Name:

Enrolment No:

UPES

End Semester Examination, May 2024

Course: Robot Motion Planning and Navigation **Semester: II**
Program: M.Tech Robotics Engineering **Time : 03 hrs.**
Course Code: ECEG7040 **Max. Marks: 100**
Instructions: Attempt all the questions. Assume any missing data.

S.No		Marks	CO
	SECTION A (5Qx4M=20Marks)		
Q 1	List the disadvantage of PID controller over model-based controller.	**4**	**CO1**
Q 2	Explain the various consideration while solving the path planning algorithms with suitable scenarios.	**4**	**CO1**
Q 3	State the significance of obstacle avoidance methods in autonomous robot path planning.	**4**	**CO1**
Q 4	Explain briefly applications of mathematical model of an autonomous robot.	**4**	**CO1**
Q 5	List the advantages of feedback control over the feedforward controller.	**4**	**CO1**
	SECTION B (4Qx10M= 40 Marks)		
Q 6	Explain briefly how PID controller can be used for trajectory tracking for a desired reference trajectory by a robot?	**10**	**CO4**
Q 7	Discuss the possibilities in obtaining the robust path for an arena by Dijkstra algorithm.	**10**	**CO2**
Q 8	An autonomous vehicle is required to travel in stealth mode to avoid radar detection. Suggest the problem formulation consideration in framing the path planning.	**10**	**CO3**
Q 9	Explain briefly the steps required by A* algorithm in obtaining the shortest path in a grid map with suitable example. **Or** Illustrate the rapidly exploring random trees (RRT*) algorithm in obtaining the robust path in a grid map with suitable example.	**10**	**CO3**
	SECTION-C (2Qx20M=40 Marks)		
Q 10	Apply the inverse kinematics in obtaining the control action sequence for trajectory tracking by the for the differential drive robot. The inverse kinematics model of the differential model is given below.	**20**	**CO4**

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$$\begin{bmatrix}\omega_L \\ \omega_R\end{bmatrix} = \begin{bmatrix}\frac{1}{a} & 0 & -\frac{d}{a} \\ \frac{1}{a} & 0 & \frac{d}{a}\end{bmatrix} \begin{bmatrix} cos(\psi) & sin(\psi) & 0 \\ -sin(\psi) & cos(\psi) & 0 \\ 0 & 0 & 1\end{bmatrix} \begin{bmatrix}\dot{x} \\ \dot{y} \\ \dot{\psi}\end{bmatrix}$$

$$\begin{bmatrix} x(t+1) \\ y(t+1) \\ \psi(t+1)) \end{bmatrix} = \begin{bmatrix} x(t) \\ y(t) \\ \psi(t)) \end{bmatrix} + \Delta T \begin{bmatrix}\dot{x} \\ \dot{y} \\ \dot{\psi}\end{bmatrix}$$

Where x, y and ψ, represent x coordinate, y coordinate and orientation from the x axis of the robot. And a, d represents the length between the wheels and d represents the diameter of the motored wheels. The rotational speeds of the right and left motored wheel are presented by ω_L and ω_R.

For the differential drive robot consider a = 2 unit and d as 0.5 unit. The desired reference trajectory is to travel 9 units north and then 9 units west at the speed of 3 units per second. The initial orientation of the robot is towards north and placed at the origin.
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<td>Q 11</td>
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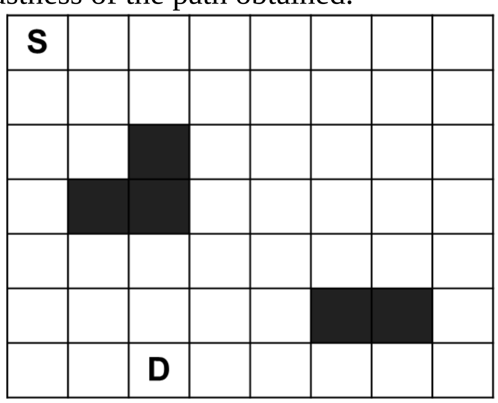
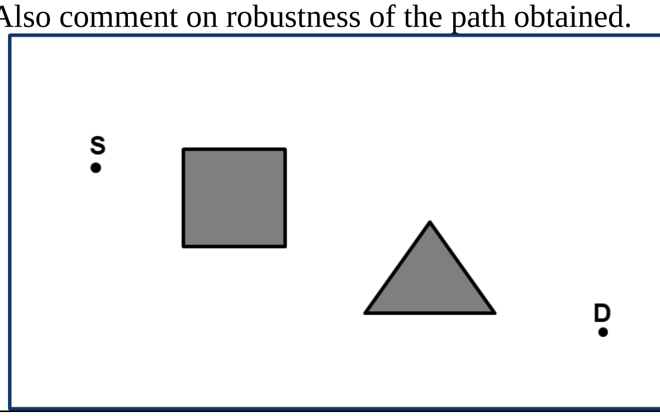
Apply artificial potential field in determining the robust path from start position (S) to destination (D) in the shown arena. Discuss the limitations of the algorithm and comment on robustness of the path obtained.



Or

Apply the Dijkstra algorithm in obtaining the robust path from start point (S) to destination (D) in the following figure. State the assumptions taken to obtain the shortest path. Also comment on robustness of the path obtained.



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