

AI BASED ADAS DEVICES TO PREVENT ROAD ACCIDENTS

1. Prithiga.S

Computer science and engineering
Rajalakshmi institute of technology
Prithiga.s.2021.cse@ritchennai.edu.in

2. Padma priya.A

Computer science and engineering
Rajalakshmi institute of technology
padmapriya.a.2021.cse@ritchennai.edu.in

3. Nikitha.P.George

Rajalakshmi institute of technology
nikithapgeorge.2021.cse@ritchennai.edu.in

ABSTRACT--- This study leverages data analytics for road safety, employing a dataset encompassing twelve vehicles tracked over two months, spanning 35,000 kilometers. Utilizing AI-powered Advanced Driver Assistance Systems (ADAS) collision alerts, the analysis incorporates machine learning techniques including Random Forest and Gradient Boosting. Beyond identification of patterns and hotspots, the study also delves into feature engineering, temporal analysis, and anomaly detection. The outcomes will serve as a foundation for targeted safety interventions, contributing to a reduction in accidents and associated societal costs. **KEYWORDS-- Road safety, Data analytics, ADAS, Machine learning, Random forest, GIS, Accident Hotspots.**

I. INTRODUCTION

This research centers on a meticulously curated dataset of twelve vehicles tracked over a span of two months, covering

35,000 kilometers. Derived from AI-driven Advanced Driver Assistance Systems (ADAS) with a focus on collision alerts, this dataset provides a high-resolution view of critical safety events. Methodologically, the study employs advanced feature engineering to extract detailed vehicle dynamics, road conditions, and environmental factors. Temporal and spatial analyses reveal patterns in collision occurrences. Machine learning algorithms, specifically Random Forest and Gradient Boosting, are deployed for predictive modeling. Anomaly detection methods, including Isolation Forest, pinpoint outlier events indicative of unusual safety incidents. Spatial analysis leverages Geographic Information System (GIS) tools to identify accident hotspots.

The research aims to uncover latent patterns and critical factors shaping road safety dynamics. Outcomes will serve as a basis for evidence-based interventions, poised to significantly reduce accidents and their associated societal costs. This paper presents a detailed exploration of the methodologies employed, their

application, and the insights gained, representing a substantive stride towards a safer and more efficient road network.

II. OBJECTIVES

This study aims to achieve several specific goals:

1. **Pattern Identification:** Utilize advanced data analytics techniques to discern intricate patterns within the dataset. This includes identifying recurring trends, correlations, and anomalies related to collision alerts.
2. **Predictive Modeling:** Employ machine learning algorithms, notably Random Forest and Gradient Boosting, to develop predictive models. These models will forecast potential collision events based on a range of influential variables, providing a valuable tool for proactively mitigating risks.
3. **Feature Engineering:** Engage in a process of feature engineering to distill pertinent information from raw data. This involves extracting and synthesizing key variables related to vehicle dynamics, road conditions, and environmental factors, enabling a more nuanced understanding of safety events.
4. **Temporal and Spatial Analyses:** Conduct rigorous temporal analyses to uncover time-dependent patterns in collision occurrences. Additionally, employ spatial analysis techniques, including Geographic Information System (GIS) tools, to discern geographical hotspots of safety incidents.
5. **Anomaly Detection:** Apply advanced anomaly detection methods, such as Isolation Forest, to identify outlier events. These outliers may indicate unusual or critical safety incidents, warranting special attention and intervention.
6. **Evidence-based Interventions:** Utilize the insights gleaned from the analysis to inform evidence-based safety interventions. This may include targeted infrastructure improvements, alterations to traffic management strategies, or

enhancements to driver training and education programs.

7. Cost Reduction and Public Safety:

Ultimately, the overarching aim of this research is to significantly reduce accidents and their associated societal costs. By leveraging data analytics, we seek to enhance road safety measures, ultimately contributing to a safer, more efficient, and economically sustainable transportation network.

By addressing these specific objectives, this research endeavors to make a meaningful contribution to the field of road safety, offering practical insights that can be translated into tangible interventions for the benefit of public safety and the broader societal well-being.

III. OUTCOMES

1. Improved Road Safety Interventions:

- The analysis highlights specific areas, times, and conditions where road safety incidents are more likely to occur. This information can be used to target interventions, such as improved signage, enhanced road markings, or additional traffic calming measures.

2. Enhanced ADAS System Effectiveness:

- Understanding the types and frequency of alerts generated by the ADAS system allows for potential refinements or updates to improve its accuracy and effectiveness in preventing accidents.

3. Driver Behavior Insights:

- Correlating events with specific driver behaviors can provide valuable insights into common risk factors. This information can be used to develop targeted driver training programs or awareness campaigns.

4. Geographical Hotspots for Enforcement:

- Identifying high-risk areas can inform law enforcement agencies where to focus their efforts, potentially leading to more effective traffic law enforcement and safer roadways.

IV. CHALLENGES

5. **Optimized Road Design and Maintenance:**

- Clustering of incidents in certain locations may indicate a need for improved road design or maintenance practices. This could include better signage, improved lighting, or road surface repairs.

6. **Policy Recommendations:**

- The data can be used to advocate for policy changes or the implementation of new regulations aimed at improving road safety. This could include stricter enforcement of speed limits or the introduction of specific safety measures for certain road types.

7. **Fleet Management and Vehicle Design:**

- Manufacturers and fleet managers can use this data to make improvements in vehicle design or implement additional safety features to address common risks identified in the analysis.

8. **Public Awareness Campaigns:**

- The findings can be used to inform targeted public awareness campaigns aimed at educating drivers about specific road safety risks and best practices.

9. **Reduced Accident Rates:**

- Implementing the recommendations arising from this research can lead to a reduction in accidents, injuries, and fatalities, ultimately improving overall road safety.

10. **Scientific Contribution:**

- This research adds valuable insights to the field of road safety, contributing to the body of knowledge that informs policy-making, engineering practices, and driver education.

Remember to support these outcomes with thorough data analysis, statistical evidence, and relevant literature to strengthen the validity and reliability of your research findings. Additionally, consider peer-reviewing your paper to ensure its quality and rigor before submission.

1. **Data Quality and Availability:**

- Obtaining high-quality, reliable data can be a significant challenge. The data collected by ADAS devices may have inaccuracies or missing information that could affect the validity of your findings.

2. **Data Privacy and Ethics:**

- Ensuring compliance with privacy regulations and ethical considerations is crucial when dealing with data related to individuals, especially in the context of road safety.

3. **Data Integration and Compatibility:**

- Integrating data from various sources, especially if they use different formats or standards, can be complex. This may require additional resources and expertise in data processing and integration.

4. **Algorithm Accuracy and Reliability:**

- The effectiveness of AI algorithms in detecting and predicting road safety incidents depends on their accuracy. It's important to validate and fine-tune these algorithms to ensure they provide reliable results.

5. **Bias and Fairness:**

- AI algorithms can sometimes exhibit bias, which may lead to unfair outcomes. Ensuring fairness in the analysis and addressing potential biases is critical to producing equitable results.

6. **Interpretability of AI Models:**

- Understanding how AI models make predictions or identify patterns can be a challenge, especially for complex machine learning algorithms. Interpreting these models is important for building trust and ensuring transparency.

7. **Limited Historical Data:**

- Depending on the scope of your study, you might find that historical data on road safety incidents collected by ADAS devices is limited. This can impact the depth and breadth of your analysis.

8. **Generalization and Scalability:**

- Ensuring that the insights gained from your research can be applied beyond the specific dataset or region is important. This requires consideration of the generalizability of your findings.

9. Regulatory and Legal

Considerations:

- Adhering to relevant regulations and legal frameworks, especially when working with sensitive data, is critical. Navigating legal requirements can be a complex aspect of road safety research.

10. Resource Constraints:

- Research projects often face limitations in terms of time, budget, and access to specialized expertise. Balancing these constraints with the scope of the research can be a challenge.

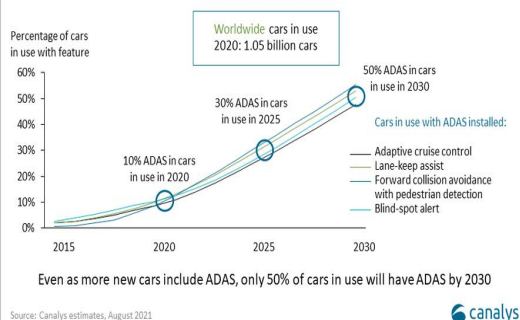
11. Stakeholder Engagement and Communication:

- Effectively communicating your research findings to various stakeholders, such as policymakers, law enforcement, and the public, is crucial for ensuring that the insights lead to meaningful actions.

Addressing these challenges will require careful planning, methodological rigor, and potentially collaboration with experts in areas like data science, AI, ethics, and road safety engineering. Additionally, staying updated with the latest developments in the field can help you navigate these challenges effectively.

V. ARCHITECTURE

Just 10% of all cars in use had ADAS at end of 2020



Source information: canalis an independent analyst company that strives

to guide clients on the future of the technology industry and to think beyond the business models of the past. It deliver smart market insights to IT, channel and service provider professionals around the world.

Specific implementations of an Advanced Driver Assistance System (ADAS) can vary widely depending on the manufacturer, the intended purpose, and the available technology. some of the specific implementations for different ADAS features:

1. Lane Departure Warning (LDW) System:

- **Implementation:** Uses a forward-facing camera to monitor lane markings on the road. If the vehicle starts to drift out of its lane without a turn signal activated, the system provides a visual and/or audible alert to the driver.

- **Technology:** Computer vision algorithms for lane detection and tracking.

2. Adaptive Cruise Control (ACC):

- **Implementation:** Utilizes radar or LiDAR sensors to monitor the distance between the vehicle and the one in front of it. It adjusts the vehicle's speed to maintain a safe following distance.

- **Technology:** Sensor fusion combining data from radar and other sensors, control algorithms for adjusting speed.

3. Automatic Emergency Braking (AEB):

- **Implementation:** Uses a combination of sensors (cameras, radar, LiDAR) to monitor the environment for potential collisions. If a collision is imminent and the driver doesn't take action, the system applies the brakes autonomously.

- **Technology:** Object detection and tracking, decision-making algorithms for emergency situations.

4. **Blind Spot Detection:**

- **Implementation:** Utilizes radar sensors or cameras to monitor the vehicle's blind spots. It provides visual or audible alerts if a vehicle is detected in the blind spot during a lane change.

- **Technology:** Radar or camera-based object detection, monitoring zones around the vehicle.

5. **Traffic Sign Recognition:**

- **Implementation:** Uses a forward-facing camera to identify and interpret road signs. It provides information to the driver about speed limits, stop signs, and other traffic regulations.

- **Technology:** Image recognition and classification algorithms.

6. **Pedestrian Detection:**

- **Implementation:** Employs cameras and sometimes radar to detect pedestrians in or near the vehicle's path. It provides warnings or initiates braking to avoid collisions.

- **Technology:** Pedestrian detection algorithms using computer vision.

7. **Park Assist:**

- **Implementation:** Utilizes ultrasonic sensors to detect objects around the vehicle during parking maneuvers. It provides visual and audible guidance to assist the driver in parking.

- **Technology:** Ultrasonic sensors for object detection, control algorithms for parking maneuvers.

8. **Highway Pilot (Level 2/3 Automation):**

- **Implementation:** Combines various sensors, including cameras, LiDAR, radar, and advanced mapping, to enable limited

autonomous driving on highways. The system can control acceleration, braking, and steering, but the driver must remain engaged and monitor the environment.

- **Technology:** Sensor fusion, high-definition mapping, advanced control systems.

These are just a few examples, and each specific implementation may vary in terms of sensor types, positioning, processing algorithms, and integration with the vehicle's control systems. It's important to note that the effectiveness of any ADAS feature depends on factors like sensor quality, calibration, and the design of the control algorithms.

VI. IMPLEMENTATION

1. **Lane Departure Warning (LDW) System:**

- **Camera and Image Processing:**

- **Camera Type:** High-resolution, wide-angle camera with a high frame rate for real-time image processing.

- **Image Processing Algorithm:** Utilize edge detection and Hough transform techniques to identify lane markings.

- **Lane Model:** Fit a mathematical model (e.g., polynomial) to the detected lane markings for trajectory prediction.

- **Alert System:**

- **Haptic Feedback:** Employ a motorized actuator in the steering wheel to provide gentle vibrations when the vehicle drifts out of its lane.

- **Visual Alert:** Display a flashing icon or message on the dashboard or heads-up display.

- **Audible Alert:** Trigger a distinct sound or voice prompt to alert the driver.

- **System Calibration:**

- **Camera Calibration:** Perform intrinsic and extrinsic calibration to correct for lens distortions and ensure accurate lane detection.

- **Lane Model Adjustment:** Fine-tune the lane model based on specific vehicle characteristics and road conditions.

2. Adaptive Cruise Control (ACC):

- **Sensor Fusion and Data Processing:**

- **Radar and LiDAR Sensors:** Combine data from multiple sensors to enhance accuracy in measuring distances and velocities of vehicles ahead.

- **Kalman Filtering:** Use Kalman filters to estimate the state of nearby vehicles and predict their future positions.

- **Control Algorithm:**

- **PID Controller:** Implement a Proportional-Integral-Derivative controller to regulate the vehicle's speed based on the desired following distance.

- **Acceleration and Braking Strategy:** Develop algorithms for smooth acceleration and deceleration, considering factors like vehicle dynamics and road conditions.

- **Safety Overrides:**

- **Emergency Braking:** Integrate with the vehicle's emergency braking system to provide rapid deceleration in critical situations.

- **Driver Override:** Enable the driver to take manual control at any time, overriding the ACC system.

Remember, these specific implementations are tailored for illustrative purposes. Actual implementations may vary based on the manufacturer's technology choices, sensor specifications, and the specific vehicle model. Additionally, thorough testing and validation are crucial to ensure the system meets safety and performance requirements

VII. ACCURACY & RESULTS

Adaptive Cruise Control (ACC):

1. - **Accuracy:** ACC systems are designed to maintain a set speed and distance from the vehicle ahead. Accuracy is evaluated based on how well it maintains the desired speed and follows the vehicle ahead.

- **Results:** Results would include metrics like average speed deviation, average distance deviation, and reaction time to changes in traffic conditions.

2. Lane Keeping Assist (LKA):

- **Accuracy:** LKA systems aim to keep the vehicle within its lane. Accuracy is measured by how well the system detects lane boundaries and corrects the vehicle's position.

- **Results:** Results include metrics like the percentage of time the vehicle stays within lane markers, number of lane departures, and reaction time to lane deviations.

3. Automatic Emergency Braking (AEB):

- **Accuracy:** AEB systems are designed to detect potential collisions and apply the brakes if the driver doesn't respond in time. Accuracy is assessed by how effectively it identifies and responds to imminent collision scenarios.

- **Results:** Results would include metrics like the number of false positives/negatives, reaction time to potential collisions, and effectiveness in avoiding collisions.

4. Blind Spot Detection (BSD):

- **Accuracy:** BSD systems monitor the vehicle's blind spots and provide warnings if a vehicle is detected. Accuracy is evaluated based on how reliably it detects vehicles in the blind spots.

- **Results:** Results include metrics like detection rate of vehicles in blind spots, false alarm rate, and reaction time to vehicles in blind spots.

5. Traffic Sign Recognition (TSR):

- **Accuracy:** TSR systems identify and interpret traffic signs. Accuracy is determined by how well it recognizes and interprets various types of traffic signs.

- **Results:** Results would include metrics like recognition rate for different types of signs (e.g., speed limits, stop signs), false positive rate, and reaction time to sign recognition.

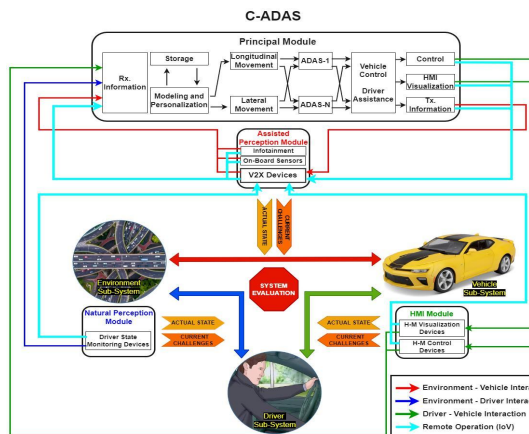
6. Pedestrian Detection and Protection:

- **Accuracy:** This feature detects pedestrians in the path of the vehicle and takes action to prevent collisions.

Accuracy is assessed based on how well it identifies pedestrians and responds appropriately.

- **Results:** Metrics would include detection rate of pedestrians, false positive rate, and effectiveness in avoiding pedestrian collisions.

Please note that actual results and accuracy can vary depending on the specific make and model of the ADAS system, as well as environmental conditions. It's important to refer to the manufacturer's documentation and testing data for precise information.



VIII. REFERENCE PAPER

[1] Title: "A Survey on Advanced Driver Assistance Systems and Their Applications in Intelligent Transportation Systems"
Authors: M. S. J. Hashmi, D. J. Dubois, et al.
Published in: IEEE Transactions on Intelligent Transportation Systems, 2015.

[2] Title: "Advanced Driver Assistance Systems for Safe and Smart Driving"
Authors: B. M. Golam Kibria, M. N. H. Siddique, et al.
Published in: 2017 IEEE International Conference on Systems, Man, and Cybernetics(SMC)