UOW
MALAYSIA
KDU PENANG
UNIVERSITY COLLEGE

PART OF THE UNIVERSITY
OF WOLLONGONG AUSTRALIA
GLOBAL NETWORK

School of Engineering, Computing and Built Environment

Department of Computing

Bachelor of Computer Science (Hons)

AUTONOMOUS MOBILE ROBOTICS (CAI3034/N)

September 2022 Semester
Final Examination

Duration: 2 hours
Total Marks: 100

Instructions

1. This examination paper consists of **3 pages**, including this cover page.
2. There are **4 questions**: Question 1 (25 marks)
   Question 2 (25 marks)
   Question 3 (25 marks)
   Question 4 (25 marks)
3. Read carefully the instructions printed at the beginning of each section.
4. All answers are to be written in the answer booklet(s) provided. Use black or blue ink only. Pencils may be used for sketches and diagrams.
5. Examination paper and answer booklet(s) are **not allowed** to be taken out from the examination room.

Question 1 (25 marks)

Answer all questions.

(a) There are a number of ways a robot can avoid running into obstacles. Describe two solutions that a robot can avoid running into obstacles.

(8 marks)

(b) Explain on the way that can a robot use path integration and landmarks to keep track of its position.

(8 marks)

(c) Describe with examples on the way that a mobile robot uses the following control methods to orient towards a landmark.

(i) open-loop (3 marks)
(ii) feed-forward (3 marks)
(iii) feedback control (3 marks)

Question 2 (25 marks)

Answer all questions.

(a) Navigation and positioning of mobile robots with machine vision systems are usually carried out with natural or artificial landmarks.

(i) Outline the process that would allow a robot to recognise landmarks of different shapes while wandering around its world.

(4 marks)

(ii) Identify two potential problems and consider possible solution for the process described in Question 2 a(i)

(8 marks)

(iii) Describe how you might use active vision to improve the performance.

(4 marks)

(b) Proprioception is an active field of research in robotic systems.

(i) Define proprioception in the context of mobile robotics. (2 marks)
(ii) Explain the approach to use vision as proprioception. (3 marks)
(iii) Besides vision, describe two other kinds of propriocepive sensors which are commonly used in robotics.

(4 marks)

Question 3 (25 marks)

Answer all questions.

The simplest and most widely utilised method to estimate the position of mobile robots is wheel odometry.

(a) Describe one main type of sensors used in wheel odometry. (2 marks)

(b) Sketch an odometry-based navigation flowchart, and explain the way that a robot navigates in outdoor environment using wheel odometry. Note that the odometry-based navigation implements odometry and compass sensor for navigation. In the case that robot encounters an obstacle along its path, the robot avoids the detected obstacle according to the range data from the attached laser rangefinder.

(10 marks)

(c) State two advantages and two disadvantages of odometry-based navigation technique stated in Question 3 (b).

(8 marks)

(d) Visual odometry has been used as a complement to wheel odometry. Define the term visual odometry and explain the advantages of visual odometry over wheel odometry.

(5 marks)

Question 4 (25 marks)

Answer all questions.

Consider the three-link gantry manipulator of Figure 1.

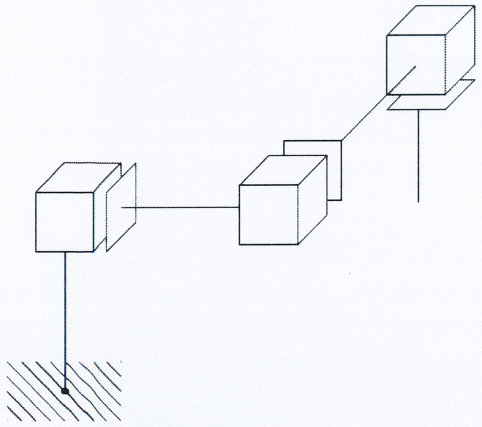

Figure 1: Three-link gantry robot configuration.

(a) Redraw the kinematic diagram and assign the frames according to the Denavit-Hartenberg rules. Also, include the prismatic parameters on your diagram. (7 marks)

(b) For each frame of the manipulator, determine:
   (i) the rotation matrix. (9 marks)
   (ii) the translation vector. (9 marks)

THE END

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