International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 09 | Sep 2024 www.irjet.net p-ISSN: 2395-0072

SAFE ROAD AI: REAL-TIME ACCIDENT DETECTION FROM MULTI-ANGLE CRASH VIDEOS: A REVIEW

Piyush Kumar[1], Dipti Ranjan Tiwari[2]

[1]Master of Technology, Computer Science and Engineering, Lucknow Institute of Technology, Lucknow, India
[2]Assistant Professor, Department of Computer Science and Engineering, Lucknow Institute of Technology, Lucknow, India

---***---

Abstract - *Road accidents represent a prominent cause of fatalities on a global scale, underscoring the need for advanced technologies to promptly detect and respond to such incidents. This comprehensive review delves into the evolution and implementation of Safe Road AI, a cutting-edge real-time accident detection system that harnesses multi-angle crash videos. Through meticulous analysis of footage from diverse viewpoints, Safe Road AI utilizes state-of-the-art computer vision techniques and deep learning algorithms to precisely identify and categorize traffic accidents as they unfold. The system's capacity to process intricate visual data instantaneously confers a notable advantage in diminishing emergency response times and enhancing overall road safety. This paper conducts a thorough evaluation of existing methodologies in accident detection, shedding light on the obstacles and breakthroughs in multi-angle video analysis. Furthermore, it delves into the ramifications of Safe Road AI in fortifying road safety measures, influencing policy-making endeavors, and delineating future research paths within the realm of intelligent transportation systems.*

Key Words: Safe Road AI, real-time accident detection, multi-angle crash videos, computer vision, deep learning, traffic safety, intelligent transportation systems, emergency response, road safety technology.

1.BACKGROUND

"Safe Road AI" is an innovative technology crafted to heighten road safety by employing real-time accident detection through the scrutiny of multi-angle crash videos. The genesis of this technology can be attributed to the escalating global apprehension regarding road safety, with myriad accidents transpiring annually, often culminating in fatalities or severe injuries. Conventional methods of accident detection heavily leaned on eyewitness testimonies, surveillance cameras with restricted angles, or tardy responses from emergency services, frequently leading to prolonged rescue durations and inadequate accident evaluations.

1.1.Early Development

The inception of "Safe Road AI" materialized in the latter part of the 2010s as advancements in artificial intelligence (AI), machine learning, and computer vision began to exhibit potential in the realm of real-time image and video processing. Scholars and technologists acknowledged the transformative capabilities of these technologies in enhancing road safety through prompt and precise accident detection, facilitating expedited response times and comprehensive data collection for analysis.

The preliminary phase of development entailed the aggregation of extensive datasets from diverse origins, encompassing traffic surveillance cameras, dashcams, and various video recording apparatuses, to train AI models. The primary focus revolved around formulating algorithms with the ability to concurrently scrutinize multiple perspectives of collision footage, discern recurring patterns, and promptly identify accidents as they unfold. This endeavor necessitated the utilization of sophisticated machine learning methodologies, notably deep learning, to effectively analyze and decipher the intricate data from varied vantage points.

1.2.Prototype and Testing

By the early 2020s, the initial prototypes of "Safe Road AI" were developed. These prototypes underwent testing in controlled environments and later in real-world scenarios. The system was crafted to seamlessly integrate with existing infrastructure, such as traffic surveillance cameras, and had the capability to be incorporated into smart city frameworks. The AI was meticulously trained to identify various types of accidents, ranging from minor collisions to severe crashes, through real-time analysis of video feeds.

A significant challenge encountered during this phase revolved around ensuring the precision and dependability of the system. The AI needed to exhibit the capacity to differentiate between genuine accidents and other similar-looking events, such as sudden braking or unexpected maneuvers. Continuous enhancements were implemented to the algorithms, which included augmenting the AI's aptitude to assimilate new data and refining its adaptability to diverse environmental conditions, such as varying weather patterns and lighting scenarios.

1.3.Implementation and Impact

"Safe Road AI" was progressively implemented in various urban centers globally by the mid-2020s. Its introduction signified a notable achievement in the realm of road safety, offering authorities a potent tool for real-time accident monitoring and response. The system's capacity to scrutinize multi-angle collision footage facilitated a more comprehensive comprehension of accidents, enabling emergency services and traffic management authorities to make well-informed decisions. The impact of "Safe Road AI" has been profound, notably decreasing the response time of emergency personnel to accident sites, potentially mitigating fatalities and lessening injury severity. Furthermore, the data amassed by the system has proved invaluable for traffic analysis and the enhancement of safer road infrastructures. Additionally, insurance firms have reaped the benefits of more precise and impartial accident assessments, resulting in fairer claims adjudication.

2.INTRODUCTION

In recent times, the escalating number of vehicles on the roads has resulted in a substantial increase in traffic accidents on a global scale. Prompt identification and response to these accidents are imperative for preserving lives, minimizing injuries, and averting subsequent collisions. Conventional approaches to accident detection often depend on delayed testimonies from bystanders or emergency services, leading to crucial time lapses. With technological advancements, there is a burgeoning interest in harnessing artificial intelligence (AI) to augment road safety through real-time accident detection.

