

Computer, Engineering and Media – Coursework Brief 2019/20

Module name:	Mobile Robotics		
Module code:	IMAT3404		
Title of the Assignment:	Implementation of a Robot Controller		
This coursework item is: (delete as appropriate)	Summative	Formative	
This summative coursework will be marked anonymously:	Yes	No	
The learning outcomes that are assessed by this coursework are: <ol style="list-style-type: none"> 1. Design and implement one or more autonomous robot controllers capable of solving complex predefined tasks. 2. Demonstrate an understanding of the theory of mobile robotics, including hardware and software factors of sensor design, software issues of a range of controlling architectures and some advanced aspects such as adaptive and group behaviour. 			
This coursework is: (delete as appropriate)	Individual	Group	
This coursework constitutes 100% of the overall module mark.			
Date Set:	18 February 2020		
Date & Time Due:	Friday 3 April 2020 at 12.00 pm midday		
Your marked coursework and feedback will be available to you on: If for any reason this is not forthcoming by the due date your module leader will let you know why and when it can be expected. The Associate Professor Student Experience (CEMstudentexperience@dmu.ac.uk) should be informed of any issues relating to the return of marked coursework and feedback. Note that you should normally receive feedback on your coursework by no later than 20 University working days after the formal hand-in date , provided that you have met the submission deadline.			6 May
When completed you are required to submit your coursework via: Submission via Blackboard ONLY . See detailed description on next pages. If you need any support or advice on completing this coursework please visit the Student Matters tab on the Computing, Engineering and Media Blackboard page.			
Late submission of coursework policy: Late submissions will be processed in accordance with current University regulations which state: “ <i>the time period during which a student may submit a piece of work late without authorisation and have the work capped at 40% [50% at PG level] if passed is 14 calendar days. Work submitted unauthorised more than 14 calendar days after the original submission date will receive a mark of 0%. These regulations apply to a student’s first attempt at coursework. Work submitted late without authorisation which constitutes reassessment of a previously failed piece of coursework will always receive a mark of 0%.</i> ”			
Academic Offences and Bad Academic Practices: These include plagiarism, cheating, collusion, copying work and reuse of your own work, poor referencing or the passing off of somebody else's ideas as your own. If you are in any doubt about what constitutes an academic offence or bad academic practice you must check with your tutor. Further information and details of how DSU can support you, if needed, is available at: http://www.dmu.ac.uk/dmu-students/the-student-gateway/academic-support-office/academic-offences.aspx and http://www.dmu.ac.uk/dmu-students/the-student-gateway/academic-support-office/bad-academic-practice.aspx			
Tasks to be undertaken: See detailed description on next pages.			
Deliverables to be submitted for assessment: See detailed description on next pages.			
How the work will be marked: See marking scheme on next pages.			
Module leader/tutor name:	Pamela Hardaker & Liz Felton		
Contact details:	Pamela.Hardaker@dmu.ac.uk & Elizabeth.Felton@dmu.ac.uk		

Specification

Your task is to write a program to demonstrate the following behaviours on a robot using a behavioural control architecture of your choice (you will need to justify your choice in the final submission report). You can use the PeopleBot robot on the V-Rep/CoppeliaSim simulator used in the labs or you can choose another simulator or physical platform.

A. Obstacle avoidance

- The robot should not collide with any walls or obstacles.

B. Wandering

- When no walls or objects are detected the robot should move in a straight line for a suitably limited random distance or period of time.
- The robot should then turn in a random direction (ie left or right) by a randomly chosen angle.

C. Edge Following

- The robot should follow any edges detected at a constant sensible distance (eg 1 metre) and as fast as possible.
- Edge following should make use of an appropriate feedback control methodology. This controller needs to be well tuned and tested. Higher marks may be awarded for more advanced control techniques used.
- The robot should leave the edge following behaviour when the end of a line has been reached.

D. Mapping

- While moving in the chosen environment the software should construct a map from valid sensor data as recorded by the robot's sensors.
- Possible solutions may vary but could include the online creation of a scattergram map (the use of libraries such as SFML, open-gl, etc. is permitted) or the offline creation of a map using more advanced techniques such as RANSAC.

E. Console

- The robot must output the following information to the console, or other output screen, **AT ALL TIMES**.
 - The state the robot is currently in
 - The distance to nearest object on the left and right of the robot
 - The current speed, heading and position
 - The RMSE in edge following

Deliverables

There are two deliverables for this coursework. A report on your work and a demonstration of the functionality of the program.

REPORT

Your report should be no more than **SIX** sides of A4 and no more than **2,000 words** (**EXCLUDING** the title page, bibliography and appendices) and should include at least the following:

- Introduction
- Avoid and wander strategies.
- Behavioural control architecture choice and justification for implemented techniques.
- Edge following feedback methodology choice and justification for implemented techniques.
- Testing of behaviours to confirm their operation to specification, including detailed measurements (put full testing schedule in appendix if large to save word count).
- Conclusions drawn, including highlights of any problems and solutions you discovered
- Complete bibliography
- Full code listing in appendix in TEXT FORMAT – **NOT PICTURES**.

