ROBOESL PROJECT

ROBOTICS-BASED LEARNING INTERVENTIONS FOR PREVENTING SCHOOL FAILURE AND EARLY SCHOOL LEAVING

Erasmus+ 2015-1-IT02-KA201-015141

Output 1: Curricula for 10 exemplary interdisciplinary robotics projects

Curriculum 6: The slalom

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Circulation: Public

Version: Final

Stage:

Date: March 31, 2017

[1] EDUMOTIVA stands for 'European Lab for Educational Technology

Declaration

This report has been prepared in the context of the ROBOESL project. Where other published and unpublished source materials have been used, these have been acknowledged.

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Table of Contents

Abstract

This document contains the description of the Curriculum n. 6, entitled ‘The slalom’ which is part of the Intellectual Output 1 (Curricula for 10 exemplary interdisciplinary robotics projects) developed and tested in teacher training courses within the context of the ERASMUS+ ROBOESL project. A state variable is used in this Curriculum in order to implement with the robot the alternative side of skipping poles in a slalom race. The presence of a simulated pole is detected using an ultrasonic sensor.

Chapter 1: **Short description and scenario (O1.1)**

(source: anamori.com)

The robot must avoid a series of obstacles moving around each of them when sensed with the ultrasonic sensor.

1.1 The scenario

A professional skier follows a specific path to alternate the side through which she passes around red and blue poles. The robot simulates this alternating behavior. Some obstacles, for example small bottles, are put on a long table or on the floor, on a straight line at sufficient distance one another. The robot, using its ultrasonic sensor, approaches the obstacle and, when it is close to it, it goes around on the side which is alternatively left and right. After a predefined number of obstacles it stops.

1.2 Connections with subjects

1. Sports: let’s consider all the rules a professional skier must obey to perform a race. In particular let’s distinguish slalom and giant slalom to appreciate different techniques and difficulties (fig. 1).

Figure 1. Types of slalom

2. Physics: several aspects related to physics (kinematics, circular motion, linear motion etc), which already influenced previous curricula, can be again highlighted in this curriculum. More specifically you can observe that a semicircle has tangents at the two extremes of a diameter which are orthogonal to the diameter itself, and this implies the rotations of 90 degrees at those extremes.

Chapter 2: **Pedagogical objectives (O1.2)**

2.1 General objectives

- To provide students with a stepwise approach for a step by step acquisition of technical skills in using robotic technologies (hardware and software) building on existing knowledge and skills.
- To offer the robotics benefits for all children, especially those at risk of school failure or early school leaving.
- To engage students in STEM related subjects through interaction with the robotics technologies.
- To support self-directed action allowing learners to learn independently.
- To engage students in robotic constructions and problem solving through an interdisciplinary scenario that reflects aspects of real-life problems and situations.
- To align the robotics project to learners' needs and interests through tasks that derive from the initial activity but introduce new levels of complexity and difficulty.

2.2 Specific objectives

More specifically, upon successful implementation of the activities described in this curriculum students will achieve the following objectives:

- Sense the presence of an obstacle by means of the ultrasonic sensor
- Calibrate motion parameters to obtain the requested behavior
- Distinguish the different types of motion (on a straight line, through orthogonal segments, on a semicircular path) and program the robot to move accordingly
- Use a state variable to condition the robot decisions
- Understand the NOT Boolean operation
- Understand how to make the robot entirely skip the black tape and follow a line

Chapter 3: **Suggestions for learning methodologies (O1.3)**

This curriculum is based on the well known slalom race scenario for developing a meaningful context for students. A special worksheet has been designed and will be used as a reference and supporting tool. The students are encouraged to work in groups. The teacher acts as a scaffold and facilitator of the learning process. S/he provides feedback without revealing solutions and probing students through key questions to overcome emerging problems and difficulties. The activity starts with the delivery of the scenario to the students. The teacher in an easy to grasp way elaborates on the scenario. The students are encouraged to discuss the given scenario in groups and to form a general methodology for dealing with the problem. The students are then called to create the mock-up, the environment into which the robot will operate based on the scenario of the activity and to decorate the robot to look like a skier. The activity progresses with the teacher explaining the way the distance/ultrasonic sensor can be mounted on the tribot. The teacher provides all the necessary information regarding the way the distance/ultrasonic sensor operates. This stage is followed by practical experimentations by the students.

