Design and Implementation of a Plug-and-Play Edge-Cloud Architecture for Retrofitting EVs with Autonomous Safety Features

EDGE COMPUTING
EDGELORDS

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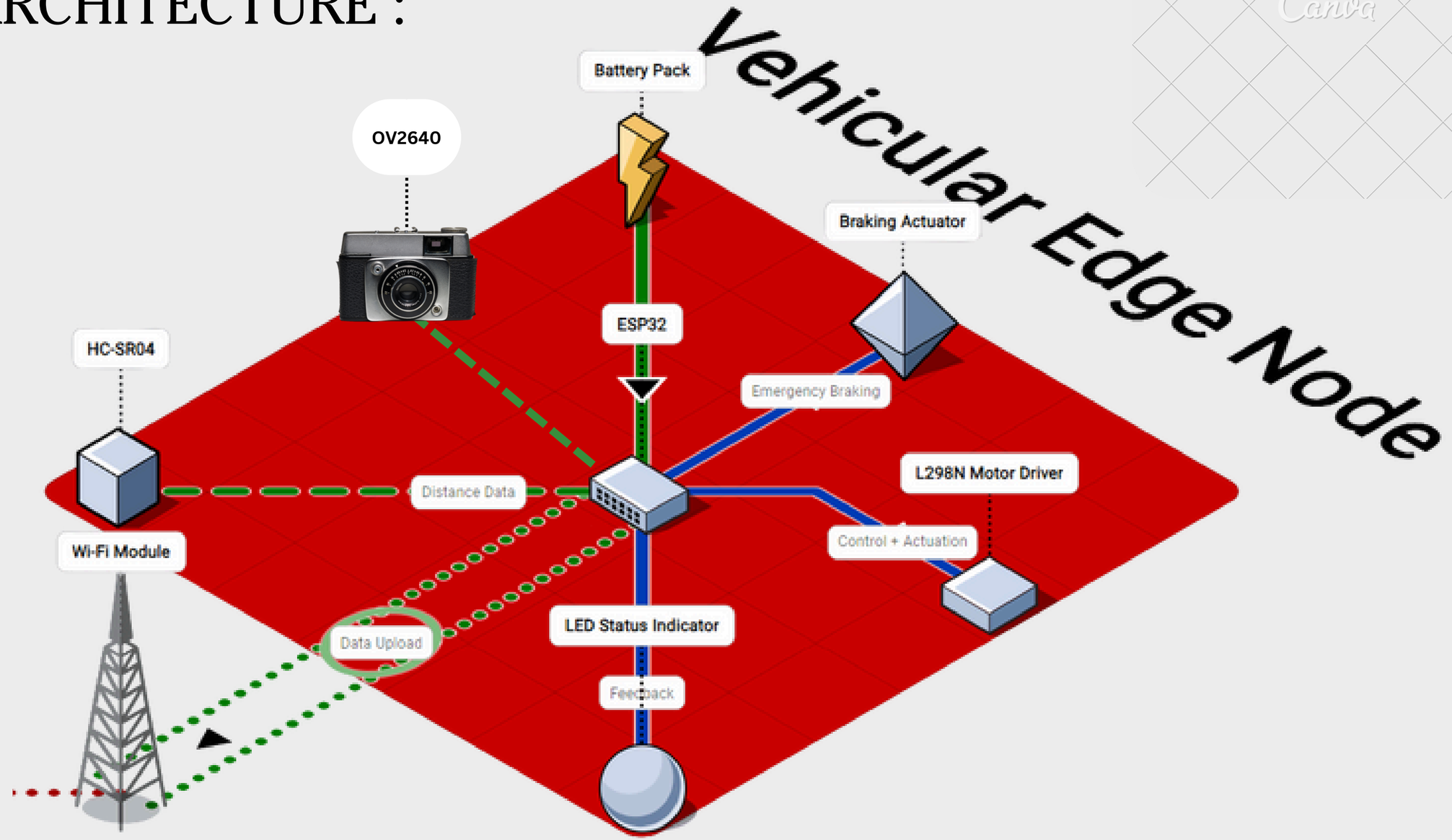
ARCHITECTURE :



