Robot competition rule book (22.2.2024)

Aim

The goal of the competition is to build a robot (or a team of robots) that will autonomously collect toys —blocks of assembled Duplo-like bricks— in a challenging, semi-structured home-like environment, and bring them to the collection point.

General Competition Rules

- The rules may be changed by the competition committee at a reasonable notice, *e.g.*, if a clarification is needed, or if a team appears to abuse a loophole.
- You have a maximum time of 5 minutes to set up your robot in the arena, before the clock starts ticking. If your set up time is less than 5 minutes, the clock will start ticking at the robot's first motion.
- *Timeout*: 10 minutes to complete as much of the task as possible.
- *Robot reset*: the competition judge may allow a team to "reset" their robot if it gets stuck.
  - Primarily applied if the robot gets stuck for a period of 15 seconds.
  - In this case, the team may physically interact with their robot (including rebooting, repairing or changing faulty parts, etc.) and it may be repositioned.
  - The new centre must lie within a 25 cm radius of the point where it got stuck.
  - Any orientation may be chosen.
  - The competition clock will continue to run.
  - **The competition judge's decision is final.**

The Robot

You will be given a catalogue with a wide variety of mechatronic parts, which you may buy using your virtual budget. You are not restricted to solely using this catalogue, nor do you have to use it at all. Additional materials can be bought and parts can be built using the DLL-PROT facilities (e.g., by 3D printing or laser cutting; refer to the *Budget* section of this rulebook), or ordered at EPFL professional workshops. You are free and are encouraged to be creative with your designs, providing your robot adheres to the following rules:

- The robot must be completely autonomous: **no remote controlling or data processing is allowed** during the competition. You can transmit data from the robot for monitoring (telemetry) and display purposes, but no external commands (except for start/stop and emergencies) are allowed to be sent to the robot.
- All the computation must be done on-board. Any computational devices may be used, but they must physically be on the robot.

- The robot must carry its own power source (*e.g.*, batteries). Energy sources producing potentially toxic exhaust gases (*e.g.*, diesel generators) are forbidden.
- All robot components, with the exception of trivial parts (*e.g.*, cables, screws, tape, etc.), must be bought either on the virtual or real budget. To ensure fairness between the teams, the use of personal components (*e.g.*, microcontroller boards, batteries, laptops) is not permitted.
- There is no explicit weight or size limit. The arena dictates however a few constraints. There will be a minimum clearance of 50 cm between any parallel walls or fixed obstacles, and the elevated platform is only guaranteed to resist to weights up to 30 kg.
- You can implement a multi-robot solution, and you can exchange any kind of data between the robots (including computation offloading). In this case a robot is defined as a device —physically placed in the arena for the whole duration of the competition— that includes **at least one actuator having a practical purpose** related to the goal of the competition. If it is possible to perform the same action of that device without using any actuators, then the device does not count as a robot.
- The robot must not be destructive or dangerous. Collected objects must arrived intact at the collection point.
- Flying solutions are not permitted for safety reasons, as there are no security nets.

Toys

Toys are defined as **small, solid, constructions made of Duplo-like bricks**. They might be of any colour and shape, but will always be smaller than the lowest obstacle placed in the arena. A toy can be made with bricks of different colours. The toys will be evenly distributed on the ground, and all toys on the ground in a given area will be worth the same number of points.

There will also be toys placed on furniture (*e.g.*, on small table or on a sofa), or under it (*e.g.*, under a table). These toys will have bonus points[1] compared to regular objects from the same zone, and will be only placed in zones 1 and possibly 2. There *might* as well be other toys with bonus points, *e.g.*, those that are particularly difficult to detect (*e.g.*, harder to see) or to grasp.

Robots must avoid damaging or disassembling the toys. The position of toys is randomly determined for each team just before the start of their robot, and items can be placed in any orientation.

Scoring points

The points will be allocated depending upon two criteria: the toy's score (depending on its location and potentially on bonus points) and where it is deposited at the end of the competition.

[1] The exact amount of bonus points depends on the type of object support (*e.g.*, table or sofa). The *maximum* bonus is 8× (an object of this type in zone 1 will thus be worth 80 points).

- The original location of the toy will determine its value (see Fig. 1 for an example). If the robot destroys the scoring barcode placed on the toy, or disassembles the toy, no points will be allocated.
- If the robot deposits the toy at the collection point (see later), the full number of points will be awarded for that object.
- If the robot successfully retrieves the toy, but deposits it in the marked area near the collection point, only half the points for that object will be allocated.
- Any toy the robot is holding when the clock stops will be worth a quarter of the points for a *regular* object from its source zone. This means that objects with bonus points will count as normal ones!
- Any toy the robot deposits elsewhere does not earn any points.

The Arena

The arena used for the competition will have a size of 8 m × 8 m and consist of four different types of terrain, plus the collection point. An example arena configuration is shown in Fig. 1, but **this is given only as an example**, the actual setup might be slightly different.

