1. Perception System Requirements

Sensor Integration: Support for LiDAR, radar, cameras, ultrasonic sensors, and GPS.

Object Detection and Recognition: Use of computer vision and deep learning to detect pedestrians, vehicles, and obstacles.

Environmental Mapping: Real-time SLAM (Simultaneous Localization and Mapping) for dynamic environmen

2. Localization and Mapping

High-Precision Localization: Fusion of GPS, IMU, and odometry data to determine position.

Real-Time Map Updates: Capability to update maps based on sensor data in real time.

Global and Local Mapping: Support for both high-definition global maps and local environment maps.

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3. Path Planning and Navigation

Route Planning Algorithms: A\* or Dijkstra for global path planning.

Obstacle Avoidance: Dynamic re-routing and path adjustment using local sensors.

Trajectory Generation: Smooth, collision-free motion planning.

4. Motion Control

Real-Time Control Systems: PID, MPC, or RL-based control systems for steering, acceleration, and braking.

Kinematics and Dynamics Modeling: Accurate modeling for different robot types (wheeled, legged, drones)

5. Communication and Networking

Vehicle-to-Everything (V2X): For autonomous vehicles, support for V2V, V2I, and V2N protocols.

Low-Latency Networking: Real-time data sharing among components and external systems.

6. Decision-Making and AI

Behavior Prediction: AI models for predicting actions of other agents (vehicles, people).

Autonomous Decision Logic: Rule-based or learning-based decision-making for complex scenarios.

Multi-Agent Coordination: For fleets or robot swarms.

7. Simulation and Testing

Software-in-the-Loop (SIL) and Hardware-in-the-Loop (HIL) support.

Digital Twins and 3D Simulators: For testing scenarios before deployment (e.g., Carla, Gazebo, AirSim)

8. Safety and Redundancy

Fail-Safe Mechanisms: Redundant control and power systems.

Error Detection and Recovery: Real-time monitoring and fallback strategie

9. User Interface and Teleoperation

Monitoring Dashboards: Real-time status, diagnostics, and logs.

Manual Override: Ability to remotely or locally take control if neede

10. Security and Compliance:

Cybersecurity Protocols: Encryption, authentication, and secure data channels.

Regulatory Compliance: Adherence to automotive or robotics safety standards (ISO 26262, ISO 102)