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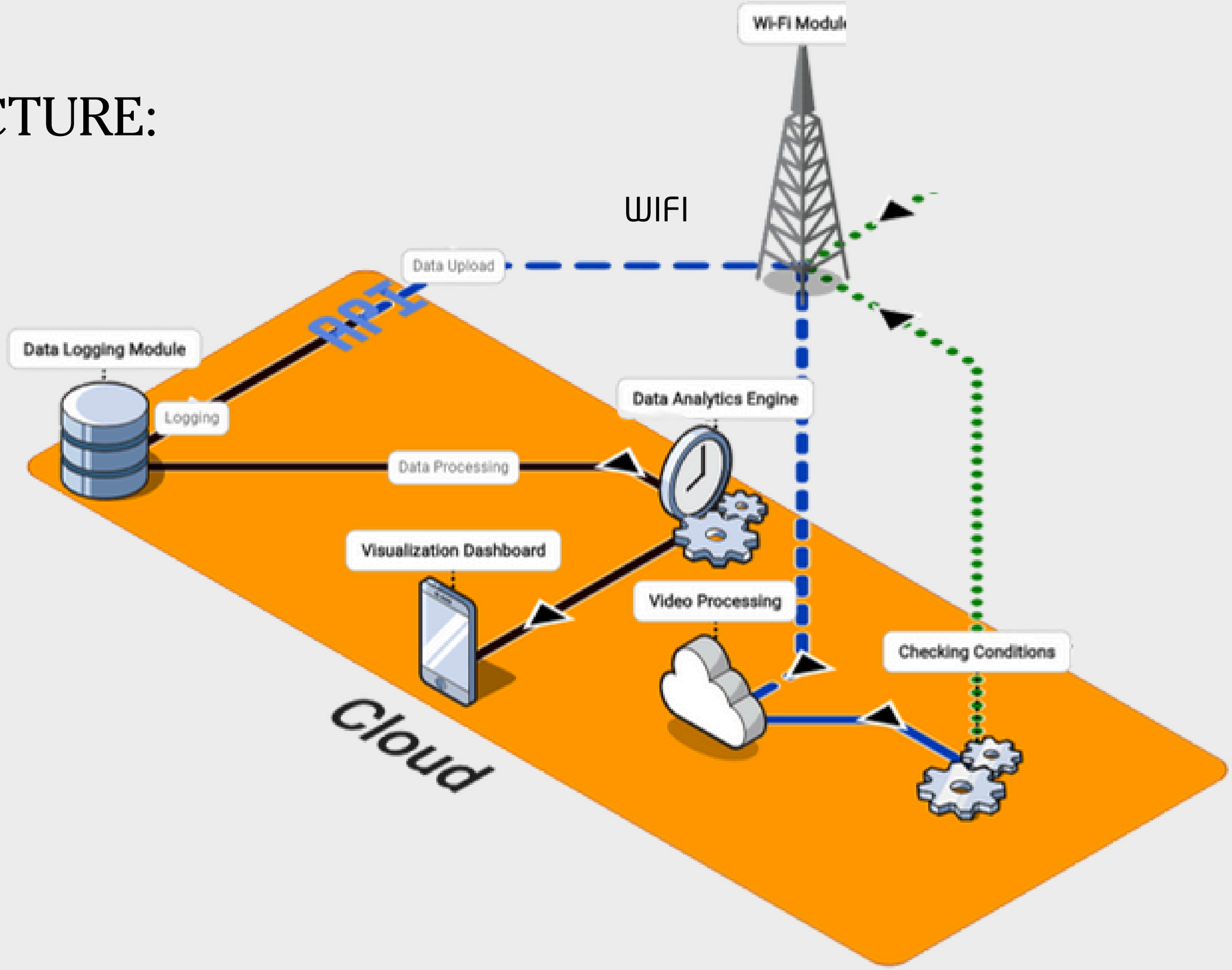
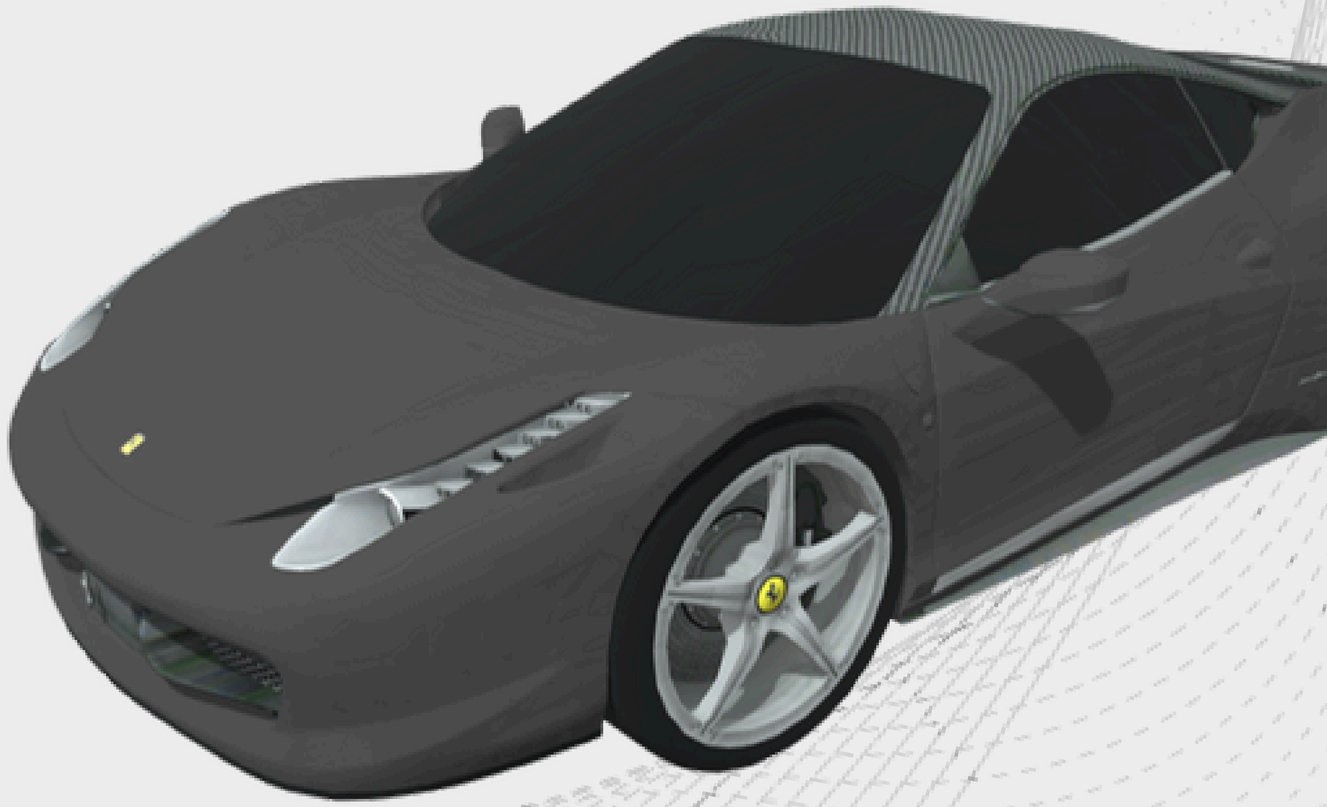


