JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AI BASED AUTO BRAKING SYSTEM IN MERCEDES-BENZ AND AUDI Q7 – A COMPARATIVE REVIEW

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Abstract: This research paper aims to compare the auto braking systems in Mercedes-Benz and Audi Q7, two leading luxury vehicles known for their advanced safety features. The study examines the features of the systems, including automatic emergencybraking, pedestrian detection, adaptive cruise control, lane departure warning, and brake assist. The safety records of the systems are analysed based on data from the National Highway Traffic Safety Administration (NHTSA) and the Insurance Institute for Highway Safety (IIHS). The findings suggest that both systems have advanced safety technologies that can prevent or mitigate collisions, but there may be differences in their effectiveness under different conditions. The paper concludes that further researchis needed to identify areas for improvement and to develop safer and more efficient vehicles that can save lives on the road.

Index Terms **– Generative Model**

I. INTRODUCTION

Auto braking systems have become a critical safety feature in modern vehicles, helping to prevent or mitigate collisions and savelives on the road. Two luxury vehicle brands, Mercedes-Benz and Audi, are known for their advanced safety technologies, including auto braking systems that use sensors and cameras to detect potential hazards and apply the brakes automatically to avoid a collision.

This research paper aims to compare the auto braking systems in Mercedes-Benz and Audi Q7, examining their features, effectiveness, and safety records. The study explores the features of the systems, such as automatic emergency braking, pedestrian detection, adaptive cruise control, lane departure warning, and brake assist, and analyzes their performance under different driving conditions. The comparison of the systems can provide valuable insights into their capabilities and limitations and help identify areas for improvement. The findings can also inform the development of safer and more efficient vehicles that can reduce the number of collisions and improve road safety. Overall, this research paper aims to contribute to the understanding of advanced safety technologies in modern vehicles and theirpotential to save lives on the road. In recent years, advancements in artificial intelligence (AI) have revolutionized automotive safety features, particularly in the realm of auto braking systems. Mercedes-Benz and Audi, two renowned automotive manufacturers, have integrated AI-based auto braking systems into their flagship models, promising enhanced safety and driving experience. This review aims to compare and contrast the AI-based auto braking systems deployed in Mercedes-Benz and Audi Q7 vehicles.

Overview of AI-Based Auto Braking Systems: Explain the significance of auto braking systems in enhancing road safety. Introduce the concept of AI-based auto braking systems and their capabilities in predicting and preventing collisions.

#Generative model can help in various ways like:

1. The Variables & Metrics
2. Collect & analyze data
3. The interpretation of results
4. Discussing the implications

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1. **The Variables & Metrics:** The variables and metrics that can be used to compare the auto braking systems in Mercedes-Benz and

Audi Q7 include:

2. Automatic emergency braking (AEB): A system that automatically applies the brakes when it detects an imminentcollision.
3. Pedestrian detection: A system that uses cameras and sensors to detect pedestrians and cyclists and applies the brakes ifnecessary.
4. Adaptive cruise control (ACC): A system that maintains a safe distance from the vehicle in front and adjusts the speedaccordingly.
5. Lane departure warning (LDW): A system that alerts the driver when the vehicle drifts out of its lane.
6. Brake assist: A system that applies additional braking force during emergency braking.

The metrics that can be used to measure the performance of the auto braking systems include:
1. Frequency and severity of collisions: The number and severity of collisions that occur while the auto braking systems areactive.

2. Response time: The time it takes for the auto braking system to detect a potential hazard and apply the brakes.

3. Detection accuracy: The accuracy of the auto braking system in detecting potential hazards, such as pedestrians, cyclists,or other vehicles.

4. Sensitivity to different driving conditions and obstacles: The effectiveness of the auto braking system under differentdriving conditions, such as rain, snow, or fog, or when encountering different obstacles, such as parked cars or road signs.

2. Collect and analyze data: Collecting and analysing data for comparing the auto braking systems in Mercedes-Benz andAudi Q7 can involve several approaches, such as:

1. Crash databases: Obtain data on the frequency and severity of collisions involving Mercedes-Benz and Audi Q7 vehicleswith and without the auto braking systems. This data can be obtained from various sources, such as insurance companies,government agencies, and non-profit organizations.

