledge in an independent fashion while also providing a challenging and enjoyable environment. Moreover, due to the nature of the competition, the contest participants will also develop their soft skills such as communication, time management and team work.

For this contest methodology, LEGO Mindstorms/Education EV3 kits are used at the core of the design of the contest and also in the given examples. However, a contest organiser can adapt this methodology so that it can be used with other robotics kits. Moreover, the difficulty level of the challenges and/or tasks can differ depending on the background and skills of the participants in the contest and of the intended target groups.

Contest phases

This contest methodology provides a framework for a three-phase contest. However, the contest organiser is free to determine the number of phases as well as their duration, depending on his/her needs and specific objectives.

Each of the three phases of the competition should be aimed to explore different aspects of the robotics field (e.g. motion, sensing, software).

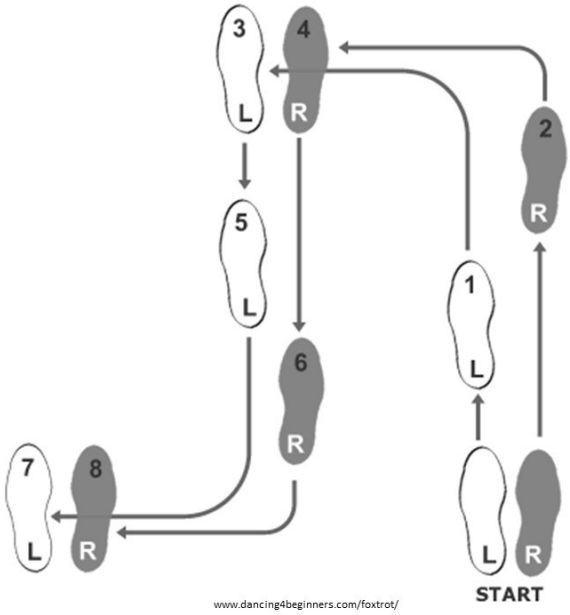
Note: This section assumes the fact that the robots are already build and provided to the competing teams. However, the contest organiser can decide to add extra phases in which the building of the robots is done by the teams, using the robotics kits.

Phase 1: Motion

The first phase aims to explore a team's ability to move a robot according to a specific task/challenge.

Example task: Dancing Robot

For this task, the team will be required to use the motors in order to perform dance moves according to the guidelines provided by the contest organiser. For example, the robot can be asked to dance the Foxtrot, which means that the team will need to program the robot to move in a certain way, in a fashion comparable to the foxtrot steps (see the figure below).



This task can be adapted to any range of motion the contest organiser desires, depending on his/her target goal.

Example task: Pick & Place Robot

For this task, each team is required to pick certain objects from one location and place them somewhere else. This can be achieved through the use of a programmable robotic arm.

The robot will start from a designated place and will be required to move to the indicated object, pick it up and bring it back to the "home base". Depending on the desired level of difficulty, the contest organiser can create obstacles between the "home base" and the object or can place multiple objects at different locations for the robot to pick it up.

Phase 2: Sensing

The second phase aims to explore a team's ability to program the robot to perform certain actions based on various sensor signals.

Example task: Musician Robot

For this task, the team will be required to program certain musical compositions so that the robot can play it when it meets a certain colour. This means that the use of the colour/light sensor is crucial and each team can decide to use colour detection or reflected light intensity detection to achieve the goals (depending on the lighting conditions in the location where the competition is held).

Each robot will be shown a coloured card and will be required to play the song specific to that colour. This can be achieved by using the *Sound* block in the Lego EV3 Software. Moreover, certain coloured cards can be used for adjusting the volume of the songs. Below, an example of how different coloured cards is given.