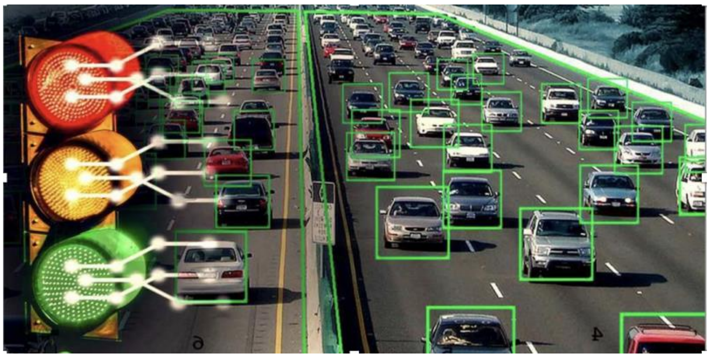

Figure-1: Safe Road AI

The emergence of AI-driven systems has paved the way for tackling the complexities of road safety. One promising strategy involves utilizing multi-angle crash videos, obtained from a variety of sources such as surveillance cameras, dashcams, and drones, for real-time accident detection. This approach enables a thorough examination of incidents, offering valuable insights that can enhance response times and potentially avert future accidents.

SAFE ROAD AI is an innovative system crafted to leverage the capabilities of AI for instantaneous accident identification. Through the analysis of multi-angle crash videos, this system strives to recognize accidents as they occur, issuing immediate alerts to emergency services and traffic management centers. The capacity to process and scrutinize data from diverse perspectives heightens the precision of detection, rendering SAFE ROAD AI a valuable instrument in the pursuit of safer roads.

This analytical paper delves into the existing landscape of research and development in AI-based accident detection systems, focusing on the utilization of multi-angle video analysis. It furnishes a comprehensive overview of the methodologies employed, the obstacles encountered, and the potential advantages of deploying such systems on a large scale. Furthermore, the paper deliberates on the future potential of SAFE ROAD AI and analogous technologies in transforming road safety and accident management.

2.1.Importance of leveraging AI and multi-angle video data for enhancing road safety.

Leveraging artificial intelligence (AI) and multi-angle video data is imperative for enhancing road safety as it enables more precise, real-time detection and analysis of accidents. AI algorithms, particularly in the field of computer vision, can efficiently process video data from various perspectives, ensuring the accurate identification of incidents while minimizing false alarms and missed detections. This capability facilitates prompt responses, which are vital in saving lives and reducing injuries. Moreover, multi-angle viewpoints offer a comprehensive outlook on accidents, empowering AI systems to examine crucial factors like impact angles and vehicle velocities. This leads to deeper insights into the causes of accidents and facilitates more informed decision-making. Additionally, the scalability of AI systems allows for the efficient monitoring of extensive road networks, offering a proactive approach to accident prevention by identifying and mitigating risks before they escalate into collisions. The fusion of AI with multi-angle video data establishes a more precise, responsive, and efficient road safety framework.

2.2.Focus on AI-based methodologies for real-time accident detection using multi-angle crash videos.

Focusing on AI-driven methodologies for real-time accident detection using multi-angle crash videos is imperative as it harnesses advanced technologies to enhance the speed and precision of identifying road incidents. AI algorithms, especially those within machine learning and computer vision domains, have the capability to analyze video streams from diverse angles concurrently, enabling a more thorough and intricate comprehension of an accident as it transpires. This multi-angle strategy ensures that the AI system captures all crucial elements of the crash, including the sequence of events, vehicle dynamics, and the precise location of impact, thereby augmenting the reliability of the detection process. By processing this data instantaneously, AI systems can promptly detect accidents, facilitating swifter emergency response times and diminishing the potential for further harm. This emphasis on AI-facilitated, real-time scrutiny of multi-angle crash videos signifies a notable progression in road safety, amalgamating state-of-the-art technology with comprehensive video data to formulate a highly proficient and effective accident detection system.

2.3.multiple viewpoints improve analysis and decision-making.

Multiple perspectives significantly enhance analysis and decision-making by offering a more comprehensive and nuanced understanding of an incident, such as a traffic collision. When an event is captured from various viewpoints, each perspective unveils distinct details that could be overlooked if only a single vantage point was available. For example, one camera angle might capture the precise moment of impact, while another angle reveals the events leading up to the crash, including the velocity and actions of the involved vehicles. By amalgamating these diverse perspectives, artificial intelligence systems can construct a more precise and intricate reconstruction of the incident, resulting in superior analysis. This holistic outlook facilitates more well-informed decision-making, whether it involves identifying the root cause of the accident, evaluating its severity, or determining the most appropriate emergency response. Ultimately, multiple viewpoints enable a profound comprehension, diminishing the probability of errors and enhancing the overall efficacy of the analysis and subsequent decisions.

