Faculty of Technology – Coursework Specification 2017/18

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: 1. Design and implementation of autonomous robot controllers capable of solving complex predefined tasks. 2. Understanding of the theory of mobile robotics, including software issues of a range of controlling architectures.			
This coursework is: (delete as appropriate)	Individual	~~Group~~	
This coursework constitutes 60 % **of the overall module mark.**			
Date Set:	**17 November 2017**		
Date & Time Due:	**Friday 16 February 2018 at 12:00 PM (noon)**		
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 Head of Studies (headofstudies-tec@dmu.ac.uk) should be informed of any issues relating to the return of marked coursework and feedback. [a] 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.	**Friday 6 April 2018**		
When completed you are required to submit your coursework via: 1. Turnitin for the report 2. Online submission area for zipped folder of code files **AND** video files			
Late submission of coursework policy: Late submissions will be processed in accordance with current University regulations which state: *"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%."*			
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:

Your task is to write a program for the PeopleBot robot on the MobileSim simulator to demonstrate the following behaviours using a behavioural control architecture of your choice (you will need to justify your choice in the final submission report):

A. Obstacle avoidance

The robot should detect any obstacles that come to within 0.5 m of it and avoid them.

B. Wandering

- When no objects are detected within 1.5 m, the robot should move for a random distance between 0.5 m and 1.5 m at a speed of 0.2 m/s.
- The robot should then turn by a randomly chosen angle between -140º and 140º relative to its current heading.

C. Edge Following

- The robot should follow any wall edges detected at a constant distance of 1.0 m and at maximum speed.
- Edge following should make use of an appropriate feedback control methodology. This controller needs to be well tuned and tested.
- The robot should leave the edge following behaviour when the end of a wall edge has been reached.

Completing behaviours A, B and C to a satisfactory standard can only earn you a pass mark.

To get a higher grade you will need to complete one of the following more advanced behaviours:

D. Mapping

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. Path Planning

Plan and follow a path from a pre-determined start point to a pre-determined end point in a given known map which you should be able to load into your program.

Calculate a new route if the map is changed and reloaded.

Possible solutions may vary but could include a path created from grid based or A* search planning.

NOTE: All four behaviours MUST be running at the same time – ie avoidance, wandering, edge following and mapping or path planning.

Deliverables to be submitted for assessment:

Video/s: Submit a video or series of videos of your screen showing your robot completing the four tasks outlined below.

1. Navigate through the mine map without hitting any object.
2. Demonstrate wandering in the square-map with suitable print outs to the console to show what distance has been travelled before turning and what angle of turn has been executed.
3. With the trace function turned on in the simulator follow the inside line of the parallelogram, circular and star maps. Identify any problems the robot experiences.
4. Path planning or mapping in the mine map.

NOTES:

- You should submit no more than four videos in total, with a total length of **ALL** your videos being no longer than 5 minutes (you can speed up or remove irrelevant sections if necessary).
- Submit all videos in **one** ZIP file through the link on BlackBoard.
- You may record your screen with a camera such as your mobile phone or with software installed at home such as http://www.ezvid.com/ or you can use Microsoft Expression which is installed on the lab computers. Please ensure that the video quality is sufficient to read the console print-outs and simulation results.
- As part of the video submission please show via console print-outs:
    - The state the robot is in at any time (ie avoidance, wandering, edge following and mapping or path planning)
    - The distance to the nearest object
    - The current speed, heading and position
    - The RMSE in edge following
- You need to explain what is happening in your videos by either recording a voice commentary (recommended) or adding on screen captions.

Report: Submit a report through TURNITIN of

NO MORE THAN SIX SIDES OF A4 AND NO MORE THAN 3,000 WORDS

(**EXCLUDING** the title page, bibliography and appendices)

The report should include at least the following:

- Behavioural control architecture choice and justification for implemented techniques.
- Testing of behaviours to confirm their operation to specification, including detailed measurements.
- Conclusions drawn, including highlights of any problems and solutions you discovered
- Complete bibliography
- Full code listing in appendix.

Code: A zip folder containing all your code (incl. project files, executable, etc.).

