Software Requirements for Autonomous Vehicles and Robotics

1. Perception Systems

- Sensor Integration: Support for LiDAR, radar, cameras, ultrasonic sensors.
- Sensor Fusion Algorithms: Combine inputs to generate a coherent environmental model.
- Object Detection & Classification: Identify other vehicles, pedestrians, obstacles.
- Environmental Mapping: SLAM (Simultaneous Localization and Mapping) capabilities.

2. Localization and Navigation

- GPS and IMU Integration: For real-time position tracking.
- Path Planning Algorithms: Determine the optimal route from A to B.
- Trajectory Generation: Smooth, safe movement planning.
- Map Handling: Use of HD maps and ability to update dynamically.

3. Control Systems

- Vehicle Dynamics Control: Throttle, steering, braking.
- Low-Level Control Algorithms: PID, MPC (Model Predictive Control), etc.
- Error Handling and Recovery: Fallback behaviors in case of faults.

4. Decision Making and Planning

- Behavior Planning: Lane changes, overtaking, stopping, yielding.
- Motion Planning: Collision-free trajectory within behavioral constraints.
- Prediction Models: Anticipate movement of nearby agents.

5. Human-Machine Interface (HMI)

- User Input Handling: Voice commands, touch interfaces.
- Feedback Systems: Visual, auditory, or haptic alerts for user interaction.
- Remote Monitoring and Control: For teleoperation or supervision.

6. Communication Systems

- V2X Communication: Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I).

- CAN Bus Integration: Interfacing with internal vehicle networks.

- Cloud Connectivity: Data upload/download, over-the-air (OTA) updates.

7. Safety and Security

- Fail-Safe Mechanisms: Emergency stop, fallback planning.

- Cybersecurity Protocols: Authentication, encryption, intrusion detection.

- Compliance Standards: ISO 26262 (functional safety), AUTOSAR.

8. Software Infrastructure

- Real-Time Operating System (RTOS): For deterministic task scheduling.

- Middleware: ROS (Robot Operating System), DDS (Data Distribution Service).

- Simulation and Testing Tools: Gazebo, Carla, LGSVL.

9. Data Management

- Data Logging and Analysis: For debugging and performance monitoring.

- Machine Learning Integration: Training and deploying models.

- Big Data Storage: Efficient handling of large sensor datasets.