V-REP Simulation Study

ACS6121, last updated on 07.02.2019

This assignment does NOT allow for group work. You must complete it on your own.

1 Overview

Your task is to design a control strategy for e-puck robots that do the following:

- explore the given environment to collect resources (*foraging*);
- while foraging, avoid collisions between robots and with the environment boundary.

For an object to be collected, a robot's centre must be within **5 cm** of the object's centre. There won't be any collisions between the robot and the object.

For the evaluation of this task, two foraging scenarios will be considered:

1. with a **single robot**;
2. with a **group of 5 robots** (all with an identical controller).

The controller used for both scenarios **MUST** be the same.

To assess the foraging performance of your strategy, you are expected to conduct **10 trials** per scenario. Each trial should last **60 seconds** of simulation time (note that the actual time that elapses on your watch/computer may be different.). Your report should include plots showing **the number of objects collected in total over time** (average and standard deviation over 10 trials). Include **one plot for each scenario**.

The simulation environment is shown in Figure 1. The simulations will be made using V-REP. An introduction to V-REP is provided in the Week 1 Tutorial. You must use the simulation project provided on MOLE (`scenes.zip`) as your starting point. Your are expected to design and implement a solution using the routines available in the software. **Important:**

- Do not use wheel speeds the e-puck cannot achieve. That is, when using function sim.setJointTargetVelocity(.,.), **make sure the velocity argument is bounded by [-6.24, 6.24]**.
- You should use the sensors available on the e-puck platform (e.g. camera, proximity). You may implement additional sensors, however, these must not provide any global information (e.g. absolute position or orientation) and you need to describe these in your report.

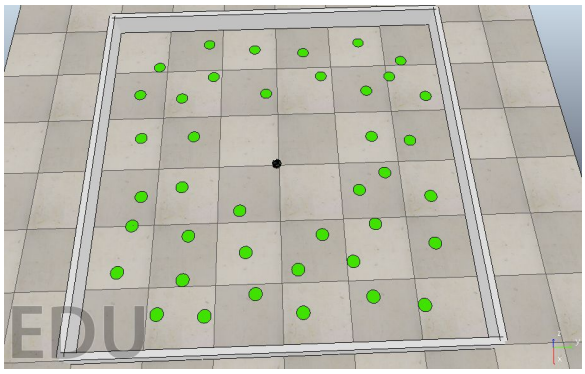

Figure 1. A snapshot taken from the V-REP simulation environment, showing 1 robot (in the centre) and 40 objects (green disks) to be collected. Once collected, an object changes its colour.

1.1 Installation

For the simulation environment, you will need to install **V-REP PRO EDU** (currently V3.5.0 rev4): http://www.coppeliarobotics.com/downloads.html

- **Windows users** download the installer and run it.
- **MacOS X users** download the zip file, extract it and move it to any folder to store it.
- **Linux users** download the file, extract it and from the terminal in the uncompressed folder run the following command: `./vrep.sh`

For **MacOS X users**, when first starting V-REP, a warning may popup, asking you to run in the terminal a command in the V-REP folder (e.g. `sudo xattr -r -d com.apple.quarantine *`). Please do so. Moreover, if you experience frequent crashes of the software, or the model tree (left side in the main window) is empty follow these steps:

1. Close V-REP;
2. Open a terminal window and navigate to the folder you unzipped (it should contain the file vrep.app);
3. In the terminal run the following command: `xattr -c -r *`;
4. Close the terminal and reopen V-REP.

1.2 Useful Information

Here are some links with information you might need or find useful while using V-REP:

- Regular API function list (by category): http://www.coppeliarobotics.com/helpFiles/en/apiFunctionListCategory.htm
- V-REP User Manual (There are also tutorials): http://www.coppeliarobotics.com/helpFiles/
- Vision Sensors/Filters: http://www.coppeliarobotics.com/helpFiles/en/visionSensors.htm

2 Report and source code

Both your report and source code have to be submitted via turn-it-in, no later than **Week 10, Monday, at 23:59pm.** For the source code, we need only the e-puck controller file (child script). Rename the file to **vrep.txt** and upload it to turn-it-in.

Your report should be **up to 2 pages** long (excluding appendix) and formatted using the standard **IEEE conference template**. The template for LaTeX or Word/OpenOffice can be found here: http://ras.papercept.net/conferences/support/support.php

Guidance on writing reports can be found on MOLE. This is an academic report, avoid using, for instance, “I”, “my”, “us”, and “we”. An example report in IEEE format (though longer than 2 pages and including sections that are not needed here) can be found here: http://dx.doi.org/10.1109/IROS.2014.6943114

The report should be structured as follows:

- Title: Come up with a meaningful title, but include “(ACS6121)” at its end.
- Author: Your name
- Affiliation: “The author is with the Department of Automatic Control and Systems Engineering, The University of Sheffield, UK” (placed on page 1, bottom of left column, according to template)
- Abstract: Describe in up to 100 words the content of your report (do not include details like “ACS6121”, your degree programme, the department name etc).

- Do not include any introduction section for this lab report.
- **I. Foraging Strategy** (section): describe your strategy on a high-level
- **II. Implementation** (section): describe how your foraging strategy (controller) has been implemented (referring to key elements of your source code, which is provided in the appendix).
- **III. Results and Discussions** (section): Describe the experimental setup (used to generate the data). Present the two plots - and describe what is being shown. Discuss critically the findings.
- Do not include any conclusions for this lab report.
- Appendix (section): Your source code properly formatted as text (no image), with syntax highlighting and line numbers. It can be in a **single column** format.

Marking criteria (report):

Points (out of 100)	Criterion
25	**General writing quality & formatting (10)** Presentation quality of report (excluding appendix). Organisation (title, author name, affiliation, abstract, sections, paragraphs, figures); writing quality and clarity (grammar, no typos, ambiguous/informal expressions, inconsistencies etc); adhering to standard conventions (IEEE format, figure captions, all figures referred to in text e.g. “Figure 1 shows… “; external images acknowledged in caption e.g. “Image reprinted from [x]”). **Abstract (5)** Motivating sentence providing some context. Stating the problem that is addressed. Stating what results are reported and summarising findings. **Appendix - source code (10)** Presentation quality of appendix (e.g. syntax highlighting, line numbers, consistent indentation, appropriate commenting).
25	**Quality of *foraging strategy*** Explain the foraging strategy you have chosen - how does is enable the robots to solve their task? Choose an appropriate level. For example, presenting source code or parameter values would be too low level (this would be *implementation*). You can get up to **15** points for the quality of the strategy itself, and up to **10** points for presenting it using suitable abstractions (e.g. finite state machine diagram, pseudocode, equations).
25	**Quality of the *implementation*** You can get up to **10** points for describing *how* the strategy has been implemented. Do not describe the strategy again. The implementation section should help the reader to understand how the source code (in the appendix) relates to the strategy (in the previous section).

	You can get up to **15** points for an efficient implementation. Are all lines of source code needed? Are you making best use of build-in commands? Does the code actually implement the strategy in a good way?
25	**Quality of *results and discussions* (critical analysis)** **17.5** points are for the single robot results. The remaining **7.5** points are for the group of 5 robots results. Note that in each case, only 5 points are awarded for performance. It is also crucial to explain how the data was obtained (so one understands what data it is), having meaningful plots, and a critical analysis.

Penalties: (Percentages of the overall mark)

- 10% penalty if source code not provided as text
- 10% penalty if appendix includes anything other than source code
- 10% penalty if report excluding appendix exceeds 2 pages
- Standard penalties for late submissions