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## Engineering Design Challenge 2.0

# Drive Smarter

## Game & Rules Description

### Short Description

The challenge is to design and build small autonomous cars that can accomplish specified tasks. Cars should be smart enough to observe the surrounding environment and move accordingly. The main focus is on navigation, computer vision, communications, and control theory. Extensive training to cover practical aspects in these domains will be provided by AUB Robotics Club, and participating teams are highly encouraged to attend.

### Time & Location

The challenge will take place on Sunday, February 12, 2017 at the American University of Beirut.

### Eligibility

Teams of 2 to 5 members of students can be part of the challenge. To qualify for winning monetary awards, all team members should be enrolled in a university as of the competition announcement date; team members who graduate in fall 2016 are allowed to participate.

### Guidance and Advising

Teams are recommended, but not required, to have an advisor. An advisor can be anybody; a professor, an engineer in a company, or even a university student, who is willing to provide consultancy when needed.

Note that advisors should only guide teams throughout the competition, not do their work. They may suggest ideas and provide feedback for teams, however they must not help with any hardware or software implementation. An advisor can guide more than one team.

Teams should inform EDC organizers of their advisor for recognition and appreciation purposes.

## Game Rules

The teams start by having a simple check, then play 2 games to score points. While games have penalties, teams cannot score negative points in either game. Teams will be given 60% on their game performance, and 40% on a technical assessment by a panel of expert judges from different universities and/or companies.

In addition to the games, a fun speed race will be held between the cars. The winner of the speed race gets a special award, but the game points will not be affected.

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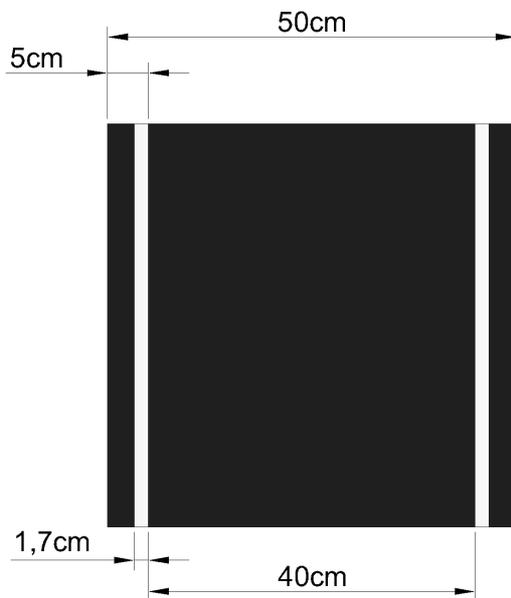
### GENERAL RULES

- 1) A car is any object that aligns with the rules. No specific shape or material is required – creativity is encouraged! Moreover, no hard limits are imposed on dimensions, but cars are expected to suit the scale of the roads and field in order to perform well on the competition.
- 2) The team must use one car only to play the games, however, minor changes or repairs can be made between rounds.
- 3) The car has to stay as one unit on the field. Anything not permanently attached to the car is not allowed on the field.
- 4) The car should not damage the playing field or pose any safety hazards. Teams who violate this rule on purpose would be disqualified. Refer to the safety regulations for more information.
- 5) The car must operate autonomously without human intervention, except within designated pit areas. Pit areas are 1m x 1m areas, colored green in field drawings.
- 6) Only one team member, designated the operator, can interact with the robot in pit areas. The operator cannot change during the round, but different team members can be operators for different rounds.
- 7) At any point during a round, the operator is allowed to bring the robot back to a pit area. The team loses a penalty of **2 points** each time.
- 8) Cars can only drive on roads, sketched in the next section and designated black in field drawings. If a car, or any part of it, goes out of designated roads, it has to be retrieved manually to a pit area by the operator, and this incurs a penalty of **2 points**.
- 9) All dimensions in field drawings have a tolerance of 5%. CAD drawings of the field are available on the competition website <http://aubrobotics.com/edc>.
- 10) Judges take the final decisions in rule matters.