3.AI Techniques for Accident Detection

AI techniques for accident detection encompass a fusion of sophisticated algorithms and methodologies crafted to scrutinize video data, pinpoint potential accidents, and offer real-time responses. Here is an intricate examination of the principal AI techniques employed in this realm:

3.1.Computer Vision Algorithms

Computer vision is the foundation of AI-based accident detection, allowing systems to interpret and understand visual data from video feeds. Several specific techniques are involved:

3.1.1.Object Detection

AI models, particularly Convolutional Neural Networks (CNNs), play a vital role in the realm of video analysis by being trained to identify and categorize various objects present in a video feed. These objects can range from vehicles and pedestrians to traffic signs and road lanes. For instance, in the context of autonomous driving, AI models utilizing CNNs can effectively distinguish between different elements on the road, enabling the vehicle to make informed decisions. Object detection, which is a fundamental task performed by these AI models, is essential for recognizing the key components involved in potential accidents and ensuring the safety of both pedestrians and drivers alike. By accurately detecting objects in real-time video streams, these AI models contribute significantly to enhancing the overall safety and efficiency of various applications, such as surveillance systems and autonomous vehicles.

3.1.2.Motion Tracking

Once objects are detected, motion tracking algorithms, often based on Kalman filters or optical flow techniques, follow the movement of these objects across frames. This helps in understanding the dynamics of the accident, such as the speed and direction of the vehicles involved.

In practical terms, consider a scenario where a surveillance camera captures a traffic intersection. When a car enters the frame, the motion tracking algorithm can identify it and monitor its path as it moves through the intersection. By analyzing the data collected from the algorithm, authorities can reconstruct the events leading up to a collision.

Motion tracking algorithms play a crucial role in various fields beyond traffic analysis. For instance, in sports, these algorithms are used to track the movement of players on the field, providing valuable insights for coaches and analysts. Similarly, in robotics, motion tracking is essential for ensuring precise and coordinated movements of robotic systems.

By leveraging advanced technologies like Kalman filters and optical flow techniques, motion tracking algorithms have become indispensable tools for analyzing dynamic systems. They enable researchers and practitioners to delve deeper into the behavior of moving objects, paving the way for improved understanding and decision-making in a wide range of applications.

3.1.3.Anomaly Detection

AI systems are extensively trained to analyze and understand normal traffic patterns and behaviors. For instance, these systems can distinguish between a vehicle moving steadily in a lane and a vehicle abruptly changing lanes without signaling. This level of sophistication enables AI algorithms to detect anomalies effectively. When an abnormal event like a sudden stop, collision, or a vehicle swerving unexpectedly is detected, anomaly detection algorithms promptly flag it as a potential accident, thereby enhancing road safety.

To achieve this, anomaly detection algorithms employ various techniques such as Support Vector Machines (SVMs) and Autoencoders. Support Vector Machines (SVMs) are particularly useful in identifying outliers in the data by creating a hyperplane that best separates different classes of data points. On the other hand, Autoencoders are adept at learning complex patterns and features from the input data, making them valuable in detecting anomalies that may not be easily discernible through traditional methods.

3.2.Deep Learning Models

Deep learning enhances the capabilities of AI in accident detection by enabling more complex and accurate pattern recognition:

3.2.1.Convolutional Neural Networks (CNNs)

Convolutional Neural Networks (CNNs) have proven to be highly effective in the realm of image and video analysis. Their ability to automatically learn and extract features from data sets them apart, especially in tasks like identifying and classifying objects and scenes in crash videos. For example, in the context of autonomous driving systems, CNNs play a crucial role in detecting potential accidents by analyzing real-time video feeds from cameras mounted on vehicles. By processing these visual inputs, CNNs can accurately pinpoint critical events on the road, such as sudden lane changes or pedestrian crossings.

Furthermore, CNNs excel in recognizing patterns and nuances within images and videos, leading to improved accuracy in accident detection. This enhanced capability is particularly valuable in scenarios where human perception may be limited or prone to error. Consider a situation where a surveillance camera captures a complex traffic incident involving multiple vehicles. A CNN can diligently analyze the footage, identify relevant objects and movements, and provide valuable insights to aid in accident investigation and reconstruction.

In essence, the versatility and efficiency of CNNs make them indispensable tools for enhancing safety and security in various domains. Whether it's monitoring traffic conditions, analyzing surveillance footage, or assisting in forensic examinations, CNNs continue to push the boundaries of what is possible in image and video analysis. Their adaptability and precision pave the way for innovative applications that prioritize accuracy and reliability in accident detection and prevention.

3.2.2.Recurrent Neural Networks (RNNs) and Long Short-Term Memory Networks (LSTMs)

These models, such as Long Short-Term Memory networks (LSTMs), are specifically crafted to handle sequential data, making them well-suited for analyzing video frames over time. LSTMs, a type of recurrent neural network, excel at capturing temporal dependencies, which play a crucial role in understanding the progression of events that may lead to an accident.

For instance, in the context of monitoring traffic intersections, LSTMs can track the movement of vehicles frame by frame, allowing for the detection of potentially dangerous patterns like sudden lane changes or running red lights. By analyzing the sequential nature of video data, these models can predict the likelihood of accidents before they occur, enabling proactive intervention to prevent them.

LