BRAC UNIVERSITY

Department of Computer Science and Engineering

Examination: Final

Semester: Summer 2023

Duration: 2 Hours

Full Marks: 35

SET- B
CSE 461: Introduction to Robotics

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1. **(CO1, CO2)**	Bracu Duburi became runner-up in the world underwater robotic competition Robosub2023. The core team members are inspired to start a start-up company. They found that the marine industry requires robots for servicing and repairing the ships underwater. So, they are planning to develop a semi-autonomous robot. (a) It has a sensor called DVL (Doppler Velocity Logger) that can identify the movement in 3 dimensional space. There is a requirement that the robot will hold its position. What paradigm will be the best for holding the position, why? **[2 Marks]** (b) It will be able to identify any kind of cracks or holes at the bottom of the ship using Camera. What kind of image processing or AI algorithm can be used to detect it, why? **[2 Marks]** What kind of purely reactive path planning algorithm can be used to go to the cracks or holes after detecting it, why? **[1.5 Marks]** (c) How can LIDAR be used in such a Robot? **[1 Marks]** (d) Do you have any idea how such a Rover can communicate underwater wirelessly? **[1 Marks]** IOT	**7.5**
2. **(CO3)**	RoboExpedition has a fun challenge for robots in two different places: **Part 1 - Forest Adventure:** Robots start at the edge of a dense forest. They need to go through the trees and bushes to find a special spot shown on a map. It's like a forest maze with lots of things in the way. The robots use their sensors and other special tools to find a safe way through. At the beginning, they also have a GPS that helps them know where they are in the forest. And you don't have the map of the forest. **Part 2 - Remote Journey:** After leaving the forest, robots enter a remote area. In this place, the GPS that helps them know where they are doesn't work very well. Robots have to rely on other things, like how their wheels move and what motion they are maintaining, to figure out where they are. They need to travel safely through the challenging area. (a) What Path planning algorithm should you use for Part 1 and why? **[2.5 Marks]** Global or way (b) As the robot does not know the map and it has a sensor to detect the object then what mapping algorithm should it use to create a map and how? **[1+3 = 4 Marks]**	**7.5**

Residual box

- IOU

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		(c) Which localization technique should be used for Part 2 and how ? [1+2 Marks] DLS	
3. (CO2)		Imagine you're managing the temperature inside a greenhouse to ensure optimal plant growth. The greenhouse has a temperature control system. Temperature sensors are placed throughout the greenhouse to measure the current temperature. Your goal is to maintain a target temperature of 25°C (77°F) inside the greenhouse. If the temperature deviates from this target, the control system takes action. For example, if the temperature rises above 25°C or drops below 25°C the control system might activate cooling/ heating mechanisms to control the temperature. (a) Explain what system you will be using for the given scenario. Justify your answer. [1+1 =2 marks] (b) For the scenario, draw a diagram of the given system and label it according to the scenario. [2 marks] (c) Suppose you are using a PI controller to control the temperature. To properly control the system you need to tune the hyperparameters of the PI controller. The resulting gain and the oscillation period are known to you, which are 20 and 0.9 respectively. Now find out the value of the parameters. [2 marks] (d) Define Rise time and Settling time [2 mark]	7.5
4. (CO3)		**Answer any 10 marks out of 14.** (a) You are tasked with developing a Computer Aided Diagnosis software. To make the prediction more accurate, we can use medical images such as X-rays, CT scans, and MRI scans. These images can provide additional information about the patient's condition, which can be used along with the performance ratings of medical robots to improve the accuracy of the prediction. An image, its pixel values and a kernel are given below. Apply Convolution on the image by using the kernel. [4 Marks]	10

kernel

0	1	0
1	(1)	1
0	1	0
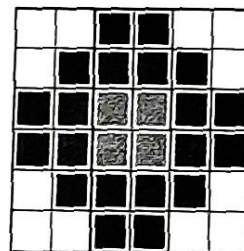
```
0 0 0 0 0 0 0
0 3 3 0 0 3 3 0
0 3 0 1 1 0 3 0
0 0 1 2 2 1 0 0
0 0 1 2 2 1 0 0
0 3 0 1 1 0 3 0
0 3 3 0 0 3 3 0
0 0 0 0 0 0 0 0
```

(b) Apply 2x2 Max Pooling to the resulting images. [2 Marks]

(c) What is the intuition behind using multiple convolution layers in a CNN? [2 Marks]

(d) Differentiate between traditional Machine Learning and Deep Learning. [2 Marks]

(e) What is the application of CNN in Robotics ? [2 Marks]

(f) Briefly describe the basic working principle of the YOLO object detection algorithm. [2 Marks]