To develop an embedded product for an autonomous car that detects objects and takes corrective actions while driving, the requirements must cover the hardware, software, and environmental constraints. Below is a comprehensive list of requirements to guide the selection of a microcontroller for this project.

1. Functional Requirements
Object Detection
Support for interfacing sensors such as LIDAR, ultrasonic, RADAR, and cameras.
Real-time image processing capability for object recognition and classification.
Corrective Action
Ability to control actuators for steering, braking, and acceleration.
High-speed decision-making to avoid collisions or maintain safe distances.
Communication
Support for CAN, LIN, and Ethernet for communication with other car systems.
Ability to interface with GPS and IMU sensors for positioning and orientation.
Fail-Safe Mechanisms
Redundant systems to ensure reliability in case of hardware or software failure.
Automatic transition to manual driving in case of system failure.

2. Performance Requirements
Processing Power
High-performance ARM Cortex-M or Cortex-A cores capable of handling complex AI/ML algorithms.
Minimum clock speed: 200 MHz.
Support for hardware accelerators (e.g., DSP or AI inference engines).
Memory
Flash memory: ≥ 2 MB for program storage.
RAM: ≥ 512 KB for real-time processing.
Real-Time Operation
Must support real-time operating systems (RTOS) for deterministic behavior.
Low latency for sensor input to action output (≤ 50 ms).
Power Consumption
Optimized power consumption for automotive environments, with sleep modes and low-power states.

3. Hardware Requirements
Interfaces
Multiple UART, SPI, I2C, and GPIOs for connecting peripherals.
Support for high-speed data interfaces like USB or PCIe.
Robustness
Temperature range: -40°C to 125°C.
Vibration and shock resistance per automotive standards.
Safety Standards Compliance
Compliance with ISO 26262 for functional safety (ASIL-B or higher recommended).

Analog and Digital Input/Output
Support for ADCs and DACs for sensor inputs and control outputs.

4. Software Requirements
Development Tools
Support for standard toolchains like GCC, Keil, IAR, or vendor-specific IDEs.
Debugging capabilities with JTAG or SWD.
Connectivity
Support for wireless communication standards like Wi-Fi, Bluetooth, or 5G for over-the-air updates.
AI and Machine Learning
Compatibility with AI frameworks like TensorFlow Lite or ONNX for embedded systems.
Hardware or software-based ML acceleration.
Firmware Update
Secure bootloader for over-the-air firmware updates (OTA).
Encryption and authentication for updates.

5. Environmental Constraints
Automotive Standards
Must comply with AEC-Q100 for automotive-grade microcontrollers.
Electromagnetic compatibility (EMC) and susceptibility (EMS) compliance.
Power Supply
Operate within 12V DC automotive systems with tolerance for voltage spikes.

6. Cost and Scalability
Cost Constraints
Affordable while meeting all performance and safety requirements.
Scalability
Easily scalable for integration into different vehicle models.

S32G3 vehicle network processors combine ASIL D safety, hardware security, high-performance real-time and application processing and network acceleration. S32G3 supports the needs of new vehicle architectures: service-oriented gateways, vehicle computers, domain controllers, zonal processors, safety processors and more.
Functional Requirements:

Object Detection: Integrates high-speed interfaces (PCIe, Ethernet TSN) to connect external vision processors and sensors like LIDAR, RADAR, and cameras.
Corrective Action: ARM Cortex-A53 cores enable real-time decision-making and control of actuators.
Communication: Supports CAN FD, LIN, and Ethernet for robust in-car communication, as well as GPS/IMU integration.
Fail-Safe Mechanisms: ISO 26262 ASIL-D compliance and built-in hardware redundancy ensure reliability.
Performance Requirements:

Processing Power: High-performance ARM Cortex-A53 cores with clock speeds >200 MHz; integrated Neural Processing Unit (NPU) for AI/ML tasks.
Memory: 8 MB Flash and 1 MB RAM exceed the requirements for program storage and real-time tasks.
Real-Time Operation: Supports RTOS for low-latency (≤50 ms) operation.
Power Consumption: Automotive-grade power optimization.
Hardware Requirements:

Interfaces: Multiple UART, SPI, I2C, GPIOs; supports PCIe and USB.
Robustness: Operates in -40°C to 125°C, vibration-resistant, and shock-compliant.
Safety Standards: Fully compliant with ISO 26262 ASIL-D.
ADC/DAC: Built-in support for analog and digital input/output.
Software Requirements:

Development Tools: Compatible with GCC, Keil, IAR, and NXP's S32 Design Studio.
Connectivity: Supports Wi-Fi, Bluetooth, 5G for OTA updates.
AI/ML: Compatible with TensorFlow Lite and ONNX; supports hardware ML acceleration.
Firmware Update: Secure bootloader and robust encryption mechanisms.
Environmental Constraints:

Automotive-Grade Compliance: AEC-Q100 certified, with EMC/EMS protection.
Cost and Scalability:

Designed for scalability across different vehicle models.
Cost-effective considering its high functionality.