Project Report

ON

# ADVANCED DRIVER ASSISTANCE SYSTEM (ADAS)

Submitted by:

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# INTRODUCTION

Advanced Driver Assistance Systems (ADAS) represent a leap forward in automotive technology, aimed at enhancing safety, improving comfort, and reducing accidents. ADAS includes features like collision avoidance, adaptive cruise control, lane-keeping assistance, and more, all designed to assist drivers in various driving scenarios.

**Objectives**:

- Enhance vehicle safety
- Reduce driver workload
- Improve driving comfort
- Move toward full autonomy

**Scope**: This project focuses on implementing ADAS features using sensors, microcontrollers, and software algorithms.

# LITERATURE REVIEW

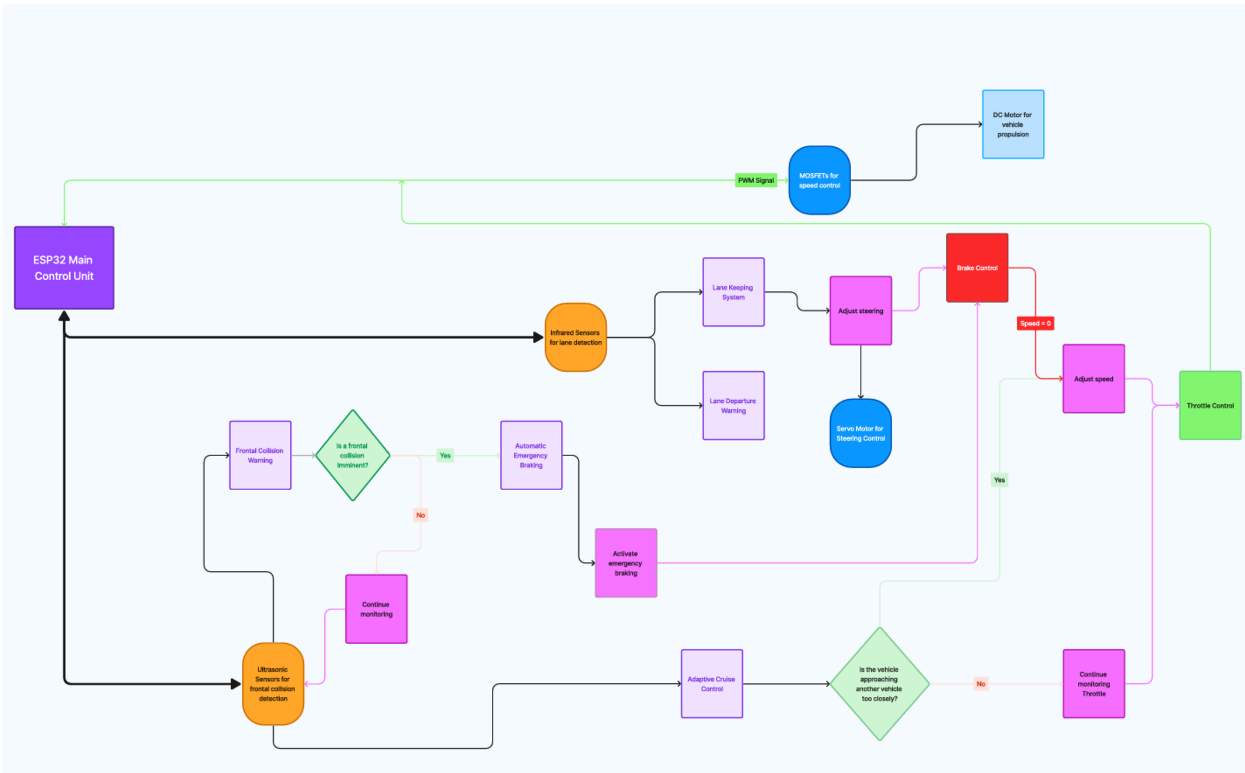
**1. Evolution of ADAS**
ADAS began with basic safety features like anti-lock braking but has advanced to include semi-autonomous capabilities, such as lane-keeping and collision avoidance, thanks to improvements in sensors, AI, and processing power.

**2. Key Technologies**
ADAS relies on sensors (radar, lidar, cameras), real-time processing, actuators, and software algorithms to monitor surroundings, make decisions, and control vehicle responses.

**3. Main Features**
Key ADAS functions include:

- **Collision Avoidance**: Prevents crashes by braking or alerting the driver.
- **Adaptive Cruise Control**: Adjusts speed to maintain safe following distances.
- **Lane-Keeping**: Keeps the vehicle centered in its lane.