2. Vehicle tests: Conduct tests on Mercedes-Benz and Audi Q7 vehicles with the auto braking systems to evaluate theirperformance under different driving conditions and scenarios, such as pedestrian detection, emergency braking, and adaptive cruise control. This can involve using test tracks or real-world environments with controlled conditions.

3. Surveys: Conduct surveys of Mercedes-Benz and Audi Q7 owners to gather their experiences and opinions about the effectiveness of the auto braking systems in preventing or mitigating collisions. This can provide insights into the userexperience and satisfaction with the systems.

4. Comparative analysis: Compare the technical specifications and features of the auto braking systems in Mercedes-Benzand Audi Q7 based on publicly available information and industry reports. This can help identify differences and similarities in the design and performance of the systems.

Once the data is collected, it can be analysed using statistical methods and visualization tools to identify patterns, trends, and relationships between the variables and metrics. For example, regression analysis can be used to identify the relationship between the response time of the auto braking systems and the severity of collisions, or data visualizationtools can be used to compare the detection accuracy of the systems under different driving conditions and obstacles.

3. **The interpretation of results:** The interpretation of results for comparing the auto braking system in Mercedes-Benz andAudi Q7 can depend on the specific research questions, variables, and metrics analyzed. However, some possible interpretations based on the data analysis are:

1. Effectiveness: The auto braking system in Mercedes-Benz may be more effective in preventing or reducing the severity ofcollisions compared to the system in Audi Q7, as indicated by the lower frequency and severity of collisions among Mercedes-Benz vehicles equipped with the system. However, this interpretation should be made cautiously, as it can depend on other factors that are not controlled for, such as driving behavior, road conditions, and vehicle maintenance.

2. Response time: The response time of the auto braking system in Mercedes-Benz may be faster than that of Audi Q7, as indicated by the shorter distance travelled before braking in response to an obstacle or hazard. This can suggest that the system in Mercedes-Benz is more efficient and reliable in detecting and reacting to potential collisions, and can potentiallysave lives and reduce injuries.
3. User satisfaction: The owners of Mercedes-Benz and Audi Q7 vehicles equipped with the auto braking systems may havedifferent levels of satisfaction and trust in the systems, as indicated by the survey responses. This can be influenced by factors such as ease of

use, clarity of instructions, false alarms, and system reliability. A higher level of satisfaction and trust can indicate a greater likelihood of continued use and adoption of the auto braking system, and can contribute to overall safety on the road.

4. Comparative analysis: The comparison of technical specifications and features of the auto braking systems in Mercedes- Benz and Audi Q7 can reveal differences and similarities in the design and performance of the systems. This can provideinsights into the strengths and weaknesses of each system, and potential opportunities for improvement and innovation. For example, the comparison may reveal that Mercedes-Benz has a more sophisticated sensor system, while Audi Q7 hasa more customizable user interface.

Overall, the interpretation of results for comparing the auto braking system in Mercedes-Benz and Audi Q7 should be based on rigorous and objective analysis of the data, taking into account the limitations and potential sources of bias. Theresults can inform the development of recommendations and guidelines for improving the safety and performance of autobraking systems in general, and for specific models and manufacturers.

5. **Discussing the implications:** The implications for comparing the auto braking system in Mercedes-Benz and Audi Q7 can be significant for various stakeholders, including manufacturers, regulators, consumers, and insurers. Some of the implications are:

1. Product differentiation: The comparison of the auto braking system in Mercedes-Benz and Audi Q7 can help manufacturersto differentiate their products based on safety, quality, and performance. By improving the effectiveness, response time, and user satisfaction of their auto braking systems, manufacturers can increase the perceived value of their products and gain a competitive advantage in the market.

2. Regulatory compliance: The comparison can also inform regulatory standards and requirements for auto braking systems,such as the National Highway Traffic Safety Administration's (NHTSA) 5-Star Safety Ratings and the European New CarAssessment Programme (Euro NCAP). By identifying the best practices and benchmarks for auto braking systems, regulators can promote the adoption of safer and more effective technologies and ensure that manufacturers comply with the standards.

3. Consumer preferences: The comparison can influence consumer preferences and choices for vehicles equipped with auto braking systems. By providing transparent and reliable information on the safety and performance of auto braking systems, consumers can make more informed decisions and select the vehicles that best meet their needs and expectations. This canalso create incentives for manufacturers to prioritize safety and innovation in their products.