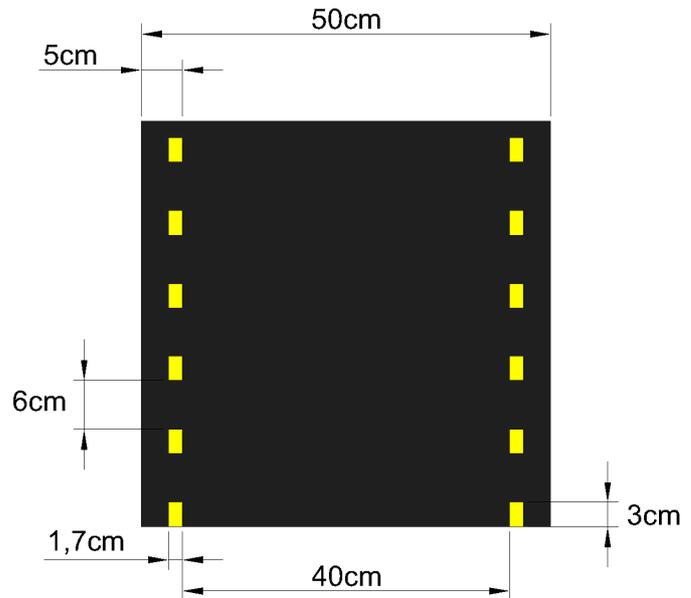
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**ROADS**

Roads are a common element between the games, and navigating them is an essential part of the competition. They are 50cm wide, and colored black with two white stripes near the edges as shown below. In game 2, some roads have dashed yellow stripes near the edges instead. Drawings of a typical strips of both types, regular and dashed roads, are shown below.



Regular Road Dimensions



Dashed Road Dimensions

Note that the whole 50cm is considered part of the road, not just the space between the white sidelines.

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**GAME 0 – SANITY CHECK (VERY EASY - 10PTS)**

Before starting the games, cars are expected to complete a simple checklist of tasks to make sure they are fit to drive. Teams get points for each item of the checklist shown below.

- 1) The car exists: **5 points**
- 2) The car can move: **2 points**
- 3) The car can stay within a straight road for more than 1 meter: **2 points**
- 4) The car can change its direction of travel by more than 90 degrees within 5 seconds: **1 point**

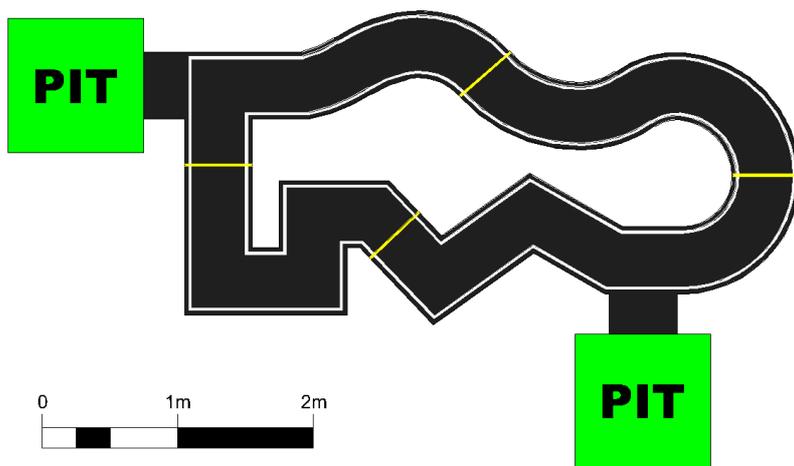
**GAME 1 – DRIVING TEST (EASY TO MEDIUM - 40PTS)**

In this game, cars have to move alongside tracks and cross checkpoints to get points. Two tracks will be available, with multiple possible starting locations for each track.

**FIELD DESCRIPTION**

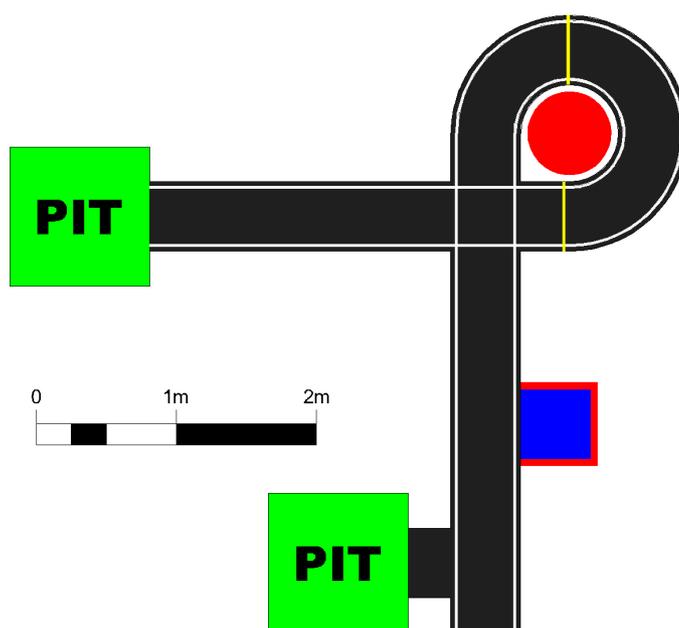
Field drawings are shown below. Pit areas are shown in green, and checkpoints in yellow.