Then the students are invited to work with the tribot following their worksheet. First, they are called to explore through trial and error ways of making the robot to skip just one obstacle/pole moving around it. Students write down in their worksheet their programming solution in their own words for further discussion.

Then tips are provided for making the robot to skip the obstacle moving around it

1. in orthogonal segments
2. in semicircular path

After the completion of the activity the students are encouraged to explore a more general solution that will not be dependent on one obstacle/pole but it will work for a random number of obstacles. Again through trial and error and playful explorations the students work to make the robot to slalom between several obstacles/poles. The teacher will support the students during this process and in the end will encourage them to discover a general programming solution exploiting the results of their trial and error experimentations. For this task the role of a state Boolean variable in the program should be introduced by the teacher.

Finally, a straight black tape is added in the scenario connecting the obstacles and students are challenged to devise a solution for an autonomous realignment of the robot after skipping the obstacles exploiting the known line follower program.

A. The role of the students

Students first discuss the problem through a free dialogue in their group and after that they devise an action plan to solve it. They work in groups following the worksheet and the discrete feedback they receive from the teacher. Students may extend their work to variants suggested by the teacher or devised by students themselves. First, they find solutions making trial and error experimentations. Then, they are encouraged and supported to find a general programming solution to the same problem. The final solutions of the groups are presented in the class, are discussed and evaluated with students reflecting with critical mind on their work, expressing their views and recording their experiences in a diary or questionnaire.

B. The role of the teacher

In the constructivist learning framework described above, the teacher does not function as an intellectual “authority” that transfers ready knowledge to students but rather acts as an organizer, coordinator and facilitator of learning for students. S/he organizes the learning environment, raises the questions / problems orally and through a worksheet, offers hardware and software necessary for students' work, discreetly helps where and when necessary, encourages students to work with creativity, imagination and independence and finally organizes the evaluation of the activity in collaboration with students.

Chapter 4: **Technical guidelines (O1.4)**

4.1 Building instructions

For implementing this curriculum, the usual *tribot* structure is enough, provided an ultrasonic sensor is put on the front of the robot as already done previously. The teacher can decide to suggest the students to prepare a different structure, funnier or more related to the specific scenario: the only requirements are the usual possibility to turn and to spin and a suitable position for the ultrasonic sensor so that it can sense objects that are on the path of the robot when it goes straight and that represent slalom poles.

4.2 Illustrative solution

The first implementation is very simple and represents a common obstacle avoidance method: when the robot is close enough to the obstacle, it turns 90 degrees on one side, for example clockwise, goes forward a bit, turns 90 degrees counterclockwise, goes forward enough to overcome the obstacle, and then performs a sequence turn-forward-turn to realign itself to the original straight path (fig. 2). When it encounters the next ‘pole’ it performs a similar sequence but on the other side with respect to the previous one, that means that all the turnings are in the opposite direction. For this purpose, it is necessary to update a state Boolean variable in the program (*right*) which says if the robot has to skip the pole on the right side, when true, or on the left side, when false; the variable is negated after each repetition (fig 3).