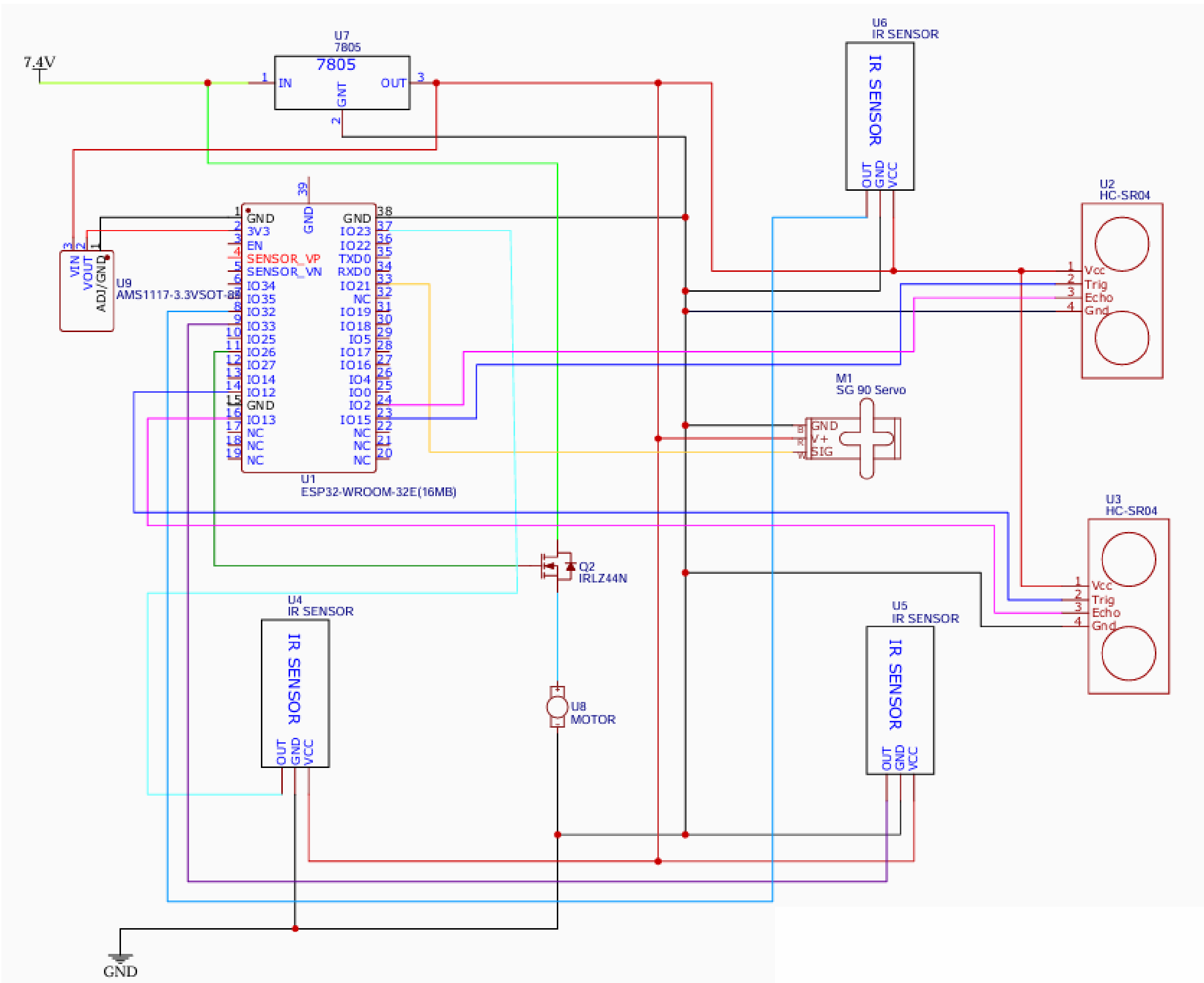
# BLOCK DIAGRAM WITH WORKING




1. **ESP32 Main Control Unit**:
   - This is the central processing unit that receives input from sensors and sends commands to different control systems like braking, throttle, and steering.
2. **Infrared Sensors for Lane Detection**:
   - These sensors detect lane markings and send information to the **Lane Keeping System**. This system is responsible for ensuring the vehicle stays within the lane boundaries.
   - If the vehicle starts to drift, the **Lane Departure Warning** system activates, alerting the control unit to adjust the steering.
3. **Steering Control**:
   - When a lane departure or drift is detected, the **Lane Keeping System** sends commands to adjust steering, which is managed by a servo motor.
   - The ESP32, through the servo motor, modifies the steering to keep the vehicle aligned in the lane.