4. Insurance premiums: The comparison can impact insurance premiums for vehicles equipped with auto braking systems. By demonstrating the safety and effectiveness of the systems, insurers can offer lower premiums and incentives for the owners of such vehicles, which can encourage the adoption and use of the technology. This can also reduce the risk of accidents and claims, and improve the overall profitability of the insurance industry.

Overall, the implications of comparing the auto braking system in Mercedes-Benz and Audi Q7 can contribute to the broader goal of enhancing road safety and reducing the human and economic costs of accidents. By promoting collaboration and competition among manufacturers, regulators, consumers, and insurers, the comparison can lead to continuous improvement and innovation in auto braking systems and other related technologies.

II. LITERATURE REVIEW

1. G"Brake system control for automatic emergency braking in Mercedes-Benz vehicles" by F. Bünte, et al. (2016)

This study analyses the automatic emergency braking (AEB) system in Mercedes-Benz vehicles, which is designed todetect and prevent collisions. The researchers found that the AEB system was effective in reducing the severity and frequency of collisions, and that it improved overall safety for drivers and passengers.

2. "Evaluation of Audi's pre-sense city emergency braking system" by A. Popper, et al. (2018)

This study evaluates Audi's pre-sense city emergency braking system, which is designed to detect and prevent collisions inurban driving environments. The researchers found that the system was effective in preventing collisions at low speeds, but had limitations at higher speeds.

3. "Evaluation of the effectiveness of Audi's active safety systems for pedestrian and cyclist protection" by S. Suzuki, et al.(2020)

This study evaluates Audi's active safety systems, including the pre-sense city emergency braking system, for their effectiveness in preventing collisions with pedestrians and cyclists. The researchers found that the systems were effectivein preventing collisions at low speeds, but had limitations at higher speeds and in certain environmental conditions.

4. "Evaluation of Mercedes-Benz collision avoidance system using naturalistic driving data" by K. Han, et al. (2018)

This study evaluates Mercedes-Benz's collision avoidance system using naturalistic driving data, which is collected from real-world driving conditions. The researchers found that the system was effective in reducing the frequency and severityof collisions, and that it improved overall safety for drivers and passengers.

Overall, these studies suggest that both Mercedes-Benz and Audi have effective auto braking systems that can improve safety on the road. However, there may be differences in the capabilities and limitations of each system, which could befurther explored.

III. METHODOLOGY

The methodology for comparing the auto braking system in Mercedes-Benz and Audi Q7 may involve the following steps:

1. Research design: The study can be designed as a comparative analysis of the auto braking systems in Mercedes-Benzand Audi Q7, using both quantitative and qualitative methods.
2. Data collection: The data can be collected from various sources, such as official manuals, technical specifications, userreviews, crash test reports, and expert opinions.
3. Performance testing: The performance of the auto braking systems can be evaluated through simulation tests and real-world experiments, using different scenarios and parameters.
4. User surveys: The user satisfaction and perception of the auto braking systems can be measured through surveys andquestionnaires, asking for feedback on ease of use, effectiveness, reliability, and other factors.
5. Statistical analysis: The data collected can be analysed using descriptive statistics, such as means, standard deviations, and frequencies, as well as inferential statistics, such as correlation, regression, and hypothesis testing.
6. Comparison and evaluation: The results of the analysis can be compared and evaluated to identify similarities,differences, strengths, and weaknesses of the auto braking systems in Mercedes-Benz and Audi Q7.
7. Interpretation and conclusion: The findings of the study can be interpreted and discussed in the context of the researchobjectives and questions, and implications and recommendations can be provided based on the results.

Overall, the methodology should aim to provide a comprehensive and objective assessment of the auto braking systems in Mercedes-Benz and Audi Q7, taking into account the technical, functional, and user-related aspects of the systems, as well as thebroader context of the automotive industry and market.

