SEMINAR REPORT

ON

VEHICLE COLLISION AVOIDANCE TECHNOLOGY USING ADAS FEATURES

Presented by

MUHAMMED FARHAN T (PKD21ME041)

B.Tech in Mechanical Engineering

Department of Mechanical Engineering

GOVERNMENT ENGINEERING COLLEGE SREEKRISHNAPURAM PALAKKAD, KERALA - 678633

2024-2025

CERTIFICATE

*This is to certify that this seminar report entitled " **VEHICLE COLLISION AVOIDANCE TECHNOLOGY USING ADAS FEATURES**" is a bonafide record of the seminar presented by MUHAMMED FARHAN T Reg. No PKD21ME041, during the seventh semester 2024 in partial fulfillment of the requirement for the award of B.Tech degree in Mechanical Engineering by the APJ Abdul Kalam Technological University.*

Mr. LEEJU C J   Mr ASKAR ALI

Assistant Professor   Assistant Professor

Seminar Guide   **Seminar Co-ordinator**

Dr.Ambilikumar C K
Head of the Department
Dept. of Mechanical Engineering

Department of Mechanical Engineering

GOVERNMENT ENGINEERING COLLEGE SREEKRISHNAPURAM

ACKNOWLEDGEMENT

ABSTRACT

COLLISION AVOIDANCE TECHNOLOGY USING ADAS FEATURES

Collision avoidance technology using ADAS features represent a pivotal advancement in automotive safety technology, aiming to proactively prevent collisions and mitigate their severity. These systems employ a sophisticated array of sensors, cameras, radar, and sometimes LIDAR to monitor the vehicle's surroundings. By continuously scanning the road ahead, they detect potential hazards such as other vehicles, pedestrians, or obstacles. Upon detecting an imminent collision, the system alerts the driver through visual or auditory warnings. In scenarios where the driver fails to respond, Advanced Driver Assistance Features will automatically enable and prevent the accidents, such features include Adaptive Cruise Control (ACC), Automatic Emergency Braking (AEB), Lane Departure Warning (LDW) and other driver-assist features, collision avoidance technology enhance vehicle safety by fostering situational awareness and rapid response capabilities. As these technologies evolve, they promise to significantly reduce road accidents, injuries, and fatalities, ushering in a new era of safer and more secure transportation systems.

Keywords: Collision Avoidance, ACC, AEB, LDW, Fostering

LIST OF FIGURES

1.INTRODUCTION

1.1 BACKGROUND

Collision avoidance technology is a set of safety features designed to prevent or mitigate accidents by alerting drivers of potential hazards or automatically taking control of the vehicle. Advanced Driver Assistance System (ADAS) features are at the forefront of this technology, utilizing sensors, cameras, and algorithms to detect and respond to threats on the road. This background underscores the importance of studying driver's behavioral responses to ADAS and highlights the ongoing need for comprehensive research in this evolving field.

1.2 SIGNIFICANCE IN ADAS FEATURES

Advanced Driver Assistance Systems (ADAS) have significant importance in modern vehicles due to their capability to enhance both safety and convenience for drivers. Here are some key aspects of their significance:

- Improved safety: Systems such as automatic emergency braking (AEB), lane departure warning (LDW), and adaptive cruise control (ACC) can intervene to prevent accidents or mitigate their severity.

- Enhanced Convenience: It also contribute to a more comfortable and convenientdriving experience.

- Efficiency: Helps to improve fuel efficiency and reduce emissions.

- Technological Innovation: By integrating sensors, cameras, and AI algorithms, vehicles can perceive their surroundings better and make informed decisions in real-time, paving the way for future autonomous vehicles.

- Consumer Demand: Consumers are becoming more aware of and interested in safety features when purchasing vehicles. ADAS technologies are now considered a selling point for many car buyers, influencing their purchasing decisions.

1.3 SCOPE OF THE REPORT

This report aims to provide wide range of technologies and functionalities aimed at enhancing vehicle safety, improving driving convenience, and paving the way for autonomous driving.

- Safety Features: ADAS includes a variety of safety systems designed to assist drivers in avoiding collisions and accidents.
- Convenience and Comfort Features: ADAS technologies also enhance driver convenience and comfort, making driving easier and less stressful.
- Integration with Autonomous Driving: ADAS technologies serve as foundational elements for autonomous driving capabilities.
- Regulatory and Market Trends: Governments and regulatory bodies are increasingly mandating the inclusion of certain ADAS features in new vehicles to improve road safety.
- Future Development: Future developments will likely focus on improving sensor accuracy, enhancing vehicle-to-vehicle communication, and refining AI algorithms for better decision-making in complex driving scenarios.