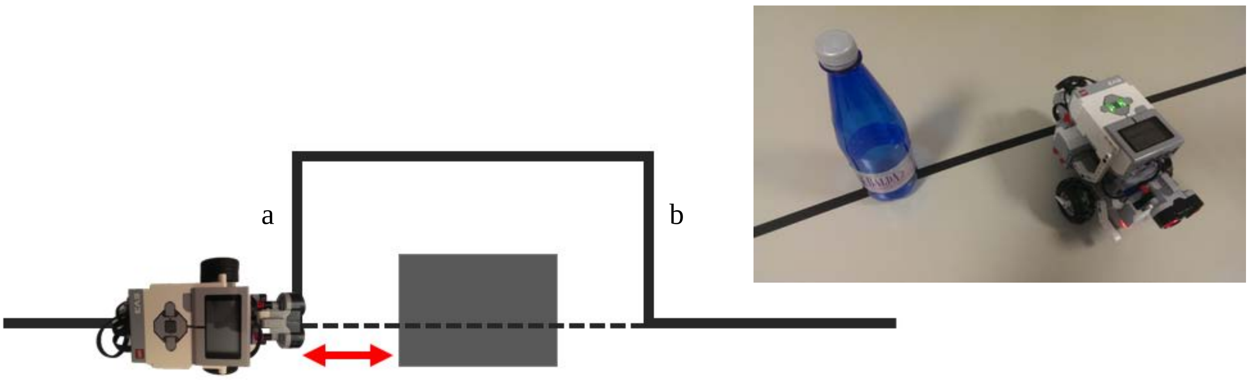

Figure 2. How to skip an object with orthogonal segments

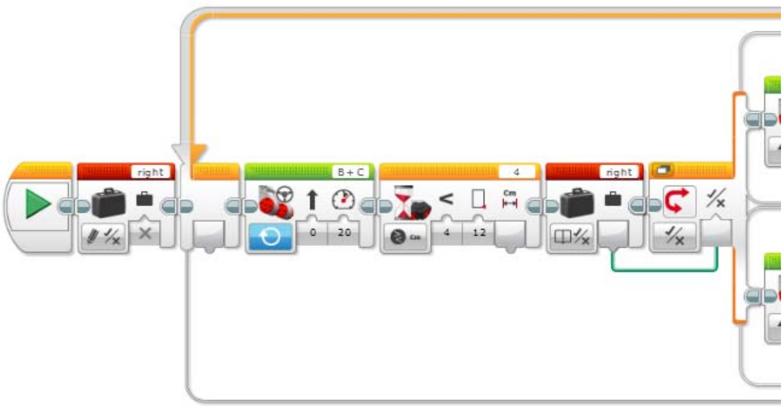

Figure 3. The program of the simplest solution

All the parameters set (the number of rotations of the orthogonal segments, degrees of turning and even speed) are indicative and must be calibrated according to the robot setup. The only requirement to realign is that segments a) and b) in fig. 2 must be equally long. It is up to the teacher to ask the students to make the program more readable implementing the two personal blocks *skipright* and *skipleft* which have suitable parameters and contain each one of the two long sequences of `Move` commands present within the `Switch` command.

4.3 Implementation suggestions

The setup is very simple and you can use small common objects as poles, like bottles or cans. The distance in between two successive poles must be chosen accordingly with the segments' length to avoid that the robot touches an obstacle when trying to skip it. After some trials, the students can calibrate all the parameters in the program in order to obtain a sufficiently precise turn of 90 degrees and a correct realignment.

4.4 Extensions and variants

4.4.1 Variant a: Skipping along a circle [easy]

In this variant, instead of 'drawing' a rectangle around the obstacle, the robot draws a semicircle whose radius is related to the steering factor, as we saw in a previous curriculum. In this way, apart the initial and final turning of 90 degrees, only one `Move Steering` command is necessary to draw this arc of circle (fig. 4). In fig. 5 the section of the program to modify for this variant. Again all the requested parameters must be experimentally calibrated to assure a sufficiently precise realignment and the two subsequences can be realized in form of parametrized personal blocks.

