UNIVERSITY of York

MSc in Intelligent Robotics

Group Robotics Project 2019/2020

Department of Electronic Engineering

Open Assessment

1. **The Tender Presentation** will be held on Tuesday, 14 July 2020 on **Skype** (Summer Vacation term Week 4; grading weight **15%**).

2. **The Final Report** will be submitted to the online library http://nugget.its.york.ac.uk/projectlibrary by 12 noon on Wednesday, 2 September 2020 (Summer Vacation term Week 11). It should consist of the following two reports (a) and (b):
    a. **Individual Report** which will be written by each member (**30%**, 7-9 pages)
    b. **Group Report** which will be written by all the group members (**20%**, 7-9 pages)
    c. **The Performance Review** evaluated through the Weekly Reports and Section 2 of Individual Report (**10%**)

3. **The Final Presentation (3.1)** and **the Physical Demonstration (3.2)** will be both held on Thursday, 3 September 2020 in a V-REP based virtual simulation environment (Summer Vacation term Week 11). The grading weight of the Final Presentation is 15% and the Physical Demonstration is 10% (thus total **25%**).

The total weight is 100%.

An assessment that has been handed in after this deadline will be graded initially as if it had been handed in on time, but the Board of Examiners will normally apply a lateness penalty.

Any queries on this assessment should be addressed to:
Dr. Mark Post
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Cooperative Autonomous Robots for Search and Rescue Mission

Working as part of a group, your mission is to develop a robotics system for two or more types of robot to complete the following search and rescue task in a manner compliant with the criteria listed below, using only resources available in simulation (see Figure 1).

Situation:

- We have lost contact with Mr. York who was driving a Manta buggy yesterday afternoon (approx. 24 hours ago). We believe he had an accident somewhere in the York Robotics Laboratory (simulated in V-REP due to the lack of access to an actual York Robotics Laboratory).
- Your mission is to find him and transport him to the hospital.
- We know that Mr. York is a brown teddy bear, approximately 0.5-1 units in length depending on his pose. Mr. York will be wearing a green T-shirt.
- The car has ArUco tag(s), a red coloured light beacon, and a registration number, and we know that it is red.

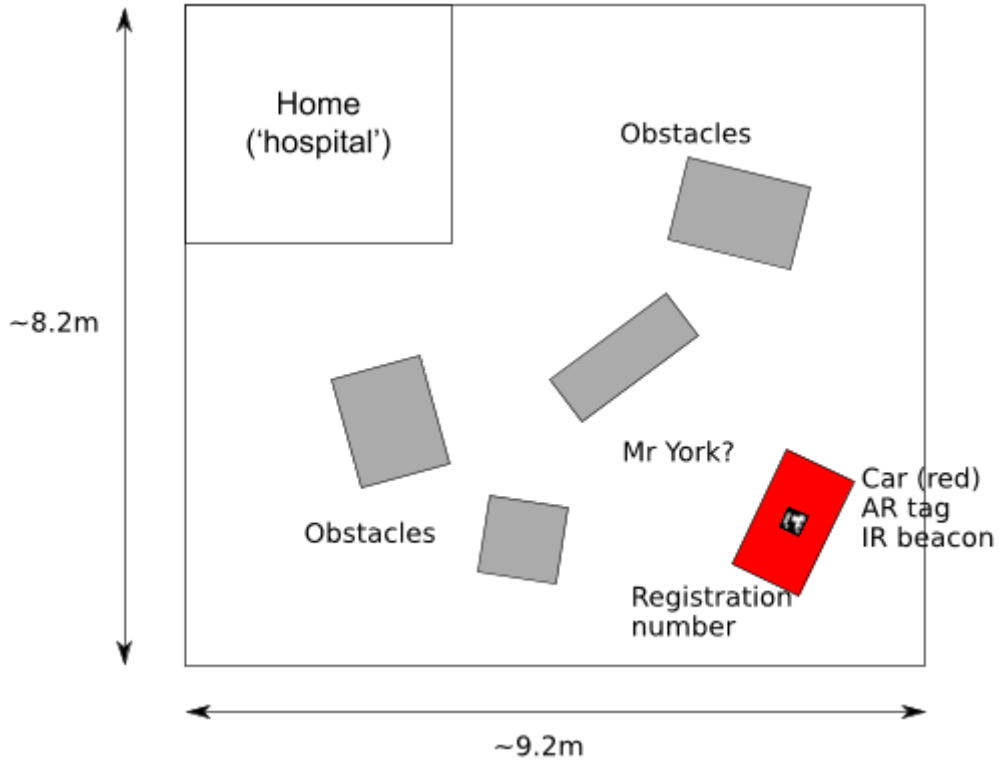

Figure 1 - Possible scenario.