By providing a comprehensive examination of these aspects, the report will illustrate how ADAS is broad and evolving, encompassing a range of technologies that aim to enhance vehicle safety, improve driving comfort, and pave the way for increasingly autonomous vehicles in the future.

2.LITERATURE REVIEW

1. On the road safety benefits of advanced driver assistance systems in different driving contexts, (2022) Leandro Masello, German Castignani, Barry Sheehan, Finbarr Murphy, Kevin McDonnell

The methodology of the paper integrates academic literature on Advanced Driver Assistance Systems (ADAS) and publicly available road safety reports to quantify accident reductions across various driving contexts. First, the study identifies key environmental conditions (such as road types, lighting, and weather) that influence ADAS performance, with a focus on eight common accident types. The performance of ADAS under different combinations of these contextual variables is then assessed to determine their effectiveness in reducing accidents. A structured approach called the Analytical Hierarchy Process (AHP) is used to rank these contextual combinations in terms of their potential to maximize ADAS effectiveness. The AHP involves pairwise comparisons of road types, weather conditions, and lighting conditions to assign relative weights to each criterion. This allows for a rational representation of which driving conditions most affect ADAS functionality. For instance, motorway driving in clear weather during daylight is ranked higher in terms of ADAS performance compared to urban driving in snow during darkness. After ranking the driving contexts, the study links these conditions with UK road safety reports, which provide detailed information about accident types, frequencies, and severities. Using these reports, the study estimates accident reductions attributable to ADAS by comparing the effectiveness of various systems—such as Automatic Emergency Braking (AEB), Lane Departure Warning (LDW), and Blind-Spot Warning (BSW)—in different contexts. The results show that ADAS can reduce accidents by 23.8%, with the largest decreases seen in frequent accident types like rear-end collisions and pedestrian accidents. By combining literature and empirical data, the methodology provides a comprehensive framework for evaluating the potential of ADAS to improve road safety in specific environmental conditions. This interdisciplinary approach not only informs the development of ADAS technologies but also helps policymakers and safety stakeholders target interventions in the most relevant accident contexts.

2. Drivers' behavior when driving vehicles with or without advanced driver assistance systems (2022) A driver simulator-based study: Raghuveer Gouribhatla, Srinivas S. Pulugurtha

The literature review on the impact of Advanced Driver Assistance Systems (ADAS) on driving behavior indicates that ADAS technologies are designed to reduce human errors and enhance road safety by providing drivers with timely warnings or assisting in specific driving maneuvers, such as lane keeping, collision avoidance, and speed regulation. Various studies highlight the significant role ADAS plays in mitigating driver errors, which are a leading cause of traffic accidents. Research shows that ADAS, including systems like Lane Departure Warning (LDW), Blind Spot Warning (BSW), and Over Speed Warning (OSW), generally improve driving behavior by reducing instances of aggressive driving, such as speeding and sudden braking, and by encouraging safer driving practices. However, the effectiveness of these systems can vary depending on several factors, such as road type (rural, urban, freeway), weather conditions, and driver demographics, including age and gender. For example, LDW is effective in reducing lane departures across different driving scenarios, while OSW significantly influences speeding behavior, particularly in rural and urban areas. Moreover, while ADAS features are designed to enhance safety, their effectiveness is not uniform across all environments. For instance, adverse weather conditions, such as rain or fog, can impair the functionality of certain ADAS sensors, leading to reduced effectiveness. Similarly, lighting conditions, such as nighttime driving, present challenges for systems like Forward Collision Warning (FCW) that rely on visual data. The literature also points to the need for further research on how different ADAS systems interact with each other and how drivers adapt to these technologies over time. There is a growing interest in understanding the long-term impact of ADAS on driver behavior, especially as more advanced autonomous driving technologies are introduced. ADAS technologies offer significant potential for improving road safety by reducing human errors and encouraging safer driving behaviors. However, their effectiveness can be influenced by external factors, and there are challenges related to driver understanding and reliance. Ongoing research is necessary to optimize the use of ADAS and address any unintended consequences related to driver behavior.