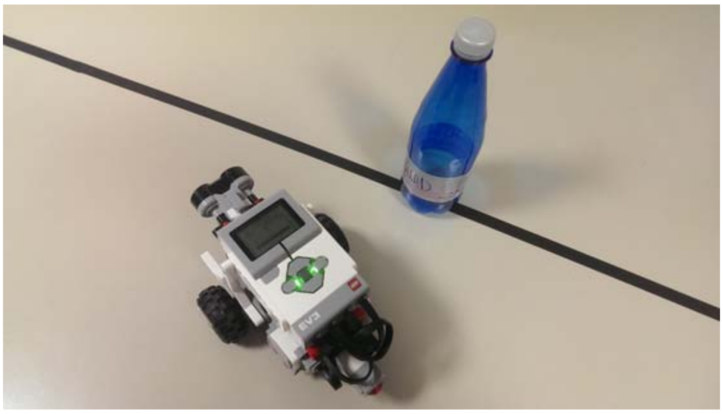

Figure 4. Along an arc of circle

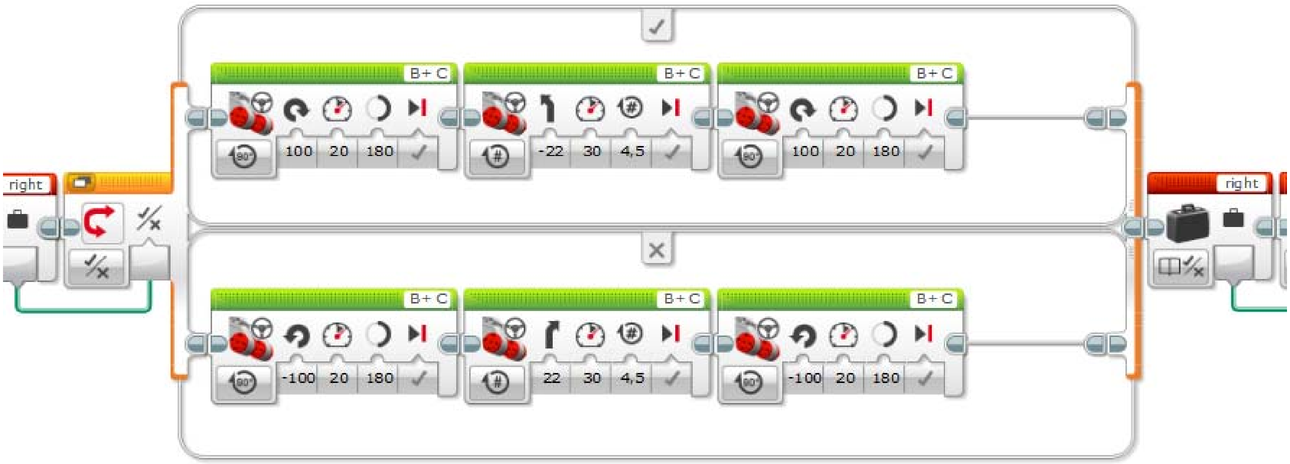

Figure 5. The code for a semicircle

The students can verify experimentally that the realignment is rather critical due to its sensitiveness to the length of the arc of circle drawn, which depends on the number of rotations (or, equivalently, of degrees, if you would prefer this kind of duration) in the central `Move Steering` command. The positive aspect of this variant is that it better simulates the behavior of a slalomist.

4.4.2 Variant b: Skipping along a circle and realign [easy/medium]

Following the last remark, here we add an autonomous realignment of the robot, provided the obstacles are put along a straight black tape on a light surface, exploiting the usual line follower feature. Therefore, we must equip the robot with the color sensor mounted so that it can collect the light reflected by the surface (fig. 6).

Figure 6. Setup for realignment

After having drawn the semicircle, we assume that we would make the robot realign to the left margin of the tape. To render this realignment easier, when the robot comes from the right side, we stop the steered motion only when it completely overcomes the tape: we make the robot go forward a bit so that, when turned 90 degrees, it is already close to the left side of the tape. On the contrary, when coming from the left side, this further advancement is not necessary and, therefore, the two alternative subsequence are now not similar (fig. 7). The robot realigns through the usual line following for a while (2 s) and then the main cycle is repeated. This solution makes the robot behavior less critical in detecting all the successive poles with its ultrasonic sensor (fig. 8).

