

Introduction to Mobile Robotic Systems

Components of Mobile Robots

- Mechanical structure and chassis
- Actuators
 - DC motors, servo motors, stepper motors
 - Linear actuators
 - Pneumatic and hydraulic systems
- Power systems
 - Batteries and power management
 - Energy harvesting approaches
- Sensors
 - Proprioceptive (encoders, IMUs, gyroscopes)
 - Exteroceptive (cameras, lidars, sonars, tactile)
- Computing hardware
 - Microcontrollers vs. embedded computers
 - GPU acceleration for perception
 - Field-programmable gate arrays (FPGAs)
- Communication systems

Sensing, Planning, and Actuation Pipeline

- Perception: converting sensor data into useful information
- Localization: determining robot position and orientation
- Mapping: building representations of the environment
- Path planning: determining how to reach goals
- Motion control: executing planned movements
- The sense-plan-act paradigm

Locomotion Mechanisms for Mobile Robots

- Wheel arrangements and configurations
 - Two-wheel differential drive
 - Four-wheel and six-wheel designs
 - Castor and Swedish wheels
- Drive mechanisms
 - Direct drive vs. geared systems
 - Belt and chain drives
 - Differential gearing
- Steering mechanisms
 - Differential steering
 - Ackermann steering
 - Skid steering
- Performance considerations
 - Stability
 - Maneuverability
 - Efficiency
 - Payload capacity

Differential Drive Kinematics

- Forward kinematics: wheel velocities to robot velocity
- Inverse kinematics: robot velocity to wheel velocities
- Kinematic constraints
- Instantaneous center of rotation (ICR)
- Mathematical model of differential drive