S211C/329C

DUBLIN INSTITUTE OF TECHNOLOGY

DT211C BSc. (Honours) Degree in Computer Science (Infrastructure)

Year 3

SUMMER EXAMINATIONS 2015/2016

MOBILE ROBOTICS [CMPU3025]

DR. DIANA CARVALHO E FERREIRA

THURSDAY 12TH 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) Name and describe two significant differences between robots portrayed in the media and robots in reality.

(5 marks)

(b) List the five components of mobile robotics.

(5 marks)

(c) Name and describe two advantages of servo control systems, versus non-servo.

(5 marks)

(d) What do you understand by a "fully observable and deterministic environment"?

(5 marks)

(e) Describe one advantage of Model-Based control architecture versus Reflex control architecture.

(5 marks)

(f) What do you understand by the terms "dead reckoning"?

(5 marks)

(g) Describe one advantage of Electroactive Polymers (EAPs) as actuators for robotics.

(5 marks)

(h) Explain the origin of the main advantage of adaptive cell decomposition in mapping.

(5 marks)

2. (a) Describe the fundamentals of electrical current, by referring to electrons and protons, charges, static electricity and conductivity.

(10 marks)

(b) Describe the working of electric motors.

(10 marks)

3. (a) Describe three causes of errors in real-world measurements with sensors.

(10 marks)

(b) Describe three advantages of the Evolution Robotics' ViPR (visual pattern recognition) technology for computer vision.

(10 marks)

4. (a) Describe one advantage and one disadvantage of adding degrees of freedom to a robotic leg.

(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 $\theta = 0$, $r = 2$, and $l = 3$ and the robot engages its wheels unevenly with $\phi 1 = 4$ and $\phi 2 = 2$.

Compute the velocity in the global reference frame.

(10 marks)

5. (a) Describe one advantage and one disadvantage of keeping Multiple Hypothesis Belief for robot Localization, versus Single Hypothesis Belief.

(10 marks)

(b) Briefly describe the "Bug 1" motion planning algorithm.

(10 marks)