Topic: Robotics

Multiple Choice Questions (1 mark each)

Ques 1 - A mobile robot in a hospital needs to transport medicine between floors while avoiding humans. Which sensor combination is most optimal?
Options:
a) Lidar + GPS
b) Camera + Microphone
c) Infrared + Sonar
d) Lidar + Camera + Ultrasonic
Answer: *d) Lidar* + *Camera* + *Ultrasonic* – Lidar helps with mapping, cameras assist in recognizing humans, and ultrasonic sensors prevent close-range collisions

Ques 2 - Which of the following is a major drawback of odometry-based localization?
A. It provides highly accurate long-term positioning
B. It does not require any external sensors
C. It accumulates drift over time
D. It works only in indoor environments

Answer: C. It accumulates drift over time

Ques 3 - Which path-planning algorithm is best suited for dynamic environments with moving obstacles?
A. Dijkstra's Algorithm
*B. A Algorithm**
*C. D Algorithm**
D. Greedy Best-First Search

Answer: *C. D Algorithm**

Ques 4 - What is the primary advantage of using force sensors in robotic arms?
A. Increases motor speed
B. Prevents excessive force application
C. Reduces power consumption
D. Makes the robot completely autonomous

Answer: B. Prevents excessive force application

Ques 5 - A warehouse robot encounters a scenario where its primary sensor system

fails. Which of the following would LEAST likely represent an effective adaptive strategy?

A. Switching to alternative sensor fusion
B Implementing conservative movement protocols
C. Immediately requesting human intervention
D. Using learned environmental models from previous mapping

Answer: c) Immediately requesting human intervention

Explanation: Advanced robots should prioritize autonomous problem-solving and adaptive strategies.

Ques 6 - In designing a search and rescue robot for unpredictable disaster environments, which sensor combination would provide the most robust situational awareness?

A. GPS + Camera
B. Infrared + Microphone
C. Lidar + Thermal + Acoustic
D. Ultrasonic + Pressure Sensors

Answer: c) Lidar + Thermal + Acoustic

Explanation: Multi-modal sensing allows comprehensive environmental interpretation across different conditions.

Ques 7 - A robot's control system encounters conflicting sensor inputs during navigation. What fundamental principle should guide its decision-making?

A. Always trust the most expensive sensor
B. Prioritize sensor with highest resolution
C. Apply probabilistic sensor fusion
D. Disable conflicting sensors

Answer: c) Apply probabilistic sensor fusion

Explanation: Probabilistic approaches help manage sensor uncertainty and make informed decisions.

Ques 8 - Which robotic design philosophy most closely aligns with adaptable, real-world problem-solving?

A. Rigid, predetermined task mapping
B. Machine learning with continuous adaptation
C. Purely reactive response mechanisms
D. Single-sensor dependency

Answer: b) Machine learning with continuous adaptation

Explanation: Adaptive learning enables robots to improve performance through experience.

Ques 9 - In developing a service robot for elderly care, which characteristic is most critical beyond technical specifications?

A. Maximum lifting capacity
B. Processing speed
C. Human-centric interaction design
D. Battery life duration

Answer: c) Human-centric interaction design

Explanation: Social acceptance and intuitive interaction are crucial for assistive technologies.

Short Answer Questions (2 marks each)

Ques 10 - Why does odometry-based localization become inaccurate over long distances?

Answer: Odometry accumulates drift due to sensor noise, wheel slippage, and small measurement errors over time.

Ques 11 - *Why is A path-planning algorithm preferred over Dijkstra's in robotics?**

Answer: A* is more efficient because it uses a heuristic function to prioritize the shortest path, reducing unnecessary calculations.

Ques 12 - Why do robotic arms need closed-loop control instead of open-loop control?

Answer: Closed-loop control adjusts movements in real-time using feedback from sensors, improving accuracy and stability.

Ques 13 - How does reinforcement learning help robots in navigation?

Answer: It allows robots to learn optimal paths by exploring different routes and receiving rewards for efficient movement.

Ques 14 - Explain how sensor noise can exponentially complicate a robot's decision-making process in dynamic environments.

Answer: Sensor noise introduces uncertainty, causing cascading errors in perception. Each noisy measurement can trigger suboptimal decisions, potentially creating a compounding effect that drastically reduces navigation accuracy and reliability.

Ques 15 - Describe how biomimetic design principles could revolutionize robotic mobility in unpredictable terrains.

Answer: By studying natural organisms' movement strategies, robots can develop adaptive locomotion mechanisms. For instance, snake-like or multi-modal movement systems can navigate complex environments more effectively than rigid, single-mode mobility.

Long Answer Questions (3 marks each)

Ques 16 - A mobile robot is deployed in a warehouse using odometry and IMU for localization. Over time, it drifts from its expected path and fails to reach its destination accurately.

- (a) What are the possible reasons for this drift?
- (b) How can the robot improve its localization accuracy?
- (c) Compare and contrast odometry with SLAM in terms of accuracy and real-world applicability.

Answer:

- (a) Drift occurs due to sensor noise, wheel slippage, and cumulative errors in movement estimation.
- (b) The robot can use SLAM (Simultaneous Localization and Mapping), landmark-based corrections, or sensor fusion (Lidar + IMU + Cameras) to improve accuracy.
- (c) Odometry is fast but accumulates errors, while SLAM dynamically builds a map while localizing the robot, reducing long-term drift.

Ques 17 - A disaster response robot must navigate a complex, debris-filled urban environment after an earthquake. Design a comprehensive sensor and decision-making strategy that goes beyond traditional navigation approaches.

Answer: *Strategy Components:*

- Multi-modal sensor fusion (thermal, acoustic, lidar)
- Probabilistic path-planning with real-time environmental learning
- Adaptive locomotion using modular, reconfigurable body design

Key Focus: Creating a system that can dynamically reassess and modify its approach based on continuous environmental feedback.

Ques 18 - Critically analyze the ethical and practical challenges of increasing robot autonomy in human-centric environments. What safeguards and design principles are essential?

Answer: *Critical Considerations:*

- Transparent decision-making algorithms
- Robust fail-safe mechanisms
- Clear human-override capabilities
- Continuous performance and safety monitoring

Central Principle: Designing robots as collaborative partners, not replacements, emphasizing augmentation of human capabilities.