Task:

1. Starting from the home/hospital area (the home is defined as the volume within the gantry area), have one robot locate Mr. York in the arena.
2. Recruit at least one other robot to the location (recruiting multiple robots is allowed).
3. Have a drone take a photo of the situation and send it to the operator so that you can find out the condition of Mr. York, and the car registration number.
4. Transport Mr York to the home area somehow.
5. Return all deployed robots to the home area.

Criteria:

1. You are required to utilise at least one drone/airship and one ground robot.
2. Each robot type must "collaborate" with at least one other robot type during the task. "Collaborate" implies that there is some form of communication (one way or two way, direct or indirect) that is required for successful task completion.
3. All stages of the task must be completed in a total time of under 10 minutes.
4. Mr. York may be moved in any way you choose.
5. Autonomous operation is encouraged. The more autonomy your system displays, and the less human input is required, the better your grade is likely to be. But human intervention is absolutely allowed, and it is still possible to gain a good grade even if your system requires some human intervention (planned or unplanned!).

Resources:

1. You have access to all of the stock components in the V-REP/CoppeliaSim simulator, which you can freely run on your own computer.
2. You can use, reverse-engineer, and modify the other robots in V-REP/CoppeliaSim for various purposes, but you are required to build the robot that does the "rescuing" from scratch using the V-REP scene builder. You can use the example robot(s) you developed/used as part of the Practical Robotics module as the base for robots as well.
3. For the drones/airships, you can use the Quadricopter model in V-REP/CoppeliaSim or create your own if you prefer for more flexibility.
4. You can use cameras on your robots and both ArUco tags and colour/blob detection for finding the car, Mr. York, and other robots as you have done in Practical Robotics – you may find the aruco-vrep library useful.
5. Groups will be provided with remote access to a high-performance computer running this simulator so that large multi-robot simulations can be run, though depending on the access arrangements only one group may be able to use it at a time.
6. A scene for V-REP/CoppeliaSim will be provided for this challenge in advance, and groups are allowed to make modifications to it such as adding markers or temporary structures to the walls and floor, as long as the original obstacles and elements remain in place.

Constraints:

- For as long as there is the slightest risk of COVID-19 transmission (at least several months), you should expect that you will need to work on this project remotely and communicate by telepresence and electronic social media. Make sure that you stay in touch, ideally daily or at least weekly with your teammates and arrange means by which to share files and documents.
- You are encouraged to prototype your robots and algorithms on your own computers. However, as you will ultimately need to make your robots work together in the same environment, you will need to import them into the same scene which can be run on one of your computers or the remote access HPPC. Make sure you are familiar with how to do this and plan ahead for integration.
- There will be two groups operating. While you are able to use your own computers for initial work, using the remote access HPPC may only be possible with one group at a time. Therefore, you will need to coordinate with the other group when you will need to test things on the HPPC.

1. Tender Presentation (15% of total grade)

In this presentation, you will be presenting your approach to the problem over Skype.

- Present slides by one member sharing their screen and all members speaking as a group for a 25 minute talk + 5 minutes Q&A.
- All group members should be involved in preparing and delivering the presentation.

Your tender presentation should have at least the following components:

- A title slide, including your names, the team name, and the date;
- Details on your proposed solution(s) to the task;
- Details of the roles of each member of the team;
- A Gantt chart describing the project timetable.

Grades will be allocated for:

- Problem formulation, analysis, approach to the challenge;
- Novelty (originality), feasibility, practicality, and applicability (generality) in approach;
- Management plan, role distribution, task allocation, communication method with the supervisor, timetable;
- Presentation (voice, timing, slides, Q&A).

Tips for presentation:

- Present in a “top-down” style
- Avoid too many bullet points
- Typically, 1 minute required for 1 slide

2. Final Report

The Final Report consists of two reports: the **Individual Report** and the **Group Report**. Word counts should be adhered to but no specific deduction will be assessed for going a small percentage over/under the word limits (though you should be worried about completeness if you only have 2000 words!) Page counts stated are approximations and can vary due to headings, graphics, etc. Note that Title/Contents/References/Appendices are not counted within the word limits.

a. Individual Report (30% of total grade; 4000 words)

This report will focus on the specific tasks that you as an individual have undertaken, as opposed to simply talking about overall group activity.