Green – play *Fur Elise*

Blue – play *Swan Lake* theme song

Yellow – turn volume up

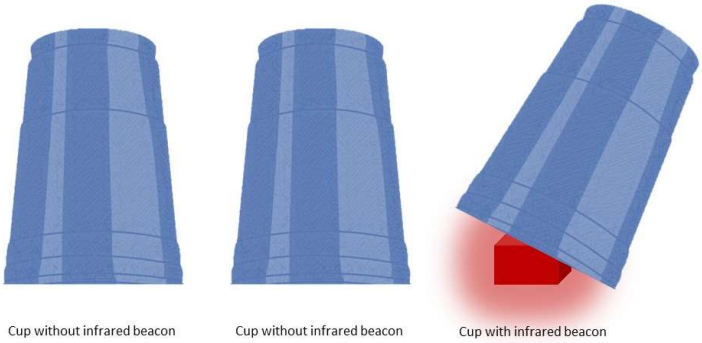
Red – turn volume down

Black – stop song

Example task: Infrared Beacon Finding Robot

For this task, each team will be required to program their respective robot to find the infrared beacon placed by the contest organiser under one out of a number of plastic cups. Also, they need to avoid hitting and toppling the plastic cups that do not have anything underneath them.

Each robot will need to sense using the infrared sensor if an infrared beacon is placed under each cup, avoiding the ones that do not hide anything and be attracted only by the cup that emits infrared radiation through the infrared beacon.



It is advised that the contest organiser checks the transparency of the cups used for this task, as they need to be completely opaque so that the infrared beacon will not be visible with the naked eye. Furthermore, as the infrared beacons provided in the LEGO Mindstorms/Education EV3 kits can work on 4 different channels, it is advised to make sure that the infrared beacon is set on the same channel as the infrared sensor block in the programming environment.

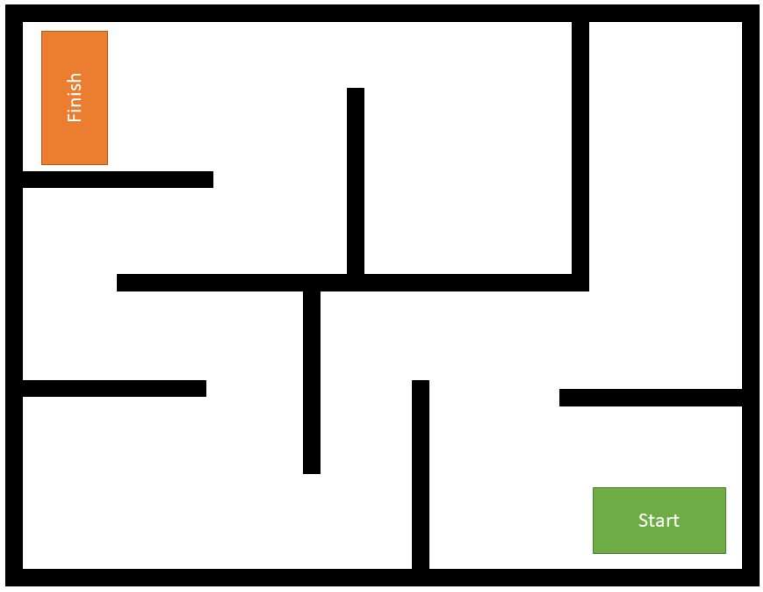
Phase 3: Software

The third phase combines the use of sensors and motion in a more complex task than in the previous phases focuses more on a team's ability to create efficient programming that can control the robot through various situations. This refers to programming concepts such as nested loops.

Example task: Maze Escaping Robot

For this task each team is required to program their respective robot to escape a maze, starting from the "Start" position and ending in the "Finish" position. The decision process that makes the robot either left of right when meeting a wall is paramount for this task. This requires nested loops that activate based on sensor readings such as distance, touch and light.