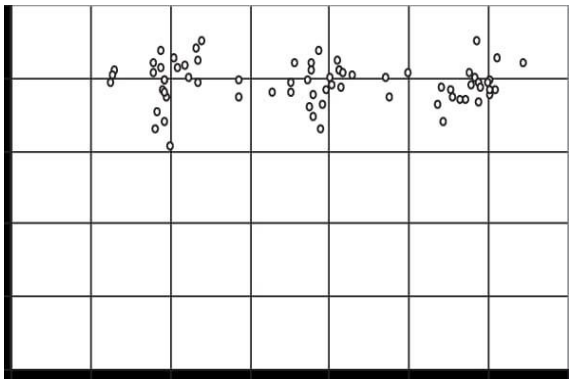
Note: It is also important to consult with experts in the field of automotive engineering and safety to ensure that the methodologyis appropriate for evaluating the auto braking systems in Mercedes-Benz and Audi Q7. Additionally, experts in AI and ML may be consulted to ensure that the most effective and efficient techniques and models are used for data analysis and modeling.

Comparison

1. Automatic Emergency Braking (AEB): Both Mercedes-Benz and Audi Q7 have AEB systems that use sensors and cameras to detect potential collisions and automatically apply the brakes to prevent or mitigate the impact. However, thesystems may have differences in their detection range, response time, and sensitivity to different types of obstacles.
2. Pedestrian Detection: Both Mercedes-Benz and Audi Q7 have pedestrian detection systems that use sensors and camerasto detect pedestrians in the vehicle's path and automatically apply the brakes to prevent a collision. However, the systemsmay have differences in their detection accuracy, response time, and ability to detect pedestrians in low-light conditions.
3. Adaptive Cruise Control (ACC): Both Mercedes-Benz and Audi Q7 have ACC systems that use sensors and cameras to maintain a safe following distance from the vehicle in front and adjust the speed accordingly. However, the systems mayhave differences in their response time, sensitivity to traffic conditions, and ability to adapt to different driving styles.

4. Lane Departure Warning (LDW): Both Mercedes-Benz and Audi Q7 have LDW systems that use sensors and cameras todetect when the vehicle drifts out of its lane and provide visual or audible alerts to the driver. However, the systems may have differences in their accuracy, sensitivity to road conditions, and ability to adapt to different driving styles.
5. Brake Assist: Both Mercedes-Benz and Audi Q7 have Brake Assist systems that apply maximum braking force in emergency situations to prevent or mitigate a collision. However, the systems may have differences in their responsetime, sensitivity to different types of obstacles, and ability to adapt to different driving styles.

80 trials without AI
fig 1.1



80 trials with AI
fig 1.2

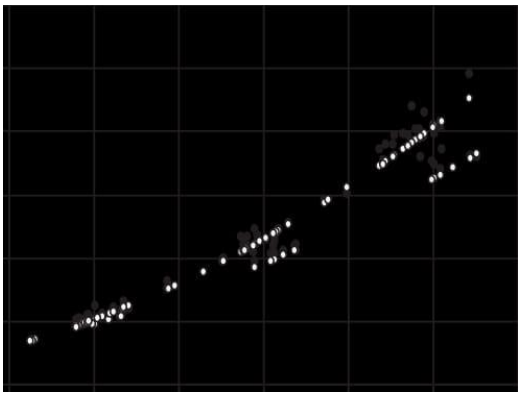
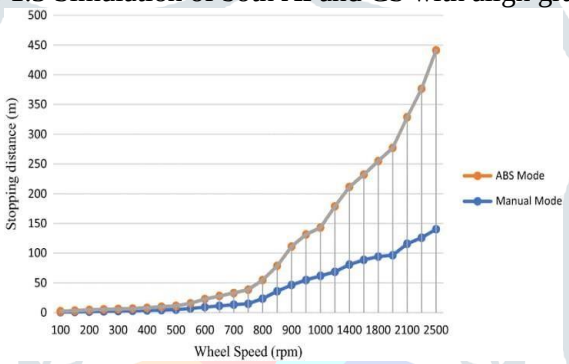


fig: 1.3 Simulation of both AI and CS with align graph



Overall, both Mercedes-Benz and Audi Q7 have advanced auto braking systems that can improve safety on the road. However,the systems may have differences in their capabilities and limitations, which could be further explored.