3. Exploring the factors influencing acquisition and learning experiences of cars fitted with advanced driver assistance systems (2023): Sonali Nandavar, Sherrie-Anne Kaye, Teresa Senserrick, Oscar Oviedo-Trespalacios

The review highlights that ADAS have shown substantial potential in increasing road safety by reducing accidents and injuries, particularly through systems like forward collision warnings and low-speed autonomous emergency braking. The review points out that there is limited research on the specific reasons drivers choose vehicles with ADAS and the strategies they use to learn about these systems. The literature also addresses the influence of demographic factors on the acceptance and use of ADAS, with some studies finding that gender and age can play a role in how these systems are perceived and utilized. Overall, the literature review emphasizes the importance of understanding drivers' behavior and learning experiences with ADAS to maximize the safety benefits of these technologies. It suggests that more research is needed to explore the factors influencing the adoption and correct use of ADAS, as well as to develop effective driver education programs that can address the gaps in knowledge and ensure that these systems are used safely and effectively.

3.ADVANCED DRIVER ASSISTANCE SYSTEM

3.1 COLLISION AVOIDANCE SYSTEM

Collision Avoidance System warn a driver of a possible crash ahead and then take various actions to improve the safety of the car if the driver does not immediately act to prevent the collision. Collision avoidance using Advanced Driver Assistance System (ADAS) features use a combination of technologies. It enhances road safety, reduces accidents and protect lives. Also here we will discuss about varies ADAS features, how these features will prevent accidents.

3.2 ADVANCED DRIVER ASSISTANCE SYSTEM

Almost all vehicle accidents are caused by human error, which can be avoided with Advanced Driver Assistance Systems(ADAS). The role of ADAS is to prevent deaths and injuries by reducing the number of car accidents and the serious impact of those that cannot be avoided. They increase safety by coordinating efforts between the driver and the car. This system monitors vehicle speed, the speed of vehicle in front and rear, and the distance between the vehicles. These are broken down into various chips which are referred to as systems on a chip (SoCs). These SoCs work by connecting the sensors through electronic control units (ECUs) to operate efficiently.

3.3 COMPONENTS OF ADAS

ADAS are a collection of technologies that work together to provide assistance to drivers and enhance their Driving Experience. It uses:

- Cameras: Uses optical sensors to capture images of the vehicle's surroundings, providing information about lane markings, traffic signs, and other vehicles.

- Radar: Uses radio waves to detect objects and measure their distance, speed, and direction of movement.

- LIDAR's: Uses laser light to create a 3D map of the vehicle's surroundings, allowing for precise detection of objects and their distance.

- Ultrasonic sensors: Uses high-frequency sound waves to detect objects and measure their distance.

- GPS: Uses satellite signals to determine the vehicle's location, speed, and direction of movement, providing useful information for navigation and traffic management. These systems process the inflow of data and communicate with the car's ECU, Radar, LIDAR, GPS, and Wheel Encoder which makes critical and timely decisions and adjusts the car's movements accordingly.
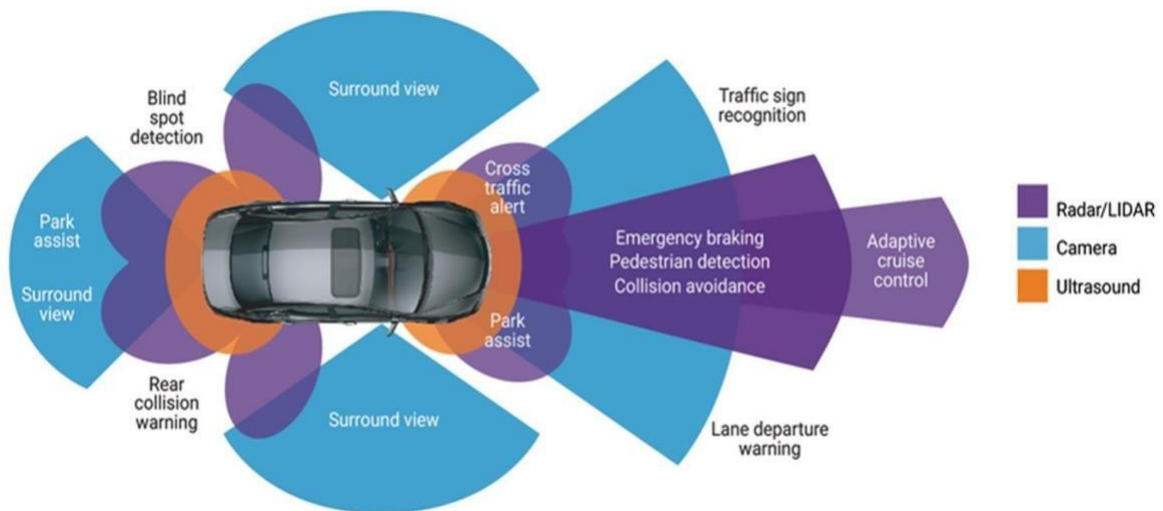

