
Robotics

Practical 7: Localisation Challenge

Andrew Davison
ajd@doc.ic.ac.uk

1 Introduction

The final practical of term consists of an easy to state localisation challenge, but I will not be giving you specific guidance on how to achieve it. You should use what you have learned in the previous practicals to design robots and algorithms which you believe will be most effective. In this challenge, accuracy and speed are both important. Importantly, we will give marks this week purely depending on the performance of your robot, and following our generosity in previous weeks *the marking scheme will be very tough!*

We will test and assess this practical in the final session of term, on **Thursday November 29th** in competition form. **The competition will start promptly at the start of the practical session at 11:00am.** You must have completed any practise, testing and training your method needs before the practical session starts. **Groups will be called up one by one in box number order for their first attempt, then will have another attempt in the second hour.**

You must be ready to go when I call your team number or you will miss your turn! Each team will get two attempts at the challenge — we will assess each one and only the better of the two will count. The team which achieves the highest number of marks, with the shortest time being used to resolve a tie, will be judged the winner and a small prize will be awarded.

This is the final ASSESSED practical. There are **10 marks** to be gained based on your performance in the challenge out of a total of 100 for the term. These accumulated marks form the only assessed coursework component of Robotics.

2 IMPORTANT: CATE SUBMISSION

In the Robotics course we have been providing regular and immediate feedback on your work via the in-lab assessments and I am glad to see that this has encouraged all of you to work hard and the standard of achievement on the exercises has been excellent. This work will set you in good stead for the final exam, the content of which is closely linked to the understanding you will have gained through the practical exercises.

I have explained that the coursework marks for Robotics have been accumulated week by week throughout term. Once this final practical is assessed, each team will have obtained a total number of marks out of 100. I will award each member of a group the same total unless there are any exceptional cases where we believe that the effort put in by some group members was much less than the others.

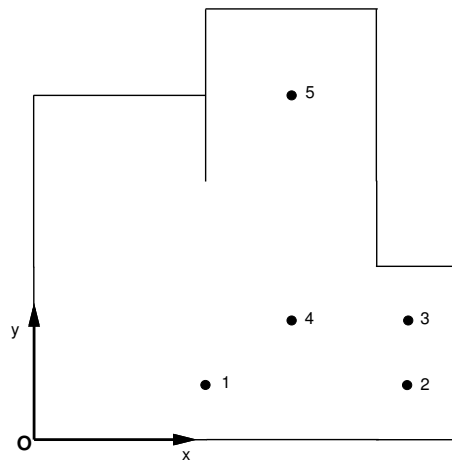
In order that I can enter the marks officially into CATE, I have set up a dummy ‘Cumulative Practicals’ coursework exercise for Robotics. Please log onto CATE straight away, and enter the details about the members of your group into the system. The exercise asks for a text file dummy.txt to be submitted but

this is just to keep CATE happy and it can be an empty file. I won't look at it. I DO NOT WANT YOU TO SUBMIT REPORTS OR ANY OTHER MATERIALS.

The deadline I have set for submitting the dummy exercise is the end of the day of the last practical (November 29th). However, since it is so easy to do please go ahead and so it straight away so I can make sure you get your marks immediately after the end of term.

3 The Goal

We will run the robots in the **same course area** which we have used for the MCL and Place Recognition practicals. As before, the floor surface in this course is the standard lab **carpet**. The courses will remain set up throughout the week so you can practise as much as you want.



For the challenge, we will use five of the marked waypoints from the MCL Practical; waypoints 1, 2, 3, 4 and 5 (the same as in the Place Recognition practical) as shown in the picture above which have the following coordinates:

Point	x	y
1	84	30
2	180	30
3	180	54
4	138	54
5	138	168

The timed challenge will consist of the following:

1. Your robot will be placed randomly by us in one of the five marked waypoint positions. The robot will be placed precisely in terms of (x, y) at the chosen waypoint, but at a **random orientation**. Timing will start when your program starts running.
2. Its goal is to work out where it is, then navigate as quickly as possible to all four of the other four marked waypoints in any order, and finally to return to the waypoint it was originally placed at. Note that the fact that the robot must return to where it started means that there is no obvious advantage to starting in any particular waypoint position.

