Chettinad College of Engineering & Technology
Approved by AICTE-New Delhi and Affiliated to Anna University-Chennai

CMR Question Bank
Unit 1

PART A

1. **What is locomotion in robotics?**
Locomotion in robotics refers to the ability of a robot to move from one place to another in a given environment.

2. **Name two types of locomotion commonly used in mobile robots.**
Wheeled locomotion and legged locomotion.

3. **What is a key challenge in designing legged mobile robots?**
Maintaining balance and stability during movement is a key challenge.

4. **Define the term "gait" in the context of legged robots.**
A gait is a sequence of leg movements that a legged robot uses to walk or move.

5. **List two common configurations of legged robots**.
Biped (two-legged) and quadruped (four-legged) configurations.

6. **What does static stability mean in robot locomotion?**
Static stability refers to the robot's ability to maintain balance without movement, typically when the center of gravity is within the support polygon.

7. **Mention two advantages of wheeled mobile robots over legged robots.**
Simpler design and higher energy efficiency.

8. **What is meant by the design space in mobile robots?**
Design space refers to the set of all possible design parameters and configurations available for developing mobile robots.

9. **Name one key mobility issue faced by wheeled robots.**
Difficulty in navigating rough or uneven terrain.

10. **Give one application each for unmanned aerial and underwater vehicles.**
Aerial: Surveillance and mapping.
Underwater: Marine exploration and data collection.

PART B

1. Explain the key issues in robot locomotion and how they impact robot design.
2. Compare and contrast legged and wheeled mobile robots in terms of configuration, stability, and mobility.
3. Describe the concept of stability in legged robots and the methods used to achieve it.

4. Discuss the design space considerations in mobile robot development.
5. Differentiate between unmanned aerial vehicles (UAVs) and unmanned underwater vehicles (UUVs) with examples.

Unit-2

PART A

1) **Define maneuverability in the context of robotics.**

   Maneuverability refers to a robot's ability to move and change direction efficiently within its operating environment.

2) **What is meant by the workspace of a robot?**

   The workspace of a robot is the physical space within which the robot can operate and perform its tasks, defined by the reach of its arms or end-effectors.

3) **Explain the concept of degrees of freedom (DoF) in robotics.**

   Degrees of freedom (DoF) refer to the number of independent movements a robot can make, typically corresponding to the number of joints or axes it has.

4) **Differentiate between path and trajectory in robotic motion planning.**

   A path is a sequence of positions that a robot must follow, while a trajectory includes the path along with the time-based motion profile, specifying how the robot moves along the path.

5) **What is holonomic control in robots?**

   Holonomic control refers to a system where the robot can move in any direction instantaneously, often requiring as many control inputs as degrees of freedom.

6) **Give an example of a holonomic robot.**

   An example of a holonomic robot is an omni-directional mobile robot, which uses omni-wheels to move in any direction without changing orientation.

7) **What are the benefits of holonomic robots?**

   Holonomic robots have superior maneuverability, can navigate complex environments with ease, and can perform precise positioning tasks more effectively.

Part-B

1) Discuss the importance of maneuverability in robotic systems and how it affects their performance in different applications. Provide examples to support your discussion.
2) Explain in detail the concept of workspace for robotic arms. How do different factors such as arm length, joint limits, and obstacles within the environment influence the effective workspace of a robot?
3) Analyze the significance of degrees of freedom (DoF) in robot design. Compare and contrast the capabilities of robots with different DoFs, and discuss the trade-offs involved in increasing or reducing DoF.

4) Describe the process of path and trajectory planning in robotics. What are the key considerations for ensuring efficient and collision-free motion? Discuss algorithms commonly used for path and trajectory planning.

5) Provide a comprehensive overview of holonomic robots. How do their design and control differ from non-holonomic robots? Discuss the applications where holonomic robots offer significant advantages and the challenges faced in their implementation.

Unit 3

Part A:

1. **What is the primary purpose of sensors in mobile robots?**
   Sensors enable mobile robots to perceive and interact with their environment by collecting data about position, motion, orientation, and surroundings.
2. **Name two key parameters used to characterize sensor performance.**
   Accuracy and resolution.
3. **What are wheel encoders used for in mobile robots?**
   Wheel encoders measure the rotation of wheels to estimate the robot's distance traveled and velocity.
4. **Mention one drawback of using wheel sensors alone for localization**.
   They accumulate errors over time due to wheel slippage or uneven terrain.
5. **What is a heading sensor, and give one example?**

   A heading sensor measures the robot's orientation or direction; an example is a compass or gyroscope.

6. **What are ground-based beacons used for in robotics?**
   Ground-based beacons provide position references to help robots localize themselves in a known environment.
7. **Name one active ranging sensor and its principle of operation.**
   LIDAR, which uses laser pulses and measures the time of flight to determine distances to objects.
8. **What does a motion/speed sensor typically measure in mobile robots?**
   It measures the robot's translational and rotational speed.
9. **What is the role of a camera in mobile robot perception?**
   A camera captures visual information about the robot's environment for tasks like object recognition and navigation.
10. **What is feature extraction in vision-based perception?**
    Feature extraction involves identifying visual features (like edges, corners, textures) from images to assist in navigation or object detection.