Fig. 1: ADAS features

4.ADAS FEATURES

4.1 ADAPTIVE CRUISE CONTROL (ACC)

Adaptive Cruise Control is a driver assistance system that automatically adjusts a vehicles speed to maintain a safe distance. If the car ahead slows down, ACC can automatically match it. It uses a combination of radar sensors, cameras and location technology to change in speed, track vehicles, and adjust to traffic and road conditions.
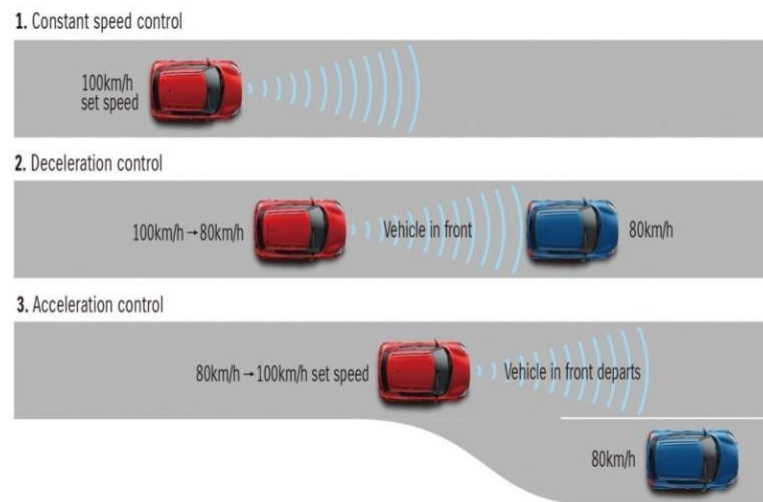
Fig. 2: Adaptive cruise control

4.2 AUTOMATIC EMERGENCY BRAKING (AEB)

Automatic Emergency Braking is a technology that can help to prevent or reduce the severity of a collision by automatically applying the brakes hen it detects a potential hazard. When a potential collision is detected, the system may alert the driver with visual and audio warnings, and then apply light braking to prompt the driver to take action. If the driver doesn't respond, the system may apply full emergency braking before the collision
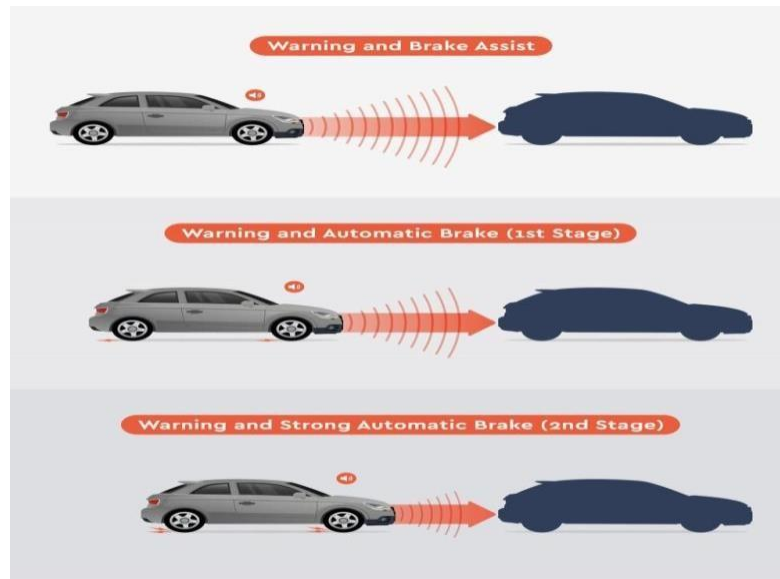
Fig. 3: Automatic emergency braking

4.3 BLIND SPOT WARNING (BSW)

Blind spot involves cameras that monitor the driver's blind spots and notify the driver if any obstacles come close to the vehicle. The cameras are usually located under the rear bumper or side view mirrors. This allow you to see the curb (edge) and the rear tire clearly enabling better judgement while parking etc. Exceptionally useful for learners, new drivers or elderly.