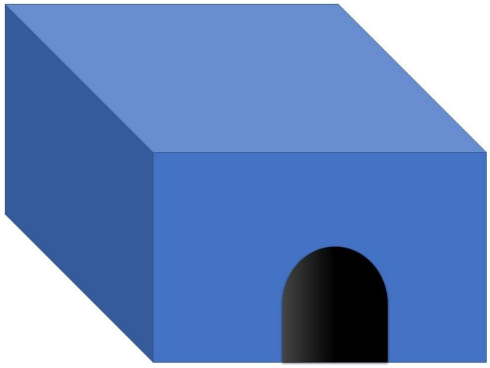
A lightbulb can be placed at the end of the maze in order to make sure that the light sensor will be employed and also to make it easier for the robot to detect the end. The image below illustrates an example maze that can be used for this task.

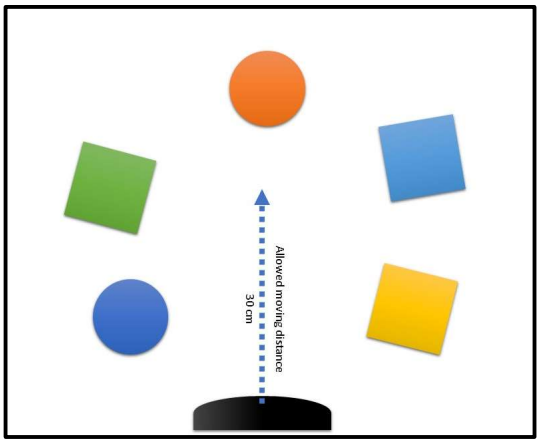


In order to make sure that the team uses a decision-based software, it is advised not to reveal the configuration of the maze before the start of the challenge.

Example task: Exploration Robot

For this task, the robot will be required to enter a closed chamber (e.g. a box) and – through the use of sensors, motors and software – create a map of the inside. As an example of the contents of the closed chamber, the contest organiser can place a number of geometrical shapes of different colours (e.g. cubes, cylinders etc.). The image below illustrates an example of the closed chamber from outside as well as inside (including also the placement example of some geometric shapes).





Due to the fact that the participants will not be able to see inside the closed chamber, it is advised to give the teams instructions regarding the allowed distance of travel inside the chamber, so that they will not hit the items placed inside. This can be anything from saying that the robot can move in a straight line only for 30 cm inside the box to providing a chart of allowed movements and distances.

Guidelines

The contest is to be ranked based on a multidimensional scale that includes the dimensions the contest organiser wants to explore or assess. As an example, scoring dimensions can be related to the technical aspect of the contest (e.g. design of the robot, time required for completing a task, the efficiency of the software etc.) and also to the interpersonal skills (e.g. teamwork, communication, responsibility etc.).

Regarding the teams, it is advised to have 2 to 4 participants in each team, depending on the objectives of the contest organiser. It is important to be aware of the fact that – even though in some cases, 1 person can be enough for completing a challenge – team work and interpersonal skills should also be addressed during the organisation of the contest. Therefore, the contest organiser should encourage the splitting of roles within a team such as one member responsible with the programming, one responsible with the building of robots etc.

If the contest organiser desires to give awards, a winning team can be selected based on the cumulative scoring of the dimensions defined before the competition. Furthermore, awards can be given for the teams that scored the most for the individual dimensions (e.g. award for the team with the most efficient software, award for the best teamwork etc.). This underlines the importance of participation and acknowledges the fact that each team has its own strong points, some being better in the technical part such as software design and others in the communication area.

It is advised not to reveal the ranking of the teams involved in the contest until the end of the competition. This is based on the idea that if the scoring is visible throughout the whole duration of the competition, the teams scoring lowest may feel discouraged, reducing in this way the enjoyment of the competition. Moreover, if the scoring is visible throughout the whole duration of the competition, if a team realises that it cannot reach first place anymore, it will not focus completely on the competition task.

Another advice is that the scoring should not be done in terms numerical values but in terms of awards (e.g. gold medal, silver medal, bronze medal) for each individual scoring dimension. This means that no penalties will be given to the teams and the ranking will be determined based on the total number of awards/medals acquired at the end of the competition.

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