DEMONSTRATION

You will need to demonstrate the functionality of your robot by some method such as a video of your screen or a live demonstration to a tutor if you are using a simulator or a live demonstration in the robot lab if you are using a physical robot.

The demonstration should cover the following as a minimum.

AVOID – The robot should be able to move in an area containing obstacles without hitting anything.

WANDER – When in an open area, the robot should wander as specified with a suitable display of the angle of turn that has been executed each time it changes.

EDGE FOLLOWING – When the robot detects an edge it should start following it at a set distance with a suitable display of the RMSE at all times.

MAPPING – A map of the robot's surroundings should be created and shown either during, or after the demonstration.

VIDEO DEMONSTRATION NOTES

- If you are videoing your demonstration please ensure that the video quality is sufficient to read the console print-outs and simulation results.
- You should submit no more than five videos in total, with a total length of **ALL** your videos being no longer than 5 minutes. Submit all videos in **one** ZIP file.
- You may speed up or edit the video if you want to show the robot traverse a whole wall or show it roaming around a map.
- You can use a voice over, captions or give a commentary in a text document if you want to add extra detail.

LIVE DEMONSTRATION NOTES

- If you want to demonstrate your program live to the tutor please book a slot in a lab and you will be given 5 minutes in which to demonstrate your functionality which the tutor may video to add on to your submission.
- You will need to prepare your submission in such a way that you can show each task and give a suitable commentary.

SUBMISSION

For the final submission of your coursework you will need to upload in **TWO**, possibly **THREE** different places:

1. REPORT -> TURNITIN - **COMPULSORY**

- You need to upload your report through TURNITIN.
- Your report **must include** all your **code in TEXT** in the appendix so that your code can be checked for originality.

2. CODE -> ASSIGNMENT SUBMISSION - **COMPULSORY**

- You need to upload a zip folder containing all your code (incl. project files, executable, etc) to the Assignment Submission link.

3. VIDEO -> PANOPTO - **OPTIONAL**

- If you are demonstrating your robot by video you should submit this through Panopto

Non-submission of any of the above may lead to a significant reduction of marks and potentially a fail.

MARKING SCHEME

Task	Weight	0-29	30-39	40-49	50-59	60-69	70-89	90-100
Wander:	5%	Robot doesn't move	Robot moves but does not follow a random wander strategy	Robot randomly turns left and right	As for 40-49 plus moves for a random distance in between	As for 50-59 plus movement adjusted based on where it has already been	As for 60-69 plus robot uses a strategy to maximise the area explored	Innovation
Avoid:	10%	Robot doesn't avoid	Robot doesn't avoid correctly	Robot stops and turns away from object on most occasions	Robot stops and turns away from object on nearly all occasions	Robot anticipates approaching object and takes early evasive action	Robot uses multi sensor approach to anticipate approaching objects and takes early evasive action	
Line follow:	20%	Robot doesn't follow lines	Robot doesn't follow lines correctly, or cannot 'stick' to a line	Robot follows line with large oscillation, stops/starts, or other unintentional effects	Robot follows the line reasonably accurately after a few oscillations and strategy is good	Robot follows the line accurately after one or two oscillations and strategy is excellent	Robot moves into its line following strategy smoothly in conjunction with other functionality	
Mapping – calculation:	15%	Robot doesn't produce a map	Robot attempts to make a map but with significant issues	Robot tries to calculate obstacle locations but is inaccurate	Robot calculates basic obstacle locations successfully	Robot calculates obstacle location successfully using a validation strategy	Robot calculates obstacle locations successfully & validates data in an appropriate manner, without impact to other functionality	
Mapping - display:	5%	No map display	Map does not display properly	Map has to be generated and viewed manually offline	Map has to be viewed offline or map can be viewed in real-time but must be manually refreshed	A real-time map is available (including a real-time version of an offline mapping method)	Map is shown in real-time, with efforts made towards making the map easier to understand or use	
Console display	5%	No console display	Console does not display all content asked for	Basic console display is present but presentation is difficult to use or understand	Basic console display shows all desired elements clearly	Console display shows all desired elements well with added functionality or information.	Excellent console display with all desired elements, added functionality and information.	
Testing:	10%	No testing	No substantial testing carried out	Basic testing carried out and simple reporting	Basic testing carried out with reasonable reporting	Good testing carried out with reasonable reporting	Excellent testing carried out with in depth reporting.	
Report	30%	No report submitted	No report of any substance, or report is incomplete	Basic report giving minimal detail; report is difficult to understand; major problems with spelling and grammar	Reasonable report giving fair detail; report is sensibly-structured with reasonable spelling and grammar, clearly justifies design choices and has a suitably referenced literature review	Good report giving good detail; report is well-structured and referenced; few to no spelling or grammar errors and has a suitably referenced literature review	Excellent report and referencing which gives enough detail to allow work to be recreated; report is well-structured and follows a logical chain; few to no spelling or grammar errors and has a suitably referenced literature review	

Please note the weighting of **EACH** topic indicated in the marking scheme.