Fig. 4: Blind spot warning

4.4 ELECTRONIC STABILITY CONTROL (ESC)

Electronic Stability Control is a computerized technology that improves a vehicle's stability by detecting and reducing loss of traction (skidding). When ESC detects loss of steering control, it automatically applies the brakes to help steer the vehicle where the driver intends to go. Braking is automatically applied to wheels individually. Some ESC systems also reduce engine power until control is regained, it helps reduce the chance of the driver losing control of the vehicle.
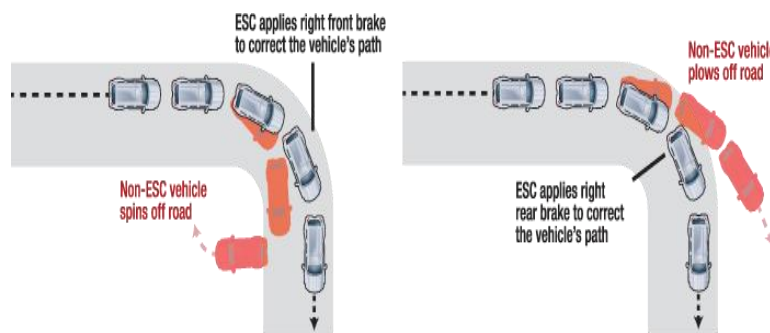
Fig. 5: Electronic stability control

4.5 FORWARD COLLISION WARNING (FCW)

Forward collision warning systems warn you of an impending collision by detecting stopped or slowly moved vehicles ahead of your vehicle by using radar, lasers, or cameras to scan the road ahead while you drive. If there is an impending collision, the system will warn you of the danger using lights, beeps, vibrations of your seat, or a combination of these.

Fig. 6: Forward collision warning

4.6 LANE DEPARTURE WARNING (LDW)

Lane departure warning is designed to help you avoid crashes due to drifting or departing your lane. The system detects lane markers and alerts you when a tire touches a lane marker. The warning is usually a flashing indicator and beeps from the corresponding side. In some systems, the steering wheel or driver's seat vibrates gently. Generally, lane departure warning systems will not alert you when your turn signal is on.

Fig. 7: Lane departure warning

5.BENEFITS AND LIMITATIONS

5.1 BENEFITS

- Enhanced Safety: ADAS technologies, like automatic emergency braking and lane departure warnings, help prevent accidents by providing real-time alerts and interventions.
- Reduced Driver Fatigue: Features such as adaptive cruise control and lane-keeping assist can alleviate the stress of long drives, allowing for a more comfortable experience.
- Increased Awareness: Systems like blind-spot monitoring and parking assistance enhance driver awareness of their surroundings, reducing blind spots and improving parking accuracy.
- Data Collection: ADAS can collect valuable data on driving patterns, which can be used for further improvements in vehicle safety and performance.
- Facilitated Learning: New drivers can benefit from ADAS as a training tool, helping them understand safe driving practices.

5.2 LIMITATIONS

- Overreliance: Drivers may become overly dependent on ADAS, leading to complacency and reduced attention to the road.
- Technical Limitations: ADAS may struggle in adverse weather conditions (like heavy rain or fog) or in complex driving environments, leading to potential failures.
- Cost: The integration of ADAS technology can increase vehicle costs, making it less accessible for some consumers.
- False Alerts: Some systems may produce false positives, leading to unnecessary driver anxiety or distractions.
- Limited Scope: While ADAS can assist in many driving situations, they do not replace the need for full driver attention and control.

6.PERFORMANCE EVALUATION

6.1 COLLISION AVOIDANCE

One of the most significant metrics is the system's ability to prevent or mitigate collisions. This includes measuring the success rate of systems like Automatic Emergency Braking (AEB) and Forward Collision Warning (FCW) in preventing rear-end and pedestrian collisions

6.2 ACCURACY

The Accuracy of Advanced Driver Assistance Systems (ADAS) is a critical measure of how well these systems can detect, interpret, and respond to the environment around a vehicle. Accuracy in ADAS involves several key components and factors, each contributing to the overall effectiveness of the system in ensuring safety and enhancing the driving experience

6.3 RESPONSE TIME

Response time in Advanced Driver Assistance Systems (ADAS) refers to the speed at which the system can detect a situation, process the information, and execute an appropriate action. The response time is critical for the safety and effectiveness of ADAS, as it directly impacts the system's ability to prevent accidents and assist the driver in real-time.

