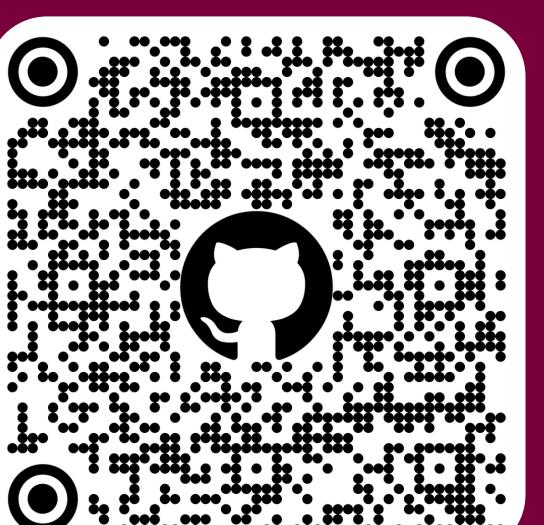




WEATHER AUTOMATED RESPONSE SYSTEM

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Objective

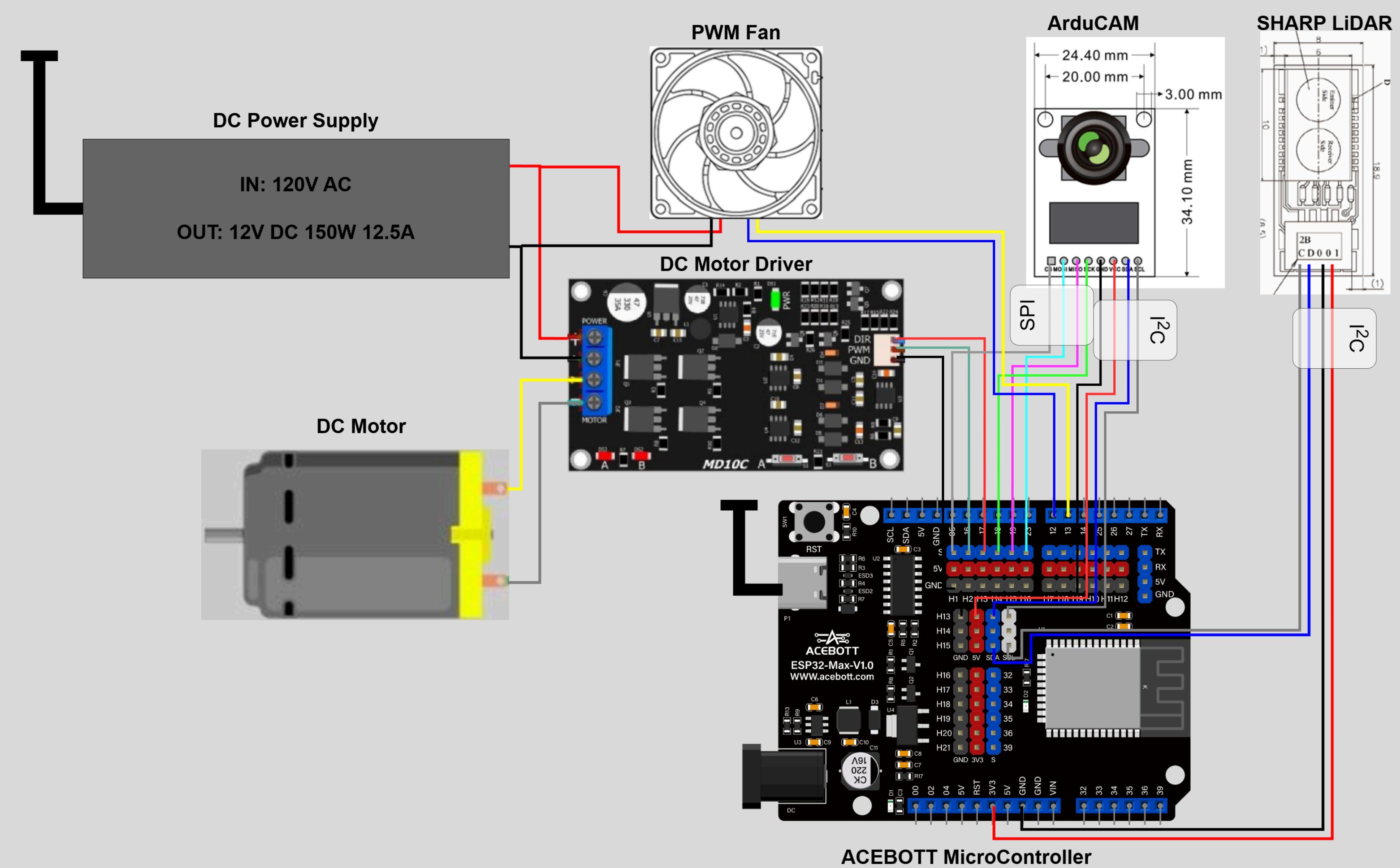
Our Capstone enhances driving safety by developing an automatic windshield wiper system using ESP-32, a camera, and LiDAR. By detecting rain, fog, and debris in real-time, the system autonomously adjusts wiper speed and activates defogging, reducing driver distraction and improving visibility. This smart solution optimizes energy use, extends wiper lifespan, and aligns with the future of vehicle automation.

Challenges

- Camera integration with ESP-32 required firmware changes.
- No existing neural networks for rain detection; opted for OpenCV-based analysis.
- Limited processing power on ESP-32; offloaded tasks to an external PC via WiFi.
- LiDAR only provided distance data, requiring a custom rain detection algorithm.
- Motor torque limitations led to using a rear-window wiper for the demo.

CAN BUS

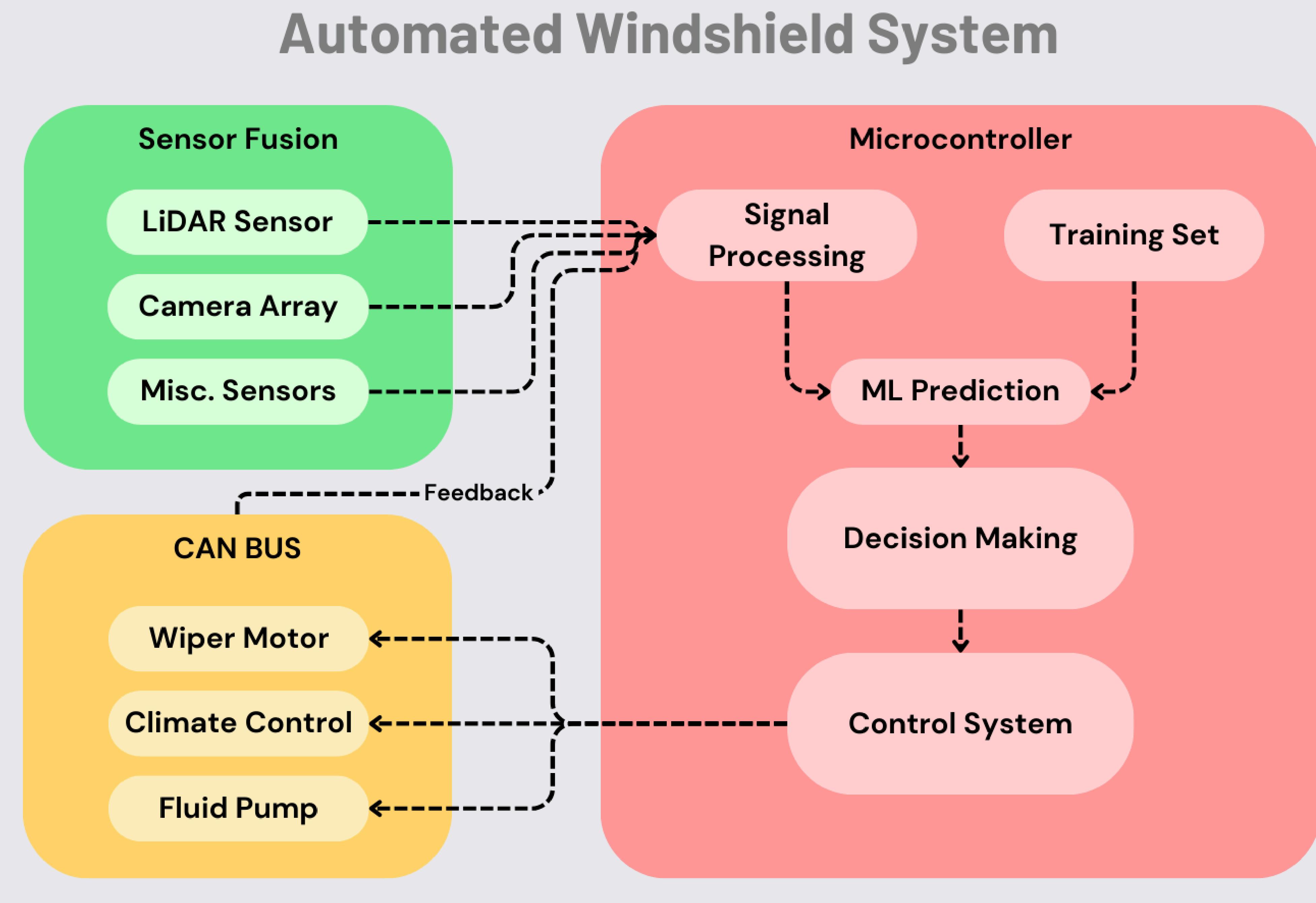
We considered the OBD-II port to integrate our system with older cars, controlling wipers and climate systems via CAN BUS. However, manufacturer-specific protocols and the need for real vehicle testing made implementation too complex, so we paused this feature to focus on a functional prototype. ECU communication remains a goal.



Components and Framework

- Microcontroller: ESP-32 handles communication and control between sensors & motors.
- HD Camera & LiDAR: Captures images & measures distance data to determine rain intensity.
- DC Motor & Wiper System: Speed adjusts based on detected rain intensity.
- Python: Implementation of Neural Network and Image processing for raindrop detection.
- Arduino Code: Controls decision-making, SPI & I²C communication, and motor actuation (PWM).

System Overview



How it Works



1. Camera and LiDAR Sensor capture windshield conditions
2. Neural Network and OpenCV processes images to detect raindrops.
3. ESP-32 receives rain intensity data from a Python-based server.
4. Wiper speed is adjusted dynamically based on detected rain.
5. Fog detection triggers a PWM fan to defog the windshield.