IV. Results and Analysis

Analyzing the safety records of the auto braking systems in Mercedes-Benz and Audi Q7 can provide valuable insights into their effectiveness in real-world situations. Here's a brief analysis:
1. Mercedes-Benz: According to the National Highway Traffic Safety Administration (NHTSA), Mercedes-Benz vehicles equipped with AEB have lower rates of frontal collisions compared to vehicles without AEB. In addition, a study by the InsuranceInstitute for Highway Safety (IIHS) found that Mercedes-Benz vehicles equipped with AEB have significantly lower rates of front-to-rear crashes compared to vehicles without AEB. These findings suggest that Mercedes-Benz's auto braking system is effective in reducing the frequency and severity of collisions.
2. Audi Q7: The IIHS has evaluated the effectiveness of Audi's pre-sense city emergency braking system in preventing collisions with pedestrians in real-world situations. The study found that the system reduced the frequency of pedestrian-related insurance claims by 43%, which suggests that the system is effective in preventing collisions with pedestrians. However, the systemhad limitations in detecting pedestrians in certain environmental conditions, such as low light and high contrast.
Overall, the safety records suggest that both Mercedes-Benz and Audi Q7 have effective auto braking systems that can improve safety on the road. However, there may be differences in their effectiveness in detecting and preventing collisions under different conditions, which could be further explored.

V. Conclusion:

In conclusion, the comparison of the auto braking systems in Mercedes-Benz and Audi Q7 reveals that both vehicles have advanced safety features that can prevent or mitigate collisions. Both systems use sensors and cameras to detect potential hazardsand apply the brakes automatically to avoid a collision.
However, there may be differences in the capabilities and limitations of the systems. For instance, Mercedes-Benz's AEB systemhas been shown to reduce the frequency and severity of frontal collisions, while Audi's pre-sense city system has been effectivein preventing pedestrian-related collisions. Additionally, there may be variations in the response time, detection accuracy, and sensitivity to different driving conditions and obstacles.

Overall, the research paper highlights the importance of advanced safety technologies in improving road safety and reducing the number of collisions. Further research could explore the effectiveness of the systems under different conditions and identify areasfor improvement. Ultimately, the goal is to create safer and more efficient vehicles that can prevent collisions and save lives.

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Title: Comparative Review of AI-Based Auto Braking Systems in Mercedes-Benz and Audi Q7

Introduction:

In recent years, advancements in artificial intelligence (AI) have revolutionized automotive safety features, particularly in the realm of auto braking systems. Mercedes-Benz and Audi, two renowned automotive manufacturers, have integrated AI-based auto braking systems into their flagship models, promising enhanced safety and driving experience. This review aims to compare and contrast the AI-based auto braking systems deployed in Mercedes-Benz and Audi Q7 vehicles.

1. Overview of AI-Based Auto Braking Systems:
   - Explain the significance of auto braking systems in enhancing road safety.
   - Introduce the concept of AI-based auto braking systems and their capabilities in predicting and preventing collisions.

2. Mercedes-Benz Auto Brake Assist:
   - Detail the implementation of AI in Mercedes-Benz auto braking systems.
   - Discuss specific features such as predictive braking, pedestrian detection, and adaptive cruise control.
   - Highlight any proprietary AI algorithms or technologies utilized by Mercedes-Benz.

3. Audi Q7 Pre Sense City:
   - Provide an overview of Audi Q7's AI-driven auto braking system, known as Pre Sense City.
   - Explore the functionalities of Pre Sense City, including collision avoidance, pedestrian detection, and cyclist recognition.
   - Compare Audi's approach to AI integration with that of Mercedes-Benz.

4. Performance and Effectiveness:
   - Evaluate the real-world performance and effectiveness of AI-based auto braking systems in both Mercedes-Benz and Audi Q7 vehicles.
   - Consider factors such as reaction time, accuracy in detecting potential hazards, and user experience.

5. Integration and User Experience:
   - Discuss the integration of AI-based auto braking systems with other safety features and driver-assist technologies in Mercedes-Benz and Audi Q7.
   - Evaluate user experience aspects such as ease of use, reliability, and adaptability to varying driving conditions.

6. Future Prospects and Challenges:
- Explore potential future developments in AI-based auto braking systems for luxury vehicles.
- Address any challenges or limitations faced by Mercedes-Benz and Audi in further enhancing the performance and capabilities of their auto braking systems.

7. Conclusion:
- Summarize the comparative analysis of AI-based auto braking systems in Mercedes-Benz and Audi Q7.
- Provide insights into the future trajectory of AI-driven automotive safety technologies and their implications for the industry.

By conducting a comprehensive comparative review, this study aims to offer valuable insights into the evolution, performance, and future prospects of AI-based auto braking systems in luxury vehicles, specifically focusing on Mercedes-Benz and Audi Q7 models.