6.4 USER ACCEPTANCE

User Acceptance of Advanced Driver Assistance Systems (ADAS) refers to how well drivers and vehicle owners perceive, trust, and utilize these systems. High user acceptance is crucial for the widespread adoption and effective use of ADAS features, as these systems are only beneficial if drivers feel comfortable and confident using them.

6.5 RELIABILITY

Reliability in Advanced Driver Assistance Systems (ADAS) refers to the consistent and dependable performance of these systems under various driving conditions. Reliable ADAS ensures that the system functions as intended, with minimal errors or malfunctions, thereby building driver confidence and enhancing overall vehicle safety.

6.6 COMPLIANCE

Compliance in the context of Advanced Driver Assistance Systems (ADAS) refers to the adherence to industry standards, regulations, and guidelines that govern the design, implementation, and operation of these systems. Ensuring compliance is crucial for safety, legal operation, and market acceptance of ADAS technologies

6.7 SPEED MANAGEMENT

Adaptive Cruise Control (ACC) and Over Speed Warning (OSW) are evaluated by their ability to maintain safe speed and distances from surrounding vehicles, especially in variable traffic conditions.

7.CURRENT APPLICATIONS AND ADAS LEVELS

7.1 NO AUTOMATION

No automation; the driver handles all tasks. This include safety systems like backup cameras, blind spot warnings, and collision warnings. It provide temporary aid, but the driver still responsible for all driving tasks.

7.2 DRIVER ASSISTANCE

ADAS features provide basic assistance to the driver, typically focusing on specific functions. Examples include adaptive cruise control (ACC) and lane-keeping assistance (LKA).

7.3 PARTIAL DRIVING AUTOMATION

Partial automation, where the vehicle can assist the driver with specific tasks simultaneously. Features like lane centering, automatic braking, and self-parking are included at this level.

7.4 CONDITIONAL AUTOMATION

Conditional automation, allowing the vehicle to take control under specific conditions or situations. In Level 3, the driver can disengage from actively monitoring the road, but they must still be ready to intervene when requested by the system.

7.5 HIGH AUTOMATION

The vehicle can perform most driving tasks without human intervention within certain operational domains or specific environments. However, Level 4 automation is limited to predefined conditions, such as specific geographic areas or favorable weather conditions

7.6 FULL AUTOMATION

Full automation, where the vehicle can perform all driving tasks without any human intervention, regardless of the driving conditions or environment. Level 5 vehicles are fully self-driving and do not require a human driver.

8.FACTORS AFFECTING ADAS FEATURS

8.1 ROAD TYPE

- Highway: High speeds and long distances were challenging.

- Urban: A variety of scenarios, such as pedestrians, cyclists, and complex intersections to be handled.

- Rural: Inconsistent Road Conditions and low connectivity (poorer cellular or GPS signal strength)

8.2 WEATHER CONDITIONS

- Rain: Rain can sometimes cause sensors to malfunction or produce false readings due to water interference.

- Snow: Snow can cover sensors and cameras, obstructing their field of view and reducing their effectiveness

- Fog: Fog can severely limit visibility, making it difficult for cameras and sensors to detect road markings, signs, and obstacles

8.3 LIGHTING CONDITIONS

- Daylight: Direct sunlight or reflections from other vehicles can cause glare, which might affect the performance of optical sensors and cameras.

- Darkness: Darkness significantly reduces visibility, making it harder for cameras and sensors to detect lane markings, road signs, and obstacles

9.BEST ADAS EQUIPPED CARS IN INDIA

9.1 HYUNDAI TUCSON

The Hyundai Tucson equipped with Advanced Driver Assistance Systems (ADAS) offers an array of cutting-edge safety features designed to enhance driving confidence and convenience. Key functionalities include Forward Collision-Avoidance Assist, which helps prevent accidents by detecting vehicles and pedestrians, and Lane Keeping Assist, which aids in maintaining lane position.

9.2 MG GLOSTER

The MG Closer is an electric SUV that combines contemporary design with advanced technology, making it a compelling choice for eco-conscious drivers. Its sleek exterior is matched by a spacious and comfortable interior, featuring modern amenities and smart connectivity options.

