DUBLIN INSTITUTE OF TECHNOLOGY

DT228 BSc. (Honours) Degree in Computer Science

Year 3

DT282 BSc. (Honours) Degree in Computer Science (International)

Year 3

SUMMER EXAMINATIONS 2016/2017

MOBILE ROBOTICS [CMPU3025]

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THURSDAY 11TH MAY 1:00 P.M. – 3:00 P.M.

TWO HOURS

ANSWER **QUESTION 1** (40 MARKS) AND **THREE** OTHER QUESTIONS (20 MARKS EACH)

1. (a) What does the First Asimov's Law state?

(5 marks)

(b) What is a "utility function" in the context of robot control architectures?

(5 marks)

(c) Why is GPS unsuitable for indoor navigation?

(5 marks)

(d) Describe one disadvantage of adding more degrees of freedom to robotic legs.

(5 marks)

(e) What is a "greedy algorithm"?

(5 marks)

(f) Name one advantage of servo control systems.

(5 marks)

(g) What do you understand by the terms "stochastic environment"?

(5 marks)

(h) Describe one advantage of model-based control architectures versus reflex control architectures.

(5 marks)

2. (a) Describe the relationships between magnetic fields and electrical currents.

(10 marks)

(b) Describe the difficulties with making humanoid robots move naturally by referring to artificial muscles.

(10 marks)

3. (a) Explain the need to use different types of sensors to navigate with robots.

(10 marks)

(b) Describe the "classification problem" with computer vision and refer to an example.

(10 marks)

4. (a) Comment on the following statement: "There is generally an inverse correlation between controllability and manoeuvrability". Give an example of an easily controllable wheel arrangement.

(10 marks)

(b) Consider the following forward kinematic model for a differential drive robot:

$$\xi_I = R(\theta)^{-1}\,\xi_R = R(\theta)^{-1} \begin{pmatrix} (r\phi_1)/2 + (r\phi_2)/2 \\ 0 \\ (r\phi_1)/2l + (-r\phi_2)/2l \end{pmatrix}$$

$$R(\theta)^{-1} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Figure 1: Forward-kinematic model for a differential drive robot with powered wheels of radius r.
$\phi 1$ is the speed of wheel 1 (right wheel); $\phi 2$ is the speed of wheel 2 (left wheel);
l is the distance between each of the wheels and the midpoint P between the wheels.

Suppose the robot is positioned such that $\theta = \pi$, $r = 2$, and $l = 1$ and the robot engages its wheels unevenly with $\phi 1 = 1$ and $\phi 2 = 3$.

Compute the velocity in the global reference frame.

(10 marks)

5. (a) Briefly describe the "Bug Scenario" and the "Bug 0" motion planning algorithm.

(10 marks)

(b) Explain how a robot can improve its belief state in terms of localization by moving.

(10 marks)