The first track is a closed circuit constructed as the figure below.



Game 1 – Track 1

The second track is constructed as shown below. Structures shown in red are guaranteed to be solid and at least 40cm high. No other solid objects will be placed near this track.



Game 1 – Track 2

## RULES

- 1) Teams will have the chance to compete in both tracks, with each being timed and scored separately.
- 2) For each track, the car can start in any of the designated pit areas.
- 3) Successfully passing a checkpoint, by having the whole car cross from one side of the yellow line to the other side, scores **5 points**. Passing each checkpoint is only counted once.
- 4) Successfully parking in the blue parking area in the second track counts for **10 points**. For a parking to be considered successful, a car needs to drive completely inside the blue parking area and be stationary for at least 5 seconds, without touching any of the walls during the process. Touching the walls is penalized the same as going out of the track.
- 5) For each track, the team is allowed to have 3 trials, with a maximum time limit of 2 minutes for each trial. A trial terminates if the time limit passes, or if the robot is stationary and the team wants to finish the trial. The trial with the maximum points will be considered for scoring.

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**GAME 2 – SHAWARMA EXPRESS (MEDIUM TO CHALLENGING - 50PTS)**

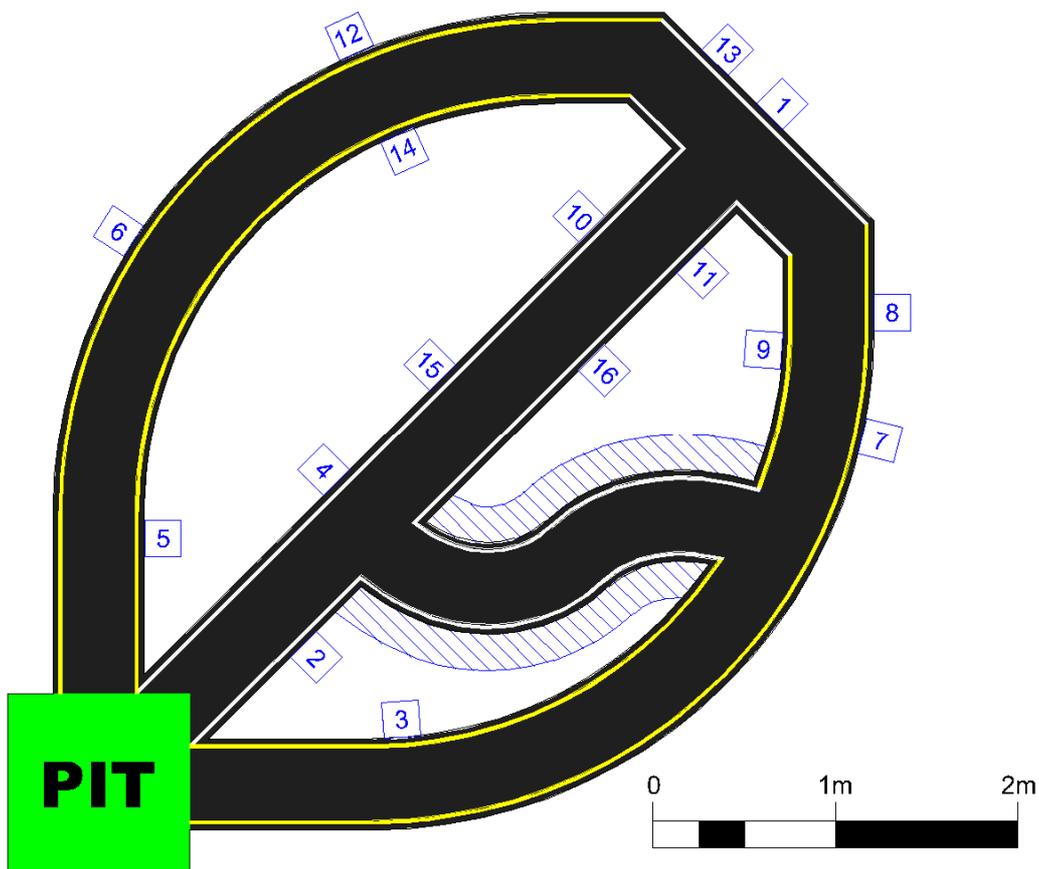
Teams have to complete certain deliveries in a track described below. The car carries cargo units to destinations; some given beforehand, while the rest are assigned as soon as the car starts the round.