9.3 MERCEDES-BENZ E-CLASS

The Mercedes-Benz E-Class is a sophisticated luxury sedan that epitomizes elegance, performance, and advanced technology. Known for its refined design and high-quality materials, the E-Class offers a plush interior with spacious seating and cutting-edge infotainment systems.

9.4 BMW 5 SERIES

The BMW 5 Series is a premium executive sedan that seamlessly combines luxury, performance, and cutting-edge technology. Renowned for its dynamic driving experience, the 5 Series features a range of powerful engines.

9.5 VOLVO XC60

The Volvo XC60 is a sophisticated compact luxury SUV that emphasizes safety, comfort, and Scandinavian design. With its sleek lines and elegant profile, the XC60 stands out on the road while offering a spacious and well-appointed interior filled with high-quality materials.

10,FUTURE AND DEVELOPMENT

10.1 TECHNOLOGICAL ADVANCEMENT

Sensor Fusion: Combining data from various sensors (LiDAR, radar, Cameras) will enhance the accuracy and reliability of ADAS, enabling better real-time decision-making. Artificial Intelligence: Machine learning algorithms will improve the system's ability to interpret complex driving scenarios and adapt to new situations over time.

10.2 LEVELS OF AUTOMATION

Progression to Higher Automation: ADAS will evolve toward higher levels of automation (up to Level 4 and beyond), where vehicles can handle most driving tasks without human intervention, especially in specific environments like highways or urban areas.

10.3 VEHICLE-TO-EVERYTHING (V2X) COMMUNICATION

Interconnectivity: Vehicles will communicate with each other (V2V) and with infrastructure (V2I), enhancing traffic management, reducing collisions, and optimizing routes for efficiency.

10.4 ENHANCED SAFETY FEATURES

Predictive Analytics: Using AI to predict potential hazards based on driving patterns and environmental data will help prevent accidents before they occur. Automated Emergency Response: Systems that can autonomously initiate emergency braking or maneuvering in critical situations will become more sophisticated.

10.5 SUSTAINABILITY

Eco-Friendly Features: ADAS will contribute to energy efficiency by optimizing driving patterns, reducing fuel consumption, and promoting the use of electric and hybrid vehicles. It reduces unnecessary braking and acceleration.

11.CONCLUSION

Advanced Driver Assistance Systems (ADAS) represent a transformative advancement in automotive technology, significantly enhancing both safety and driving comfort. Throughout this report, we have explored the evolution, benefits, challenges, and future prospects of ADAS features.

ADAS technologies have evolved from rudimentary systems to sophisticated integrations of sensors, cameras, and AI algorithms. They play a crucial role in mitigating risks on the road by alerting drivers to potential dangers and, in some cases, taking corrective actions autonomously. Features like Automatic Emergency Braking (AEB), Lane Departure Warning (LDW), and Adaptive Cruise Control (ACC) not only improve safety but also contribute to reduced driver fatigue and enhanced driving comfort.

The benefits of ADAS are evident in improved road safety statistics, economic savings, and increased driver confidence. However, challenges such as cost, reliability in diverse conditions, and the need for comprehensive driver education remain significant considerations. Addressing these challenges will be crucial as ADAS technologies continue to evolve and become more prevalent in vehicles worldwide.

Looking ahead, the future of ADAS holds promise with advancements in AI capabilities, sensor technologies, and connectivity. These innovations pave the way for more sophisticated systems and potentially autonomous driving solutions. It is essential for stakeholders, including policymakers, automakers, and consumers, to collaborate in furthering the development and adoption of ADAS, ensuring its integration supports safer and more efficient mobility solutions.

In conclusion, ADAS represents a cornerstone in the ongoing evolution of automotive safety and driving experience. By embracing technological advancements and addressing current challenges, we can harness the full potential of ADAS to create a safer, more comfortable, and more sustainable future on our roads.

REFERENCES

1. Leandro Masello, German Castignani , Barry Sheehan , Finbarr Murphy, Kevin McDonnell, (September 2022) "On the road safety benefits of advanced driver assistance systems in different driving contexts"

2. Raghuveer Gouribhatla , Srinivas S. Pulugurtha, (March 2022) "Drivers' behavior when driving vehicles with or without advanced driver assistance systems: A driver simulator-based study"

3. Sonali Nandavar, Sherrie-Anne Kaye, Teresa Senserrick , Oscar Oviedo-Trespalacios, (April 2023) "Exploring the factors influencing acquisition and learning experiences of cars fitted with advanced driver assistance systems (ADAS) "