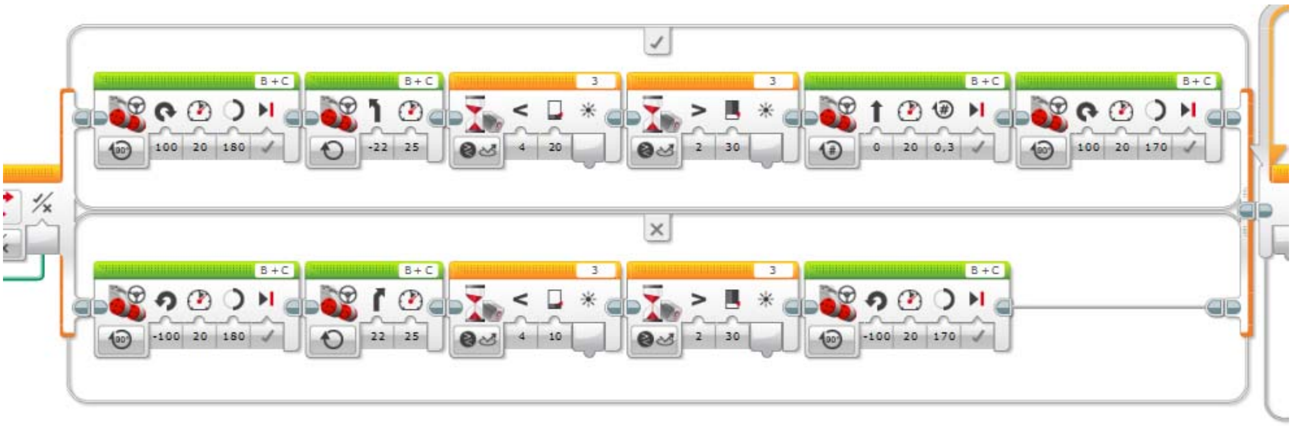

Figure 7. Modified skip

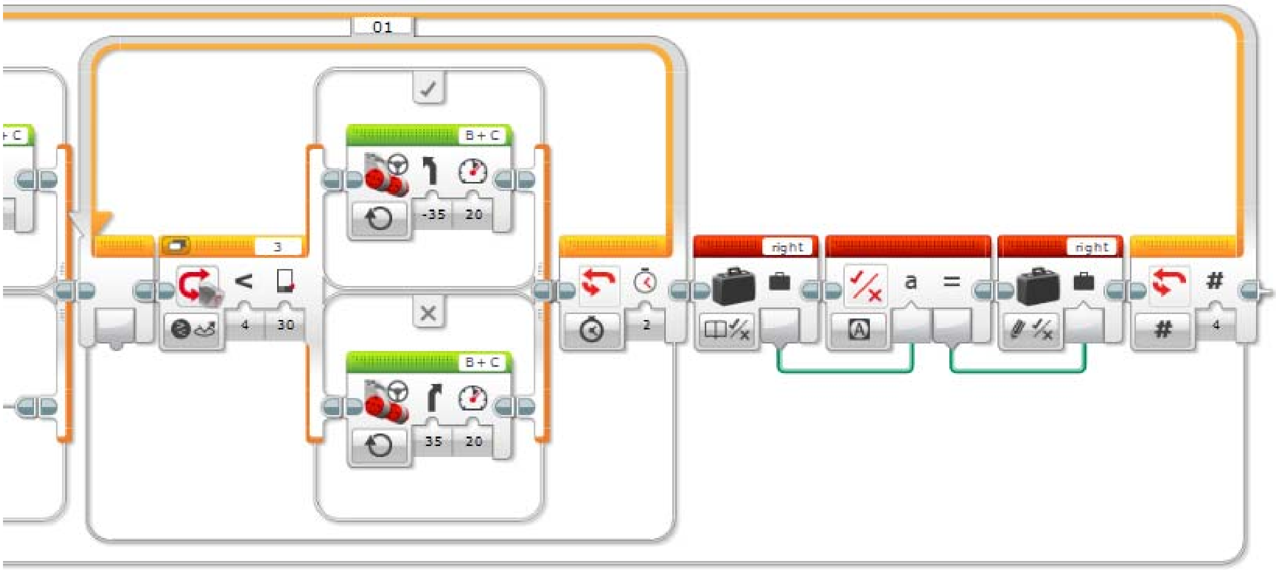

Figure 8. Realignment

Chapter 5: **Evaluation tools (O1.5)**

Use the rubric below to evaluate your students' achievement in each specific objective of this curriculum.

Name of student (or group of students): ………………………………………………………

upon completion of the activities described in this curriculum students achieved the following objectives	**Evaluation score** **0 = not attempted** **1 = attempted without success** **2 = partial success** **3 = completed with teacher's help** **4 = completed without teacher's help**
Mounted and used correctly the ultrasonic and color sensors	
Translated the scenario into a realistic representation on their desk or floor	
Sensed the presence of an obstacle using the ultrasonic sensor	
Used the Boolean state variable for correct decisions	
Instructed the tribot to skip an obstacle through orthogonal segments	
Calibrate critical parameters	
Changed the Boolean state variable	
Made the robot to entirely skip a tape by means of the color sensor	