PART B

1) Explain the classification of sensors used in mobile robots.
2) Describe the working and limitations of wheel/motor sensors.

3) Compare and contrast heading sensors: gyroscopes vs. magnetometers.
4) What is active ranging, and what types of sensors are used for it?
5) Explain the process and importance of visual appearance-based feature extraction.

Unit-4

1) Define localization-based navigation in robotics.

- Localization-based navigation refers to a robot's ability to determine its position within a given environment using sensor data and map information.

2) What is the main difference between localization-based navigation and programmed solutions?

- Localization-based navigation relies on real-time sensor data and map information to navigate, while programmed solutions follow pre-defined paths or instructions without adjusting to real-time environmental changes.

3) What is a map representation in the context of robotic navigation?

- A map representation is a structured depiction of an environment that a robot uses for navigation and localization, which can be in forms such as grids, graphs, or topological maps.

4) Explain continuous map representation.

- Continuous map representation refers to a smooth and detailed depiction of an environment, capturing fine-grained spatial information, often used in metric maps like occupancy grids.

5) What are decomposition strategies in map-based localization?

- Decomposition strategies involve breaking down a complex map into simpler, manageable segments or cells to facilitate easier and more efficient localization and navigation.

6) Briefly describe probabilistic map-based localization.

- Probabilistic map-based localization uses probability distributions to represent the robot's belief about its location, often utilizing algorithms like Particle Filters or Kalman Filters.

7) What is landmark-based navigation?

- Landmark-based navigation involves using recognizable environmental features (landmarks) as reference points to assist in localization and navigation.

8) What is globally unique localization?

- Globally unique localization ensures that the robot can determine its exact position within the environment without ambiguity, typically using unique markers or a highly detailed map.

9) Define positioning beacon systems in the context of robotics.

- Positioning beacon systems use fixed beacons placed in the environment that emit signals to help the robot triangulate its position accurately.

10) What is route-based localization?

- Route-based localization relies on predefined routes or paths within the environment, using cues and landmarks along the route to navigate.

Part-B

1) Compare and contrast localization-based navigation and programmed solutions in robotics. Discuss their respective advantages, limitations, and appropriate use cases.
2) Discuss different map representation techniques used in robotic navigation. How do continuous representations and decomposition strategies aid in efficient map usage and robot localization?
3) Explain probabilistic map-based localization. Describe the algorithms commonly used, such as Particle Filters and Kalman Filters, and their role in achieving accurate localization.
4) Describe the principles of landmark-based navigation and globally unique localization. How do these methods enhance the robot's ability to navigate complex environments?
5) Provide a comprehensive overview of Simultaneous Localization and Mapping (SLAM). Explain how SLAM algorithms work, the challenges involved, and their significance in autonomous map building and localization.

Unit-5

PART A

6) What are the main competences required for robotic navigation?

- The main competences required for robotic navigation are planning, reacting, localization, path planning, and obstacle avoidance.

7) Define path planning in the context of robotic navigation.

- Path planning involves determining a feasible route from the robot's current position to its desired destination while avoiding obstacles.

8) What is obstacle avoidance in robotics?

- Obstacle avoidance is the capability of a robot to detect and navigate around obstacles in its environment to prevent collisions.

9) Explain the concept of navigation architectures in robotics.

- Navigation architectures refer to the structural design and organization of software and hardware systems that enable a robot to perform navigation tasks.

10) What is control localization in robotic systems?

- Control localization is the process of accurately determining a robot's position and orientation within its environment to effectively control its movements.

11) What are decomposition techniques in robotic navigation?

- Decomposition techniques involve breaking down a complex navigation problem or map into simpler, manageable parts to facilitate easier processing and planning.

12) Briefly describe collaborative robots.

- Collaborative robots, or cobots, are designed to work alongside humans in shared workspaces, often enhancing human capabilities and improving efficiency.

13) What are swarm robots?

- Swarm robots are a group of robots that operate together to perform tasks, mimicking the behavior of natural swarms like ants or bees, and typically rely on decentralized control.

14) Give an example of a path planning algorithm.

- An example of a path planning algorithm is the A* algorithm, which uses heuristics to efficiently find the shortest path to the destination.

15) What is reactive navigation in robotics?

- Reactive navigation refers to a robot's ability to make real-time adjustments to its path based on sensor data and immediate changes in the environment.

Part-B

1) Discuss the various competences required for effective robotic navigation. How do planning and reacting complement each other in dynamic environments?
2) Explain in detail the process of path planning in robotic navigation. What are the key challenges and considerations in developing efficient path planning algorithms?
3) Analyze the importance of obstacle avoidance in robotic navigation. Discuss different techniques and sensors used for obstacle detection and avoidance.
4) Describe different navigation architectures used in robotics. How do these architectures influence the performance and capabilities of autonomous robots?
5) Examine the roles and applications of collaborative robots and swarm robots. How do their navigation and coordination strategies differ, and what are the advantages and challenges associated with each?