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**FIELD DESCRIPTION**

The field drawing is shown below. The pit area is shown in green. The blue-outlined boxes show the locations of the destinations with their numbers written inside, and the blue shaded area shows possible locations for the unknown order. The white-bordered roads will have regular sidelines, while the yellow-bordered ones will have dashed sidelines, described in the roads section.

Note that buildings will be placed randomly around the track, except the central road will have no buildings. Buildings will not interfere with any of the roads. The buildings are further clarified in the game rules.



Game 2

Destination boxes will be 20cm x 20cm x 5cm boxes with an open top. The boxes will be made of a solid material, and will be colored blue on the outer faces.

Moreover, 10 cargo units will be available to the team in the pit area. Each cargo unit is a 5cm x 5cm x 10cm cuboid and weighs 250g  $\pm$  5%.

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**RULES**

- 1) 10 cargo orders in total are available to be delivered by the car in each round; 6 of which are predefined orders, 3 are on-the-spot orders, and 1 unknown order.
- 2) 6 predefined orders are available to destinations 1 to 6, each counting for **3 points**.
- 3) 3 on-the-spot orders are chosen from destinations 7-16 each round, each counting for **5 points**.
  - a. The 3 on-the-spot orders will be sent to the robot via Bluetooth when the game starts; the communication procedures and format are outlined in a separate document.
  - b. 2 of the on-the-spot orders will be restricted to destinations on *regular roads*.
  - c. The last one will be targeted to one of the destinations on *dashed roads*.
- 4) Confirming the receipt of all the 3 on-the-spot order destination numbers, according to the communication format, will count for **7 points**.
- 5) The unknown order will be available along the curved street; the location of this order's destination box is changed every round, within the area shaded blue in the field drawing. The unknown order counts for **10 points**.
- 6) Only 10 cargo units will be available to the team.
  - a. If the operator brings the robot back to the pit area according to general rule 7, any undelivered cargo units that the robot is touching are also brought back with it.
  - b. Cargo units delivered to a box remain in the destination box, and cannot be brought back manually, even if the destination is not one of the orders.
  - c. Cargo units dropped by the robot, but not within a destination box, may be brought back to the pit area whenever the robot is reasonably far from it, as assessed by the judge.
- 7) The operator can load the robot whenever it is in the pit area. The robot can carry as many of the available cargo units as the operator wants, provided they are in the pit area.
- 8) The robot can either automatically unload the cargo, or require manual unloading.
- 9) Manual unloading can take place if the robot is stationary, and is less than 50cm away from the edge of the destination box according to the judges' assessment. After approval of the judge, the operator then can to pick up a cargo unit from the robot and drop it in the destination box. Each manual unloading operation incurs a penalty of **1 point**. Manual unloading is not expected to take more than 5 seconds.
- 10) A cargo unit is counted as delivered to a destination if it is partially or completely inside the destination box.
- 11) Only one cargo unit can be delivered to each destination box; delivering more cargo units to the same destination does not count.
- 12) If a cargo unit held by the robot is above a destination box when the round finishes, this cargo unit is dropped in that destination box and is considered a delivery.

- 13) With the exception of the central road, red or white buildings will be placed randomly around the track. This includes the blue shaded area of the unknown order. So, teams should take them into consideration.
- 14) The team is allowed to have 3 trials, with a maximum time limit of 4 minutes for each trial. A trial terminates if the time limit passes, or if the robot is stationary and the team wants to finish the trial. The trial with the maximum points will be considered for scoring.

## Scoring

Teams will be assessed based on the following two measures:

- 1) Actual Performance (60%):  
60% of the total points will be given based on the car's performance on the field on the challenge day, according to the scoring criteria specified in a separate document.
- 2) Technical Assessment (40%):  
The remaining 40% will be based on design evaluation by a team of judges from different universities/companies, according to the judging rubrics specified in a separate document.

## Awards

The team with the highest overall score gets a monetary prize of **\$1500**. The first and second runner ups get prizes of **\$1000** and **\$500** respectively. Other awards will be distributed among teams who demonstrate proficiency in certain aspects of the competition.

## **Changelog**

- September 23, 2016: fixed competition day of the week – said Saturday instead of Sunday.
- September 24, 2016: excluded the central road in game 2 from having buildings.