17751

BRAINWARE UNIVERSITY

Term End Examination 2024-2025
Programme – M.Tech.(CSE)-AIML-2024
Course Name – Mobile and Micro-Robotics
Course Code - MTA20201B
(Semester II)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Identify the primary function of mobile robots.
a) Data storage b) Motion and navigation
c) Image processing d) Power generation

(ii) Identify the well-known robot manufacturer from the following options.
a) Intel b) Boston Dynamics
c) Samsung d) Tesla

(iii) Given a scenario where a mobile robot operates in a disaster zone, decide the proper factor should be prioritized for navigation.
a) Speed over stability b) Sensor accuracy for obstacle detection
c) Aesthetic design of the robot d) Battery life over all other considerations

(iv) Since a wheeled robot frequently encounters uneven terrain, evaluate the best design improvements to enhance its stability and mobility.
a) Increasing the number of wheels for better weight distribution b) Reducing motor power to save battery life
c) Removing wheels and replacing them with a fixed base d) Increasing the robot's speed to avoid obstacles

(v) Identify the type of robot that has two wheels and relies on balance for movement.
a) Three-wheeled robot b) Four-wheeled robot
c) Two-wheeled robot d) Omnidirectional robot

(vi) Define the main advantage of a four-wheeled robot over a two-wheeled robot.
a) Higher speed b) Better stability

c) Reduced energy consumption
d) Lower weight

(vii) Distinguish that a three-wheeled robot typically maintains balance compared to a four-wheeled robot.

a) By using a gyroscopic stabilizer
b) By evenly distributing its weight on the wheels
c) By increasing motor torque
d) By employing a counterweight mechanism

(viii) Explain the omnidirectional wheels advantageous in robotic movement.

a) They allow movement in multiple directions without rotating the robot
b) They increase the speed of the robot significantly
c) They reduce the need for motorized wheels
d) They eliminate the need for obstacle avoidance algorithms

(ix) Define the primary goal of motion control in mobile robots.

a) To improve communication
b) To regulate the movement and trajectory of the robot
c) To increase power consumption
d) To limit the robot's mobility

(x) Identify the mathematical tool commonly used in Lyapunov-based motion control.

a) Probability Theory
b) Lyapunov Functions
c) Fourier Transform
d) Artificial Neural Networks

(xi) Use a provided Lyapunov function to demonstrate the stability of a given motion control law for a mobile robot.

a) Derive the robot's dynamic model.
b) Calculate the derivative of the Lyapunov function.
c) Simulate the robot's environment.
d) Design a sensor fusion algorithm.

(xii) Solve a practical problem where a mobile robot needs to navigate through a cluttered environment using a pre-defined motion controller.

a) Develop a new robot design.
b) Implement obstacle avoidance within the controller.
c) Calibrate the robot's sensors.
d) Design a communication protocol.

(xiii) Describe the general introduction to micro-robots in terms of their primary purpose.

a) To perform macro-scale tasks.
b) To operate in large industrial environments.
c) To execute tasks in confined or microscopic environments.
d) To replace human labor in all applications.

(xiv) Summarize the size constraints that define micro-robots according to task-specific definitions.

a) Larger than 1 meter.
b) Ranging from millimeters to micrometers.
c) Only visible to the naked eye.
d) Equal to the size of a standard industrial robot.

(xv) Analyze the advantages of using arrayed actuators over single actuators in terms of precision and control.

a) Single actuators offer better control.
b) Arrayed actuators provide finer, more complex control.
c) Both are equally precise.
d) Arrayed actuators only reduce power consumption.

Group-B

(Short Answer Type Questions) 3 x 5=15

2. Explain the methodology to improve efficiency of warehouse setting by using omnidirectional wheeled robots. (3)
3. Explain the challenges associated with providing power and communication to a multi-robot system composed of micro-robots. (3)
4. Define the common challenges faced by underwater robots. (3)
5. Analyze the difference between proximity sensors and laser scanners in obstacle detection. (3)
6. Design an autonomous underwater exploration robot for ocean floor mapping, specifying the technologies it would use. (3)

OR

Propose a new tele-robotics application that could improve daily life. Express it by key features. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. Synthesize a novel micro-robotic system for targeted drug delivery that combines a walking MEMS micro-robot with micro-grippers. Justify your choice of materials, actuators, and control mechanisms, considering the biological environment. (5)
8. Develop a micro-conveyor system that utilizes a combination of electrostatic and magnetic forces to transport and manipulate micro-particles with high precision. Analyze the advantages and limitations of this hybrid approach compared to using either force alone. (5)
9. Mobile robots are deployed in a hazardous environment for search and rescue operations. Apply your knowledge of current mobile robot applications and limitations to design a mobile robot system that can navigate through complex terrain, detect victims, and transmit critical information to remote operators. (5)
10. Compare the gyroscope and accelerometer in providing accurate robot movement tracking. (5)
11. Define the different types of mobile robots and their primary tasks. (5)
12. Develop an innovative solution for overcoming obstacles in mobile robot navigation. (5)

OR

Design a tele-robotics system for hazardous environment operations. (5)

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