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| **University of Chester -** Postgraduate Programmes Assignment Specification  **Faculty of Science, Business & Enterprise**  **Department of Computer Science** | | | |
| **Module No**  CO7316 | **Module Title**  Robotics | **Assessment No**  1 | **Weighting**  100% |
| **Submission Date**  10th October at 17:30 | | | **Feedback due by**  10th November 2024 |
| **Assignment Title**  Project Grant Proposal | | | |
| **Learning Outcomes Assessed**   1. Demonstrate a critical awareness of the capabilities of artificial intelligence and robotics. 2. Apply theoretical solutions to issues of robotics. 3. Critically analyse the role that systems such as neural networks or software agents, for example, can play in the development of robotic technologies. 4. Critically evaluate how organisations in various domains can utilise intelligent hardware. 5. Use suitable software tools to: design, implement, test, document and evaluate software that demonstrates intelligence, or to design an intelligent architecture within robotics. | | | |
| **Submission Information**  For projects that include programming code:  The TurnItIn submission box will have multiple parts. You must submit to the appropriate part   * A PDF file containing your report followed by a reference list in APA format, and all programming code from your project in an appendix (in a monospace font) at the end. * Either a ZIP file or a Word document containing a link to a OneDrive folder containing the project and video   Both files must be named with your assessment (J number), e.g. J123456.pdf and J123456.zip. The name for each entry on TurnItIn must also be your assessment number.  Files submitted in an incorrect format will usually be marked as zero.  All components must be submitted to avoid receiving a mark of zero.  Any late work penalties for assignments will be calculated using the latest submission date/time. | | | |
| **Extensions**  Extensions should be requested through the online system available on the Registry services pages on [Portal](https://v3apps.chester.ac.uk/oed/#!start). Late work is penalised at the rate of 5 marks per day or part thereof.  **Academic Conduct** The material you submit must be your own work. Please avoid colluding with peers on your work. The penalties for breaching the academic conduct policy are severe. The minimum penalty is usually zero for that piece of work. Further information is available at Portal > Support Departments > Academic Services > Academic Standards > Academic Conduct > Information for Students > [Academic Conduct](https://portal1.chester.ac.uk/aqs/Pages/aqss-academic-conduct-information-students.aspx) | | | |
| **Generative AI The use of generative AI tools where not permitted will be treated as a breach of the academic integrity policy.**  **This assignment does not permit the use of any generative AI tools, including but not limited to ChatGPT, Bard, Copilot, Midjourney, and others.** | | | |
| **Referencing code**  Code adapted from third parties must be clearly referenced using comments to denote the start and end of the adapted code. You must also include an APA format reference in the PDF file.  **Example of referenced code**  *//code adapted from Thomson, 2012* **if** (someCharacter == **'z'** || someCharacter == **'Z'**) {  someCharacter -= 25;  } **else** {  someCharacter += 1; } //end of adapted code  **Example of reference entry in PDF file** Thomson, C. (2012). Rot-13 function in Java?. Stackoverflow. Retrieved October 25, 2021, from <http://stackoverflow.com/questions/8981296/rot-13-function-in-java> | | | |

**Assignment Brief**

**Introduction**

This assignment places you in the position of requesting funding to build a robot. To secure this funding you must argue the purpose of your robot, e.g., what service does it provide, what impact it will have and what requirements it must meet. The purpose of your robot is for you to decide, and it can be in any domain of your choosing. However, robots must not have weapons or contain any form of sexual content. You must discuss the physical design of your robot, justifying every motor, hinge, and sensor. You must also describe the control system that you will use. The control system should be hypothetical and involve algorithms/techniques to achieve the requirements that your robot is designed to meet. And you must discuss any ethical implications your robot will have.

**Video**

The funding body has requested that you provide a video (e.g., MP4, MOV or WMV) of a 3D simulation demonstrating your robot working on the task that you have specified. This video will fully demonstrate the purpose of your robot and its intended purpose. You are not required to implement a fully functional control system but doing so may award you extra marks. For example, a keyboard-controlled robot with a highly detailed discussion of its control system may achieve the same marks as an autonomous robot with a less detailed discussion.

**Simulator**

The recommended tool that you should use for this 3D simulation is Webots:

Webots is an open source robot simulation tool (<https://www.cyberbotics.com/#webots>). Follow the tutorials available at <https://cyberbotics.com/doc/guide/> to learn how to use the Webots package, along with the videos and discussions on the CO7316 Moodle page.

Webots allows you to record simulations, but you may use a screen recorder, such as OBS Studio, to record your simulations. If your video is too large for submission, then a OneDrive link in your report is a recommended alternative. You are allowed to submit multiple videos to demonstrate different actions that your robot performs, no extra marks will be awarded for editing multiple scenes into a single video. However, if you do wish to edit your videos then Adobe Premier Pro is available on the university machines.

Notes of importance:

Your robot should be significantly different to the tutorial robot and must NOT be an already existing robot.

You MUST include at least 1 robot of your own design which has been built using the simulator’s tools. Already existing robots from within Webots, e.g., e-puck or UR5e, will not be awarded any marks. Other Webots robots may be used to support your robot, but you MUST have 1 of your own design.

You may build a robot similar to an existing robot, but you must make sure you have some minor differences (which are detailed in the report) and you must have built the robot yourself, i.e., you did not import a robot and then make a minor modification to it.

Please see the task break down on the next page.

**Task Breakdown:**

1. Write a report (approx. 3000 words) detailing (**70%**). Word count penalties will be applied.
   1. The task the robot will perform (**10 Marks**)
      1. Describe the purpose of the task, i.e. why is it important. You should use statistics and other information from the literature to evidence why this task is important.
      2. Give justifications of why this task should be performed by a robot. These justifications should also be supported by the literature, e.g., if you say a job is dangerous then you should provide some discussion of statistics to support your claim.
   2. Literature review detailing what robots currently exist in this area **(20 Marks)**
      1. Describe similar robots to yours and discuss what impact they have had when used to solve a similar problem to what you have suggested.
      2. Discuss what they do well vs what they struggle with. Discuss these strengths and weaknesses in detail, explaining how and why they exist.
   3. Discuss the design of the robot (**15 Marks**)
      1. Why you have designed it this way, in relation to the task. You must discuss all aspects of the design, e.g., size, shape, wheels, sensors, weight, etc. Images should be used to help discuss your design, with important components clearly highlighted for discussion.
      2. Discuss how the robot moves and its degrees of freedom. This needs to be more than just a claim of how many degrees of freedom the robot has. You should discuss all joint and actuators to explain the degrees of freedom provided. You should also reference the literature to support why the suggested degree of freedom will be suitable for the task at hand.
      3. Detail all sensors, motors, actuators, etc., that you have used and why. This should be a comprehensive discussion of each sensor, motor, etc., with details of their position, range and capabilities. Each sensor will need to be justified in relation to the task, preferably with references to the literature supporting why they were chosen.
   4. Discuss the control system of the robot (**10 Marks**)
      1. Mention whether your robot is autonomous, or keyboard controlled in your simulation. If your robot is keyboard controlled then DO NOT discuss it in detail, concentrate on the hypothetical control system that you would implement if you were given the funding to build the robot.
      2. Discuss the level of autonomy your robot has and what it can do, if your robot(s) are keyboard controlled then this will be hypothetical, i.e., what would be automated if it wasn’t controlled by the keyboard. You should discuss aspects such as navigation algorithms, machine learning algorithms, computer vision etc., to explain your control system. This should be highly detailed and MUST reference the literature. These algorithms should be discussed in relation to the task at hand, i.e., demonstrating your understanding of the algorithm and how it can be adapted to your problem.
      3. The limitations of your robot and how you may get around them. These can by physical or control system limitations which are indicated by your design. For example, your robot may have to navigate around pedestrians, so you should discuss issues that robots in the literature demonstrate when attempting to solve this problem.
   5. Evaluation of the robot’s performance in the simulation (**15 Marks**)
      1. Strengths and weaknesses of your robot. These should be justified by your design choices, e.g., a flying robot may not be able to carry heavy loads.
      2. How your robot compares to other robots you reviewed in the literature. Discuss your robot in relation to similar robots, e.g., how you think a bi-pedal robot will manage against the 4-wheel drive robots discussed in the literature.
2. Build your robot and its controller using a 3D simulation tool, such as Webots. (**30%**)
   1. Produce a 3D simulation (**15 marks**)
      1. Containing your robot(s) and any obstacles or elements it will interact with. This robot should of your own design and not too similar to the tutorial robot.
      2. A simulation to play out by simply pressing a play button (if you use another tool then please provide instructions).
      3. When you submit your project, it MUST contain all the following folders:

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Description automatically generated

* 1. Write a controller to operate your robot either autonomously or keyboard controlled and append your controller code to your report for Turnitin plagiarism detection (**10 Marks**)
  2. Record a video of the simulation – this recording should show exactly what your robot(s) is/are doing. If you are using keyboard controls then you should demonstrate a good example of the robot(s) functionalities. (**5 Marks**)

**Assessment Criteria**

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| **Report** |  |  |
| 1a | 8-10 | Highly detailed description of the scenario, with accurate references from peer reviewed sources to provide a strong justification for the use of a robot. |
|  | 7 | Detailed description of the scenario, with good use of referencing to support your arguments. |
|  | 6 | Good description of the scenario, but lacks detail regarding to purpose, justifications, and reasons for the scenario. Good use of references. |
|  | 5 | Simple description of the scenario with some attempt to justify the robot/scenario. Referencing has been used but there are some mistakes. |
|  | 4 | A short description of the scenario with little justification or referencing provided. |
|  | 2-3 | Scenario is explained, but no justification is provided. |
|  | Below 2 | Scenario is mentioned but not explained. |
| 1b | 17-20 | Thorough discussion of the robots that currently exist with detailed justifications of what makes them effective. The literature review shows a detailed understanding with solid discussions of the robots and how they have been used effectively. The review will also discuss technical aspects in good detail. |
|  | 13-16 | A good discussion of the robots that currently exist. Justifications are there but are superficial in places, e.g., providing just a reference when an explanation is also needed. Some technical aspects are discussed but not in great detail. |
|  | 9-12 | A good discussion of the robots but the discussion is more anecdotal than in detail. Justifications are weak, with only mentions of what they do and no real discussion of how/why they can perform the task. Some technical aspects are discussed but not in any detail. |
|  | 6-8 | The discussion has some misunderstandings, or the robots have been poorly described. No context or understanding has been demonstrated and the discussion only describes the robot at a superficial level. |
|  | 2-5 | The discussion is very short with only brief mentions of some robots in the literature. |
|  | 0-1 | The report has omitted any discussion of robots in the literature. |
| 1c | 12-15 | Highly detailed description of the robot, with accurate references from peer reviewed sources to provide a strong justification for the use of a motors/sensors/actuators. |
|  | 10-11 | Detailed description of the robot, with good use of referencing to support your design. |
|  | 9 | Good description of the robot, but lacks detail regarding to purpose, justifications, and reasons for the design. Good use of references. |
|  | 8 | Simple description of the robot with some attempt to justify the design. Referencing has been used but there are some mistakes. |
|  | 5-7 | A short description of the robot with little justification or referencing provided for the design. |
|  | 3-4 | Robot is explained, but no justifications are provided. |
|  | Below 3 | Robot is discussed but not explained. |
| 1d | 8-10 | Highly detailed discussion of the robot’s control system, with a strong depth of knowledge of all the possible problems that may be faced and how they can be solved. These marks are reserved for students who managed to achieve interactions between two complex robots. |
|  | 7 | Highly detailed discussion of the robot’s control system, with a strong depth of knowledge of all the possible problems that may be faced and how they can be solved. |
|  | 6 | Report shows some insight into the problems that may/did occur and how the controller may/was programmed to avoid these issues. |
|  | 5 | The details on potential problems that may/were faced are lacking in detail but are present. The student shows some understanding but not to any real depth. |
|  | 4 | Problems were mentioned but not fully discussed or resolved. The student clearly attempted the scenario but lacked the understanding to discuss the issues properly. |
|  | 2-3 | A weak attempt has been made to discuss the problems that may be faced or how to solve them. |
|  | Below 2 | Little to no attempt has been made to show any problem-solving using robotics. |
| 1e | 12-15 | A highly detailed evaluation of the robot’s performance with a strong reflection on the capabilities of machines in literature. |
|  | 10-11 | A detailed evaluation of the robot’s performance has been made. There is a reflection to the robot’s capabilities to machines in literature, but they are not necessarily peer reviewed. |
|  | 9 | A detailed evaluation of the robot’s performance with little reference made to literature. |
|  | 8 | A good evaluation of the robot’s performance with little to no reference to robots in literature. |
|  | 5-7 | An attempt has been made to evaluate the robot, but the references to literature are either not there or only have a weak connection. |
|  | 3-4 | A brief evaluation of the robot has been made, with no references to literature. |
|  | Below 3 | A weak evaluation of the robot with no references to literature. |
| 2a | 12-15 | A highly detailed and complex world with multiple interactions of robots and objects. Robots are of a more sophisticated design with many degrees of freedom or functionality. |
|  | 10-11 | A good robot design with some complexities, demonstrates a good understanding of robotics and the scenarios where they can be applied. |
|  | 8-9 | A good robot design, but lacks complexity, and demonstrates a good understanding of robotics and the scenarios where they can be applied. |
|  | 6-7 | A good robot design but operates in a simple environment. |
|  | 4-5 | Robot and the world are simple or have strong similarities to the tutorials. |
|  | 2-3 | Poorly designed robot and world which are extremely simple. |
|  | 0-1 | Non-functioning robot design in an almost empty world. |
| 2b | 10 | A highly complicated controller which uses multiple sensors and tools to navigate/interact with the environment. |
|  | 8-9 | A complicated controller which has many actions and sensors related to the purpose of the task. |
|  | 6-7 | A moderately complicated controller which has a few actions and sensors for the purpose of the task. |
|  | 4-5 | A simplistic controller which is only capable of minor interactions/actions in the environment. |
|  | 3-4 | A simplistic controller which is like what is show in the tutorials, or only utilises simple controls. |
|  | 0-2 | A non-functioning controller which has been poorly implemented and has little logic towards controlling of the robot. |
| 2c | 5 | An accurate recording which fully demonstrates all the aims of the scenario. |
|  | 4 | A recording which mostly demonstrates the actions of the robot, but some objectives aren’t successful. |
|  | 3 | A mostly successful recording, but the robot is unable to complete the main objective. |
|  | 2 | The recorded video shows a simple, but unsuccessful, attempt to solve the problem. |
|  | 1 | A very short video which shows very few |
|  | 0 | No video submitted. |

Note that marks maybe reallocated to ensure that students achieve an overall grade that reflects the strengths of the assignment, e.g.,

To obtain a pass mark you will have discussed the application of the robot with an adequate implementation. The implementation does not need to be fully working but it must show a good understanding of the process. (50-59%)

To achieve a mark above a pass you will provide a more thorough discussion of the robot’s application and its justifications. The simulation may not be very complex, but it will be a working implementation. (60-69%)

To achieve top marks the report will be very through with a working implementation. The implementation will be of a high complexity, with many moving parts and interactions. (70%+)