4. **Ultrasonic Sensors for Frontal Collision Detection**:
    - These sensors monitor the distance to objects in front of the vehicle, detecting potential collision risks.
    - If a **frontal collision** is imminent, a **Frontal Collision Warning** is triggered.
    - The ESP32 then decides whether **Automatic Emergency Braking** is necessary to avoid an accident.
5. **Automatic Emergency Braking**:
    - When a collision risk is detected, the ESP32 activates the braking system to reduce speed or stop the vehicle.
    - If the situation remains critical, the **Activate Emergency Braking** process ensures the brakes are applied until the risk is mitigated.
6. **Adaptive Cruise Control**:
    - This system manages the vehicle's speed based on the distance to the vehicle in front.
    - If the vehicle is approaching another too closely, the ESP32 adjusts the speed by engaging **Throttle Control** and potentially the braking system.
7. **Throttle and Brake Control**:
    - **Throttle Control** is responsible for adjusting the vehicle's speed based on commands from the ESP32, using a DC motor to control propulsion.
    - **Brake Control** manages the braking force, either to slow down or stop the vehicle, depending on inputs from collision and adaptive cruise control systems.
8. **PWM Signal and MOSFETs**:
    - The **PWM (Pulse Width Modulation) Signal** is used to control the speed of the DC motor through **MOSFETs** (electronic switches). This setup allows the ESP32 to vary the motor speed smoothly.
9. **Feedback Loops**:
    - The diagram includes various feedback loops where each control system continues to monitor the situation and adjust as necessary.
    - For instance, **Continue Monitoring** blocks ensure the sensors keep assessing lane position, distance to obstacles, and speed, allowing real-time adjustments.

# INTERFACING DIAGRAM



# HARDWARE DETAILS

**1. ESP32 Microcontroller**
The ESP32 is a dual-core microcontroller with Wi-Fi and Bluetooth support, making it suitable for real-time ADAS applications. It handles multiple sensor inputs efficiently and enables wireless data transmission

**2. Ultrasonic Sensors**
Ultrasonic sensors measure distances by emitting sound pulses. They are essential for collision detection and parking assistance, as they detect obstacles and calculate proximity.

**3. IR Sensors**
IR sensors emit infrared light to detect nearby objects. They are primarily used for short-range detection, like blind-spot monitoring and close obstacle identification.

**4. Motors and Actuators**
Actuators perform physical actions such as braking and steering adjustments. In ADAS, they receive commands to engage functions like collision avoidance and mirror adjustments.

**5. Power Supply**
A stable power source ensures all components work reliably, which is crucial for safety and consistent ADAS performance.

# RESULT

The Advanced Driver Assistance System (ADAS) was developed to integrate essential safety and driver-assist features, and initial testing of core functions demonstrated strong results in lane-keeping, collision avoidance, and adaptive cruise control. The tests were conducted in controlled environments that simulated real-world scenarios, including lane departure, object detection, and distance maintenance.

**Evaluation of Key Features:**

- **Lane Keeping**: The lane-keeping feature effectively used camera input and processing algorithms to detect lane markings and adjust the steering to keep the vehicle centered. During testing, the vehicle maintained alignment within the designated lane even during mild curves, achieving a high level of accuracy and stability.
- **Collision Avoidance**: Collision detection and avoidance were tested using ultrasonic and IR sensors, which enabled real-time monitoring of obstacles within a set radius. The system reliably detected objects and initiated braking at appropriate distances, successfully preventing simulated collisions.
- **Adaptive Cruise Control (ACC)**: This feature was evaluated by simulating variable traffic conditions where the ADAS adjusted vehicle speed to maintain a safe following distance. The system responded smoothly to speed changes, adapting effectively to slower-moving vehicles and maintaining safe distances.
- **Blind Spot Detection (BSD)**: Blind spot detection functionality was tested by placing objects in areas outside the driver's field of vision. The ADAS successfully alerted the driver, showcasing its utility in enhancing situational awareness.

**Overall System Performance**: The ADAS prototype showed reliable real-time responses, effectively reducing driver intervention in tasks like maintaining lane position, adjusting speeds, and preventing potential collisions. The system's performance in these controlled tests suggests it has the potential to significantly improve road safety when further refined and deployed in real-world conditions

# CONCLUSION

The ADAS project demonstrates the practical application of technology to enhance driving safety, comfort, and convenience. By incorporating key safety features like lane-keeping, collision avoidance, and adaptive cruise control, the system reduces the driver's workload and offers preventive safety measures, which are essential in modern driving environments.

The project's findings indicate that ADAS can effectively contribute to reducing traffic incidents by minimizing human error through automation. As the automotive industry advances, ADAS will play a pivotal role in achieving higher levels of autonomy.

# REFERENCES

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