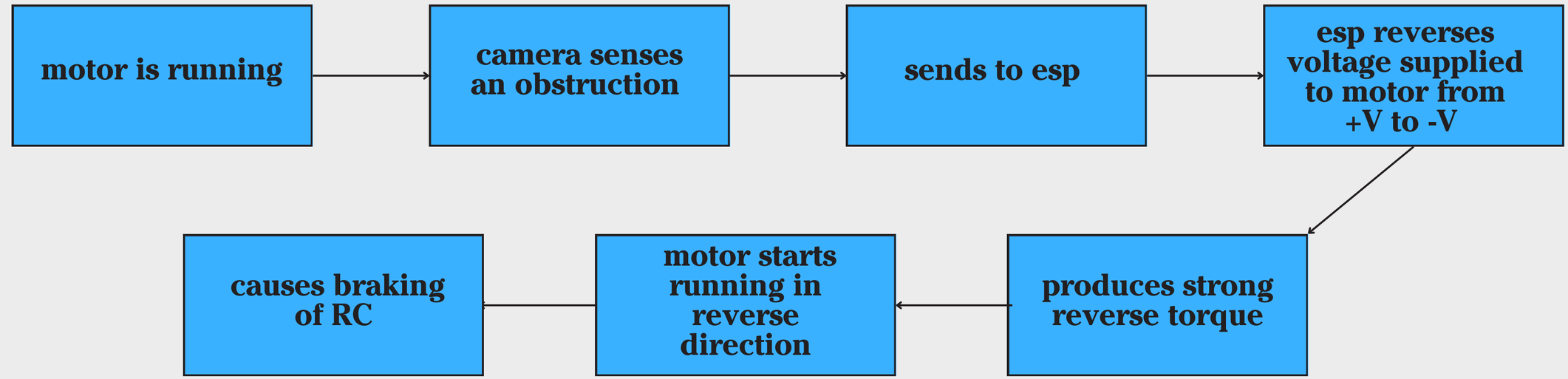
TEAR APART OF THE RC

- 2 MOTORS USED FOR TRAVEL
- 1 MOTOR USED FOR STEERING
- STANDARD 3.7V BATTERY

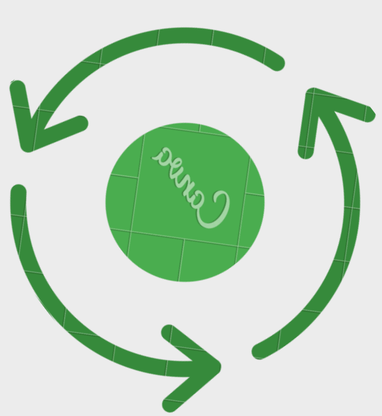


BRAKING:

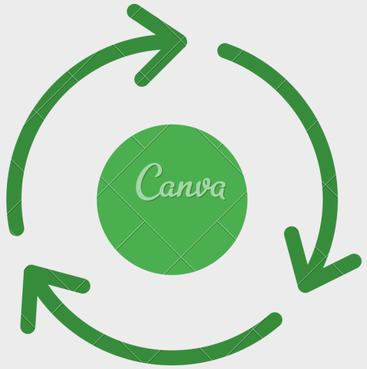
Plugging is a braking method where reverse voltage (or phase reversal) is applied to a running motor, producing a strong reverse torque that quickly stops it.



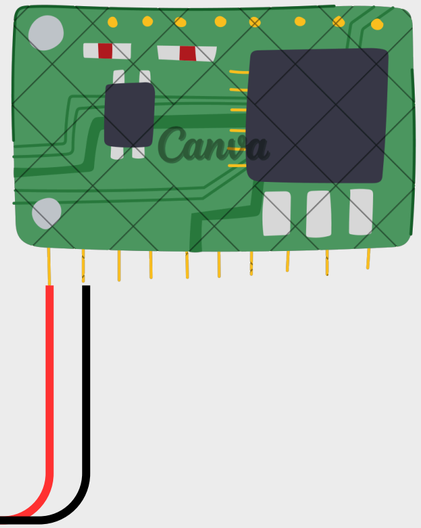
STEERING:



clock-wise

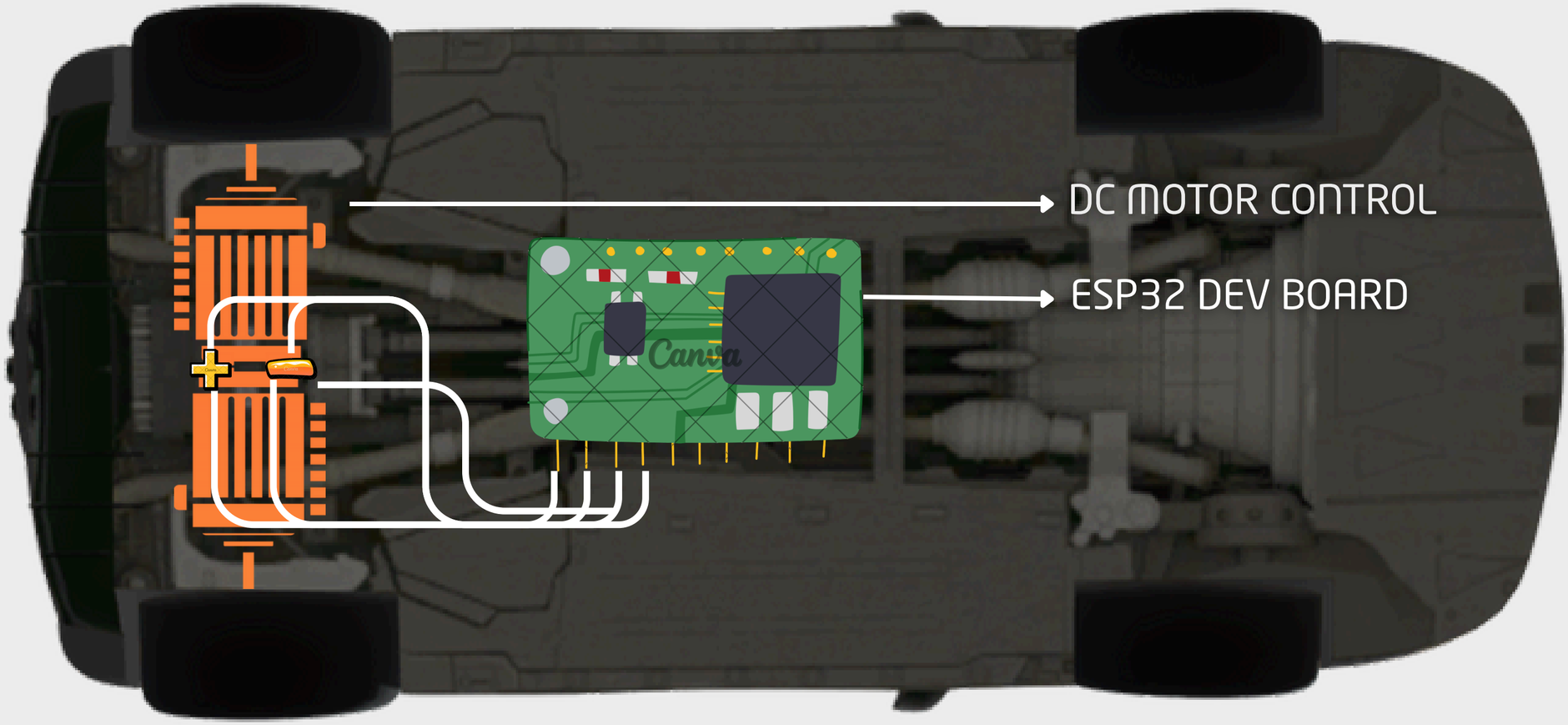


anticlock- wise



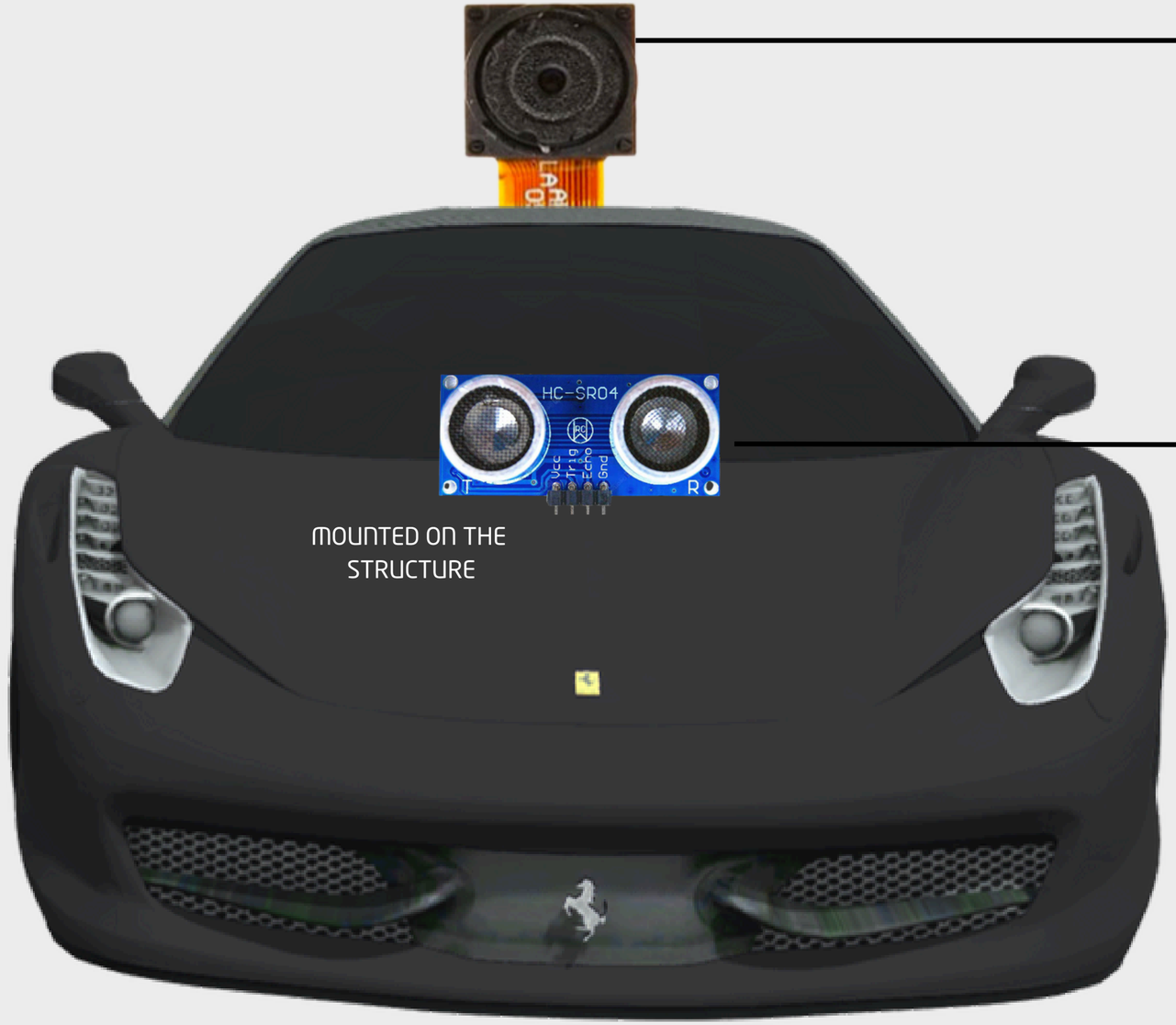
ARCHITECTURE

BOTTOM VEIW**



ARCHITECTURE

FRONT VIEW**



ESP32 CAM

ULTRASONIC

MOUNTED ON THE STRUCTURE

ESP32 INTEG:

ARDUINO: ESP32- WROOM-DA

1. Ultrasonic Sensor → Detects obstacle distance
2. Immediate Action → Plugging braking + LED if too close
3. Camera (OV2640) → Captures road image
4. Cloud CNN → Processes image for lane availability
5. Decision Making
6. Lane free → Steer left/right
7. Both lanes blocked → Brake
8. Motors → Execute forward, steering, or braking

EDGE-BASED AUTONOMY FOR RC CAR

Distance sensor → Microcontroller

Threshold filter for Stop/Go decision

Initial plan: Fuzzy logic (VERY CLOSE / CLOSE / FAR / VERY FAR)
Smooth transitions but heavy computation
Requires floating-point math → risk of overflow

