A logo of a university

Description automatically generated

***Misr University of Science and Technology***

***College of Engineering and Technology***

***Department of Mechatronics Engineering***

B. Eng. Final Year Project

**Advanced Driver Assistance Systems (ADAS)**

By:

*GROUP ( 7 )*

|  |  |
| --- | --- |
| *NAME* | *ID* |
| Abanob Malak | 95689 |
| Kareem Ahmed | 95635 |
| Omar Mohamed | 95668 |
| Magdy Maged | 91672 |
| Essam Alaa | 91679 |

Supervised By:

*Supervisor(s)*

|  |  |
| --- | --- |
| *Prof. Dr. Mohamed Ebrahim* | *Department Professor* |
| *Prof. Dr. Mohamed Kamel* | *Department Professor* |
| *Dr. Tarek Abd Elbadia* | *Department Professor* |
| *Dr. Khaldon Taha* | *Department Professor* |

# 1. Introduction and Background

* Objective: The purpose of this project is to design a car prototype integrated with essential ADAS features to improve safety and autonomous vehicle control. The design will include an Ackermann steering mechanism, which is chosen for its maneuverability and accuracy, especially beneficial in tight cornering and lane-keeping tasks essential for ADAS.
* Background: ADAS (Advanced Driver Assistance Systems) are key in developing safer and more reliable autonomous driving experiences. The primary focus for this prototype is to integrate basic ADAS capabilities, enabling the vehicle to operate within controlled environments while maintaining effective handling and stability.

# 2. Design Objectives and Requirements

* Objectives:
  + Create a chassis design that supports stable handling and integrates seamlessly with sensors and other ADAS components.
  + Implement Ackermann steering geometry to enhance maneuverability and prevent wheel slippage during turns.
* Requirements:
  + Dimensions suitable for testing in a lab environment (e.g., a smaller scale chassis).
  + Lightweight materials for ease of prototyping and durability.
  + Mounting points for sensors such as cameras, LiDAR, and ultrasonic sensors, which are crucial for adaptive cruise control and blind spot detection.
* Constraints:
  + Limited weight to ensure easy movement and handling.
  + Compatibility with ADAS software for effective communication with sensors and actuators.

# 3. Design Approach

## Ackermann Steering Geometry:

* + Ackermann steering geometry is chosen because it allows each wheel to follow the correct turning radius, reducing tire wear and improving cornering precision. This design calculates the optimal angle for each front wheel during a turn, with a focus on maintaining accurate alignment.
  + *Theory and Calculations*: Ackermann geometry is achieved by ensuring that the imaginary lines extending from each steering arm intersect at the rear axle. The steering angles are calculated based on the desired turning radius and wheelbase. These calculations help align each wheel to reduce slip and maintain stability.

## Chassis and Steering Mechanism:

* + The chassis is designed with a balanced weight distribution, factoring in the locations of the ADAS modules and any electronic components. To support the weight and functionality, we are using lightweight yet durable materials (e.g., aluminum or a sturdy polymer).

## CAD Modeling Process:

* + Using CAD software such as SolidWorks or AutoCAD, we created 3D models of the chassis, including precise dimensions for each component. Each iteration considered structural stability, especially in the areas connecting the steering mechanism to the chassis.

# 4. Suggested Material of Chassis

**1. Aluminum**

* **Properties**: Lightweight, durable, corrosion-resistant, and relatively easy to machine.
* **Pros**:
  + Good strength-to-weight ratio.
  + Affordable and widely available.
  + Resistant to rust, making it suitable for a range of environments.
* **Cons**:
  + Can be softer than steel, meaning it may not withstand extreme impacts as well.
  + More difficult to weld than steel without specialized equipment.
* **Best For**: Lightweight prototypes where moderate strength is sufficient.

**2. Steel (Mild or Stainless)**

* **Properties**: Strong and durable, with high resistance to deformation.
* **Pros**:
  + Very strong, can withstand heavy loads and impacts.
  + Stainless steel is corrosion-resistant, while mild steel can be painted or coated.
* **Cons**:
  + Heavier than aluminum, which may impact vehicle performance.
  + Difficult to machine and requires advanced tools for shaping and cutting.
* **Best For**: Applications where strength is critical, such as heavier prototypes or those subject to rough handling.

**3. Wood (Plywood)**

* **Properties**: Surprisingly durable for lightweight models, biodegradable, and easy to work with.
* **Pros**:
  + Inexpensive, easy to source and shape.
  + Plywood, especially, has good strength for lightweight applications.
  + Bamboo composites offer a sustainable, strong, and lightweight option.
* **Cons**:
  + Not as durable as metals; can warp under moisture or high loads.
  + Limited strength, not suitable for high-speed or high-stress applications.
* **Best For**: Low-cost, simple prototypes or early testing phases where advanced materials are unnecessary.

# 5. Results and Specifications

## Specifications:

* + **Chassis Dimensions**: Approximately 80 cm in length and 30 cm in width.
  + **Material**: For beginning Aluminum for the main frame, with reinforced joints for added stability.
  + **Weight**: Approximately 2-3 kg, optimized to balance durability with maneuverability.

## Key Features:

* + The prototype integrates ADAS features such as adaptive cruise control and lane-keeping assist, made possible by mounting points and wiring channels that allow easy sensor attachment.

# 6. Revisions and Recommendations

* The design process involved several adjustments, especially to the steering mechanism, where early tests showed a need for better control over the steering angles. This led to adjustments in the lengths of the steering arms and an updated Ackermann alignment.
* **Future Improvements**: Exploring alternative materials to further reduce weight and enhance modularity so that additional sensors or components can be added more easily.

# 7. Conclusion

* This car prototype design successfully meets the ADAS project requirements for handling and stability. The integration of Ackermann steering geometry has shown promise in simulation for accurate lane-keeping and obstacle avoidance. Moving forward, this design provides a foundational model that can be iteratively improved as we prepare for real-world testing and component integration.