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)

June 2020 Semester
Final Examination

Duration: 2 hours
Total Marks: 100

Instructions

1. This examination paper consists of **4 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. Answer ALL the questions.
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. Students caught copying, or having any unauthorized material, or engaging in any form of action with the intention to cheat will be penalized.

Question 1 (25 marks)

(a) Computer vision, laser rangefinders, and ultrasonic sensors are common forms of robotic sensing. However, in adverse environmental conditions these sensory modes may be unable to function efficiently. Tactile whiskers offer a strong alternative or complement to existing systems for navigating, tracking, and detection.

(i) Draw the whiskers schematic diagram for Boe-Bot. (8 marks)

(ii) Explain how the whiskers can help the Boe-Bot to avoid obstacles. (8 marks)

(b) As the Boe-Bot enters the corner, its whisker touches the wall on the left, so it turns right. When the Boe-Bot moves forward again, its right whisker bumps the wall on the right, so it turns left. Then it turns and bumps the left wall again, and the right wall again, and so on. Explain how the Boe-Bot can be programmed to escape corners.

(4 marks)

(c) A 9V battery is the power source for the Boe-Bot controller to function properly.

(i) Describe the symptoms when the Boe-Bot's batteries are running low. (2 marks)

(ii) Suggest a way on how the low battery level of Boe-Bot can be detected. (3 marks)

Question 2 (25 marks)

The simplest and most widely utilized 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 how 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 (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 3 (25 marks)

(a) A company in Japan called Softbank manufactures a robot called Pepper that has been programmed to react like a human to emotions. It has a range of human type emotions and will respond by laughing and crying to inputs. Identify and discuss two possible problems with this type of device related to the way it works with human emotions.

(4 marks)

(b) According to recent research, the power of artificial intelligent (AI) is such that the robots built using it will not only replace "low level" jobs, such as factory assembly, but also "high level" jobs such as legal advice or analysis. Describe the impact of this type of development on the future workforce, giving examples of the impact where appropriate.

(4 marks)

(c) (i) Figure 1 shows the graph of Uncanny Valley. Describe the graph and explain its effect in robotics.

(7 marks)

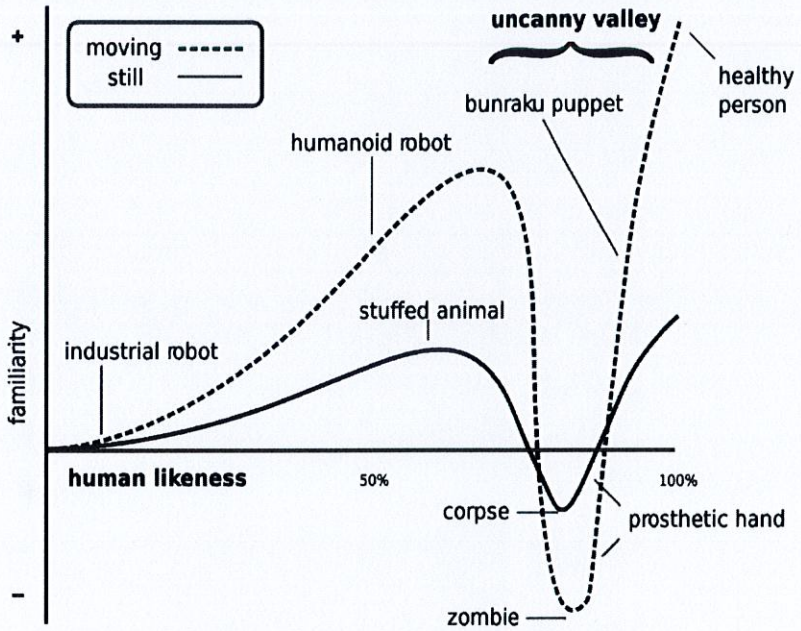

Figure 1: The graph of Uncanny Valley.

(ii) The uncanny valley theory has been investigated by researchers from various fields. Suggest and describe a way to determine whether human reactions to android robots truly exhibit an uncanny valley effect.

(10 marks)

Question 4 (25 marks)

(a) One of the key aspects to decide when designing the architecture for an autonomous system is its reactive and deliberative role and how to combine them. Within the large and extensive different architectures, one of the most common ones is the three-layer architecture. Describe briefly the three-layer architecture in the context of mobile robotics as shown in Figure 2.

(4 marks)

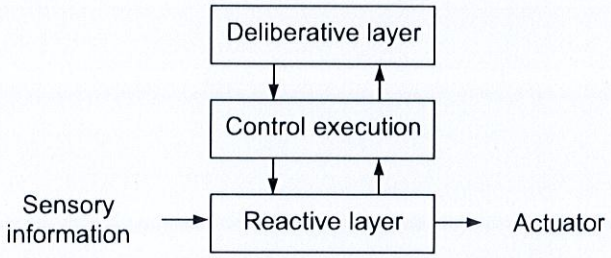

Figure 2: The three-layer architecture.

(b) A line follower robot is a robot that is capable of navigating while following a line on some terrain with the use of sensors. The line follower robot without a proper control strategy tends to wobble from side to side while following the line as depicted in Figure 3(a), whereas on the other hand with a proper control strategy is much smoother as depicted in Figure 3(b). Suggest one control strategy and explain how the strategy can be implemented to make the robot follows the line smoothly and make less error. Use appropriate diagram(s) to aid your explanation.

(17 marks)

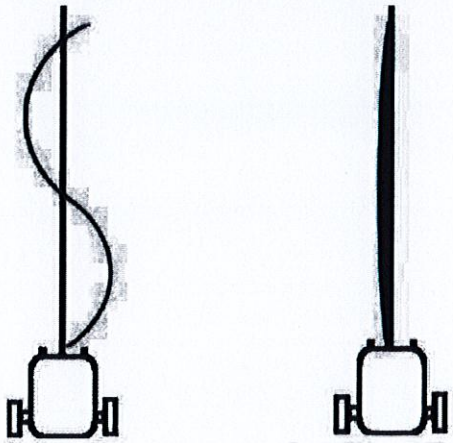

Figure 3: Comparison of a line follower robot (a) with and (b) without a control strategy.

(c) Write a routine that makes the Boe-Bot gradually increase or decrease the speed of the servos instead of abruptly changing direction.

(4 marks)

THE END

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