Constraint: Limited MCU resources (CPU + memory)

Solution: Simple if-else logic
Deterministic timing, low memory footprint

Integer/fixed-point friendly
Result: Reliable real-time control with minimal processing

CLOUD-BASED AUTONOMY FOR RC CAR

Camera feed → Cloud

CI Module (Lane + Object Detection)
CNN for lane detection
YOLO for object detection

Decision logic → Commands back to car

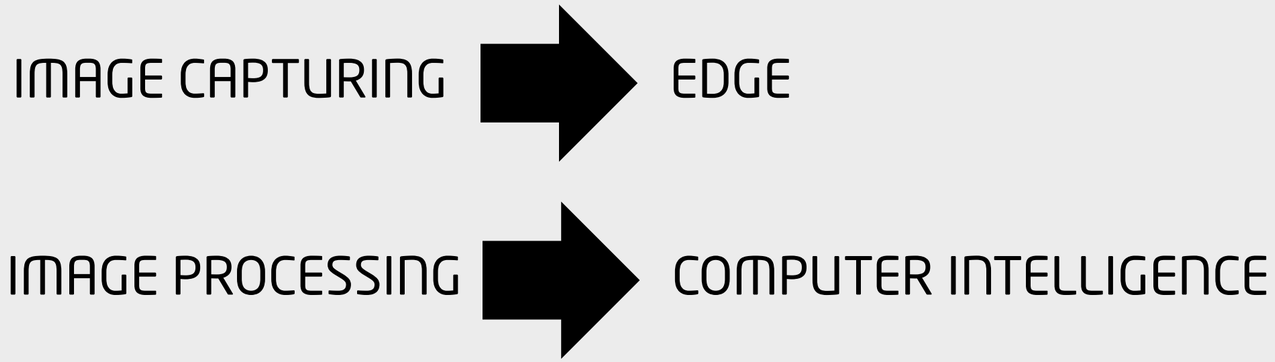
Onboard distance sensor ensures stop if object too close

COMPUTER INTELLIGENCE MODULE

- Lane Detection (CNN):
  - Learns road features to predict lane center offset
  - Keeps car aligned with road
- Object Detection (YOLO):
  - Detects obstacles in left / center / right zones
  - Guides steering around blocked paths

INTEGRATION OF EDGE AND CI

IMAGES CAPTURED BY CAMERAS SENT TO CLOUD AND PROCESSED FOR OBJECT DETECTION AND STEERING



DOUBTS ARE APPRECIATED