Section 1: This section should contain critical reflection and ethical analysis on both the technical aspects of the work you have undertaken, making reference to current literature and group documents as appropriate, and also your own performance within the group.

Grades will be allocated for:

- Your contribution in the project with respect to the significance of your technical contribution and collaborative contribution as a group member (6-8 pages). The structure of this section shall be
    - Title, author name and contact information
    - Introduction, including Related work
    - Methods (and Modeling)
    - Results and Analysis
    - Discussion and Conclusion
    - Acknowledgments
- Ethical Analysis (~1 page)
    - Any ethical concerns or potential challenges raised with respect to the hardware, software, and algorithms used, and how they might impact on a real rescue mission;
    - Your personal ethics and those of your teammates in the engineering of this rescue mission with respect to stakeholders (e.g. Mr. York);
    - More general reflection on the ethics of your project in society and the way that you and your teammates have approached this

Section 2: This section details your own activity in the project along with an assessment of the other members of the group. For the other members assessment, assume you have 100 points to allocate across all group members, you should allocate a proportion of those points to all members of the group, including yourself, so that the total of the points you allocate is 100 (1-2 pages; this section will not be graded but be counted in Performance Review; see below).

The format of the Individual Report is:

- 4000 words maximum, 11pt text.
- Pages and sections should be numbered.
- A contents page could be helpful.

b. Group Report (20% of total grade; 5000 words + appendices)

This report presents the overall achievement of the project as a group. Similar to the Individual Report, you will write a report on the design, testing, and performance of your solution (plus a description about group working and project management). Technical information may be supplied in appendices, to a maximum of 10 pages, without affecting the word count. Code should not be included in the report, but should be submitted separately in electronic form, with comments and instructions on how to run it on V-REP/CoppeliaSim.

Grades will be allocated for:

- Problem formulation and specification
- Novelty, feasibility, practicality, and applicability (generality) in approach
- Hardware and software design and development
- Validity of the approach verified in a theoretical, analytical, or statistical way
- Description of roles of members, issues faced, actions taken, reflection on set timeline with Gantt chart
- Code (ensure that the developed code is well structured and properly commented)
- Writing (text, schematics, graphs, charts, references, etc.)

The format of the report should be:

- 5000 words maximum, 11pt text.
- Pages and sections should be numbered.
- A contents page is mandatory.
- Write in a scientific (“top-down”) style.

The group leader should submit the report and file(s).

c. Performance Review (no final submission required; based on Weekly Report and Section 2 of Individual Report; 10% of total grade, given individually)

A correspondent in each group will submit short Weekly Reports on Friday of each week to the staff coordinator of the group and copied to elec-project-updates@york.ac.uk. The Performance Review will be assessed based on the Weekly Reports and Section 2 of the Individual Report and must include descriptions of the contributions of all group members. Grades will be given individually. Absences and presence in the project shall be reflected in the grade if appropriate.

3.1 Final Presentation (15% of total grade)

- Present slides as a group for 25 minutes talk + 5 minutes Q&A.
- All the slides should have slide numbers.
- Present in a “top-down” style.

You should ensure your final presentation has at least the following components:

- A title slide, including your names
- Details on the solution to the task that you implemented
- Results and discussion
- Conclusion
- Acknowledgements

Grades will be allocated for:

- Problem formulation and clear specification
- Novelty (originality), feasibility, practicality, and applicability (generality) in approach
- Hardware and software design and development
- Group working and project management
- Presentation (voice, timing, slides, Q&A)

3.2 Simulator Demonstration (10% of total grade)

Subsequently, your approach will be assessed live on two different situations (situation 1 and situation 2) of the accident.

1. For the first situation/location, the exact location of the car accident and the look of environment will be provided beforehand in a scenario file.
2. The second situation will be revealed only during the assessment, and it shall accompany an alteration of the accident site and the environment (e.g. the location of the obstacles will be changed and the car may be put in a different orientation).
3. You are allowed to restart the simulation in both cases if your mission is not successful, and your robots in the scene will be allowed to re-start from their original positions. However, you are given a one hour time limit.

Grades will be allocated for:

- Consistency to the proposed approach
- Performance: validity, efficiency, and repeatability

Good luck!

END OF ASSESSMENT