3. Upon arriving at each of the four other positions, it should stop **for exactly one second** to signal that it thinks it has reached a waypoint. Note that this should be a **complete stop**, and none of the robot's motors should be active during the stop. Upon returning to the starting location it should stop for good. The orientation of the robot when it stops at the waypoints (including the final one) is not important, only its (x, y) position.
4. The purpose of the stops is so that we can reasonably judge whether the robot has arrived at the waypoints accurately and purposefully. A waypoint will be judged as achieved if the robot stops with its centre less than 20cm from the waypoint position, and more credit will be given for stopping within 10cm or 5cm of the waypoint (see the marking scheme below).
5. If your robot manages to visit every waypoint, additional marks will be given for its overall time, from program start to when the robot finally stops back at the original waypoint.

Design of the robots and choice of algorithms is up to you, though clearly a combination of the methods of the last two practicals on MCL and place recognition is the most obvious way to proceed and should allow you to make something that works from the code you have already developed. The following is another method that might prove useful. In this practical only we will not judge the choice of methods, but simply the performance of the robots, hoping to reward those groups who have used their knowledge to make robots that work really well in practice.

You should only use the standard equipment in one standard kit which is available to all the groups (in particular three motors, one sonar). Making your sonar directable by mounting it on the third horizontal motor might be useful for both place recognition and localisation while moving.

Also note that the walls of the course (apart from the long straight side which is the lab wall) are not necessarily solidly attached to the floor and so bumping off them is not a good strategy. I am assuming that sonar and odometry will be your means of knowing where the robot is.

4 Judging and Scoring

Points will be assigned as follows out of a maximum of 25, based on the **best** run that your robot achieves from the **two attempts allowed**. Note that we will go through all the groups to have one attempt each first, and then do a second round for everybody so there will be a little time to adjust your robots in between, though you must be ready when your group is called. Also, we will make sure that your two attempts are from different starting waypoints.

1. Up to **5 points** for successful recognition of the starting location of the robot. For most robots which successfully go on to navigate through the course we will generally assume that this implies successful recognition and award 5 points here. For robots that do not manage to successfully proceed to further navigation we will award up to 5 points based on a subjective assessment of the quality of the attempt at place recognition (based on whether it does a successful circular scan and any visualisation you can show us for instance).
2. Up to **3 points per waypoint** for stopping accurately at each of the 5 waypoints: **3 points** for an error of less than 5cm, **2 points** for an error of less than 10cm, and **1 point** for less than 20cm. Remember that the robot should stop for one whole second to indicate clearly that it thinks it is at a waypoint — we will only judge its accuracy when it does this. We will judge these accuracy points based on whether the 'centre' of your robot is within circles we will mark on the floor with

5cm, 10cm and 20cm radii. We will assume that the centre of your robot is the point precisely halfway between the wheels unless you tell us that you have defined it otherwise.

3. Up to **5 points** for the total time taken (from starting the program until the robot returns to its original position and stops). These will be awarded *only if the robot gains at least one point at every one of the five waypoints for stopping correctly.*

Total time: 0–45 seconds	5 points
45–60 seconds	4 points
60–75 seconds	3 points
75–90 seconds	2 points
90–120 seconds	1 points
slower	0 points

This scoring scheme is **tough** but should allow the best teams to shine through.

The winner of the challenge will be the robot which obtains the most points, with a tiebreak on the same number of points being decided by the quickest time.

5 Marking

I will record every team's best score out of the two runs, and scale your best points score out of 25 down to a mark out of 10 by multiplying by 0.4 (rounding up to the next integer!)

6 Finish and Tidy-Up

Straight after the competition, we need to collect up the robot kits and tidy up the lab. Please:

- Disassemble your robot. Into your numbered plastic box please pack:
 - Raspberry Pi and BrickPi (these can be left together in their perspex case)
 - Wi-fi dongle
 - SD Card
 - Battery
 - Y-cable (power cable for BrickPi)
 - Battery charger
 - HDMI cable
 - SD Card reader
 - 3 motors
 - 1 sonar
 - 2 light sensors
 - 2 touch sensors

- Empty your locker.
- Return your plastic box to us together with your locker key. We will sign these back in and I won't give any groups a coursework mark until you have returned your box and key!
- Return all other Lego parts to the drawers. Please separate your Lego cables and wheels and put those into drawers 3 and 4. All other parts can be put unsorted into any of the drawers 7–18 in trays.
- If you have tape measures, scissors, sticky tape, pencils, etc. please put these into drawer 6.
- Please help us to have a general tidy up of any Lego or other Robotics bits which might be lying around the lab. Thank you.