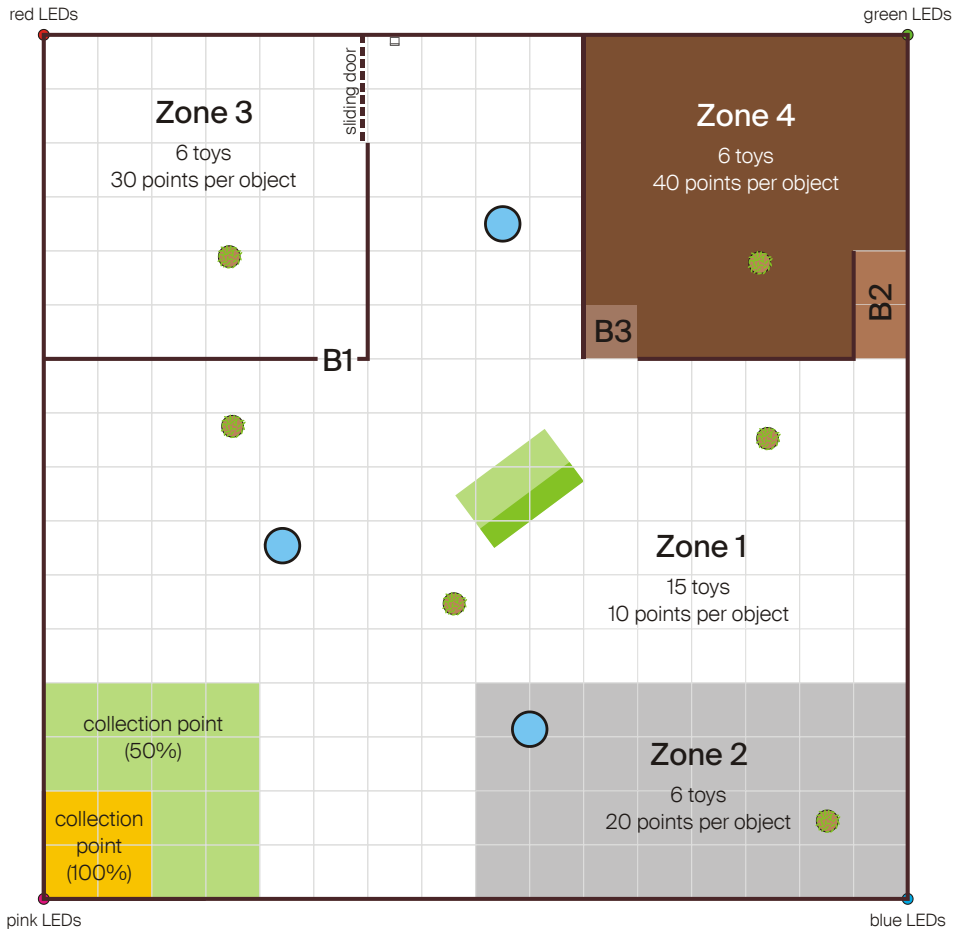

*Figure 1: An **example** arena configuration*

The different zones will be as follows:

- **Zone 1:** Carpet tiles, home furniture (*e.g.*, small table, couch).

- **Zone 2:** Moderately rough terrain, e.g., a thick carpet.
- **Zone 3:** Carpet tiles, but behind barrier **B1**, which is a wooden wall with a sliding door that the robot can open by pushing a big button placed on the wall. The exact position of the button will be visible as soon as the final arena is mounted.
- **Zone 4:** A raised platform at approx. 30 cm off the ground, which can be accessed via a gentle slope **(B2)** and some steps **(B3)**.
- **Collection point:** The carpet tiles are colour coded. The 1×1 m² surface near the corner will be yellow or orange; toys deposited on it earn the full points. The remainder of the 2×2 m² surface, with green tiles, gives 50% of the points of the toys it receives.

There will be obstacles (*e.g.*, plants, tables, couches, trash cans), randomly distributed in all the zones apart from the collection point, and being at a minimum distance of 50 cm from each other and from the walls. Obstacles will be randomly moved before each run. Each corner of the arena will be marked with a bright vertical strip of LEDs, coloured as shown in Fig. 1.

Budget

A real budget of CHF 750 will be available to each team to buy any additional required materials. **Before buying anything** —unless the expense is minimal, *i.e.*, less than 15 CHF— **it will have to be approved by your coach**. The detailed ordering procedure is explained on the robot competition web site, **any orders not following the procedure will be ignored, and orders directly placed by your team will not be paid or reimbursed**.

Furthermore, you will have an additional virtual budget of CHF 1'500 which can be used to purchase components that we have in stock (refer to the website for a list of items and virtual budget prices). You are also permitted to create your own parts, sending them to the EPFL professional workshops (cost as per their offer) or using the DLL-PROT facilities (all the cost will be debited on your virtual budget).

Parts bought from the internal catalogue that have been damaged by the team (*e.g.,* motors with broken ribbons) and can't be repaired **will be moved to the real budget**.

It is not possible to transfer money between the real and virtual budgets.

The Day of the Competition

All teams will be able to do their final calibration and adjustments during the morning. However, 30 minutes before the starting time of the competition (typically taking place at 14:00), **the arena must be completely freed** and the robots ready to compete.

Winning

The **competition winner** will be the team that accrues the most points for collecting the toys, according to the competition rules.

The team who wins the vote for the coolest robot, which will be carried out among the public just after the end of the competition, will earn the **coolest robot award**. The robot winning the competition is not allowed to win the coolest robot award at the same time.