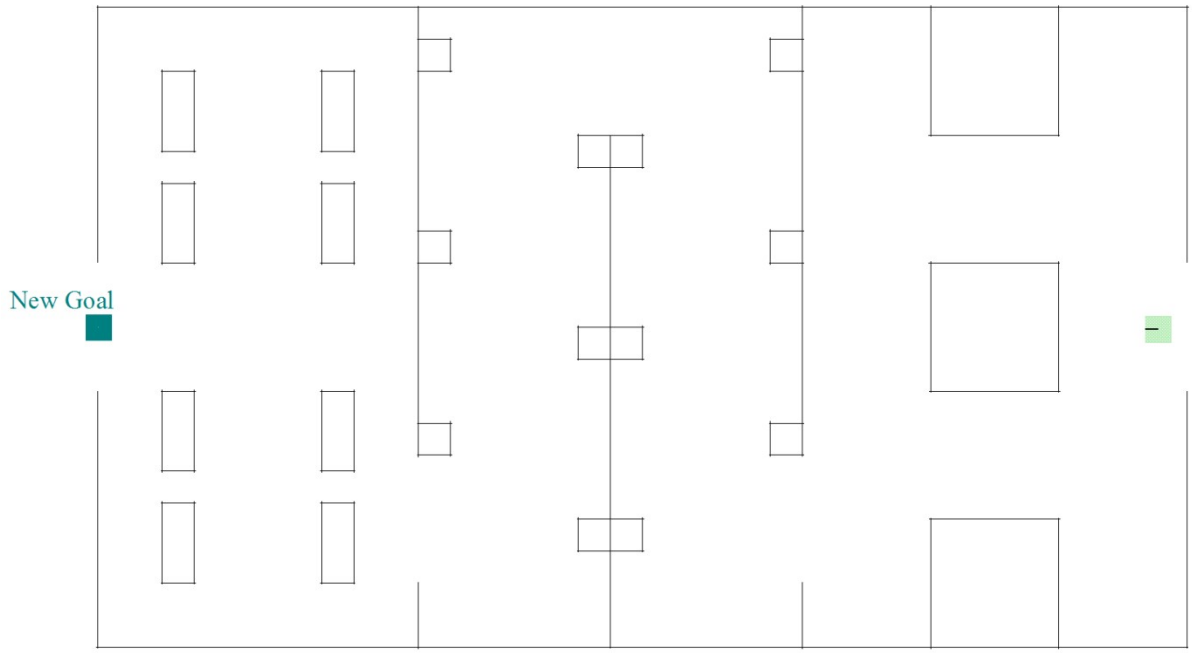
Non-submission of any of the above may lead to a significant reduction of marks and potentially a fail.

Please note the weighting of these topics as indicated in the marking scheme below.

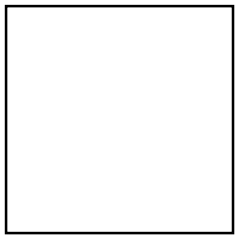
How the work will be marked:
PLEASE SEE MARKING SCHEME AT THE END

Module leader/tutor name:	Pamela Hardaker
Contact details:	Pamela.Hardaker@dmu.ac.uk

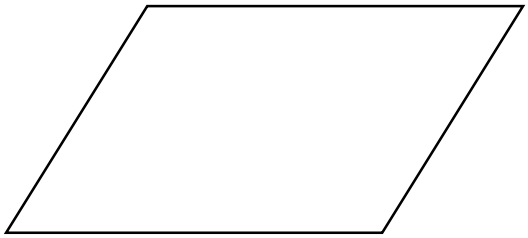
Mine-map



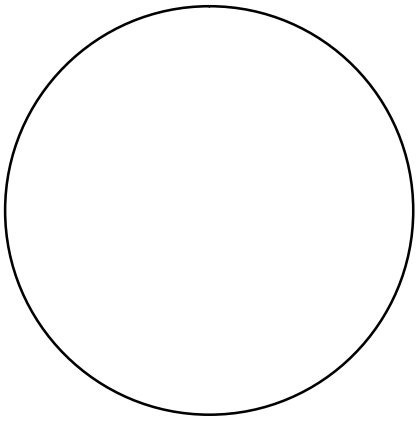
Square-map



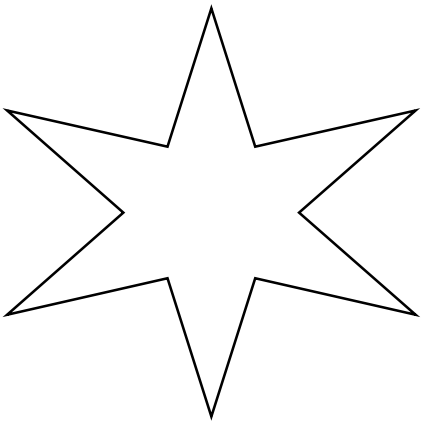
Parallelogram-map



Circular-map



Star-map



Marking Scheme

MARKS	0	1	2	3	4	5
Obstacle avoidance Max – 5 marks	No video submitted	Minimal attempt only	Implemented with only basic functionality or functionality is partially incorrect	Implementation has been attempted but functionality limited	Implemented with reasonable functionality which is correct	Implemented well with good functionality
Wandering Max – 5 marks	No video submitted	Minimal attempt only	Implemented with only basic functionality or functionality is partially incorrect	Implementation has been attempted but functionality limited	Implemented with reasonable functionality which is correct	Implemented well with good functionality
Edge following Max – 5 marks	No video submitted	Minimal attempt only	Implemented with only basic functionality or functionality is partially incorrect	Implementation has been attempted but functionality limited	Implemented with reasonable functionality which is correct	Implemented well with good functionality
Behavioural Control and Architecture Max – 5 marks	No architecture chosen, explained or justified.	Basic effort has been made to choose/ implement/ a sensible architecture.	Some effort has been made to choose/ implement/ justify a sensible architecture.	A sensible architecture has been selected and implemented but with no justification.	A sensible architecture has been selected and used to implement basic behaviours. Some justification of the controller has been done.	A sensible architecture has been selected and used to implement the required behaviours and this selection is well justified.
Coding Standards Max – 5 marks	No code submitted	No coding standards.	Poor coding standards.	Reasonable coding standards.	Good coding standards.	Excellent coding standards.
MARKS	**0**	**1-2**	**3-4**	**5-6**	**7-8**	**9-10**
Testing Strategy Max – 10 marks	No testing/analysis carried out	No substantial testing/analysis carried out.	Limited number of tests/analysis carried out.	Testing/analysis is reasonable but lack depth.	Testing/analysis is well designed with some limitations.	Testing/analysis is well designed and thorough.
Documentation/ Implementation Max – 10 marks	No report submitted	No report of any substance	Report does not detail implementation and justification sufficiently.	Report gives basic details of implementation and justification but lacks depth	Report gives reasonable details of implementation and justification.	Report gives good details of implementation and justification. Report is well structured and presented.
MARKS	**0**	**1-3**	**4-6**	**7-9**	**10-12**	**13-15**
Mapping **OR** **Path planning Max – 15 marks**	No mapping or path planning attempted	No map created **OR** No path planned	An attempt at mapping using a suitable mapping technique. Map does not appear. **OR** An attempt has been made at path planning but map doesn't load or route is Incorrectly calculated.	An attempt at mapping using a suitable mapping technique. Map appears but is incorrect **OR** An attempt has been made at path planning, map loads but route is incorrectly calculated or robot does not follow it properly.	A suitable mapping technique has been used to create a reasonable map. **OR** Map loads and a reasonable route is correctly calculated. Robot makes a reasonable attempt to follow the path.	A suitable mapping technique has been used to create and display a good map in real-time. **OR** Map loads and a good route is correctly calculated. Robot follows the path well.

Notes:

- **Bold numbers indicate marks achievable if the criteria in the same field are fully satisfied.**
- **Failure to prove ownership of any part of the work may lead to a fail.**
- **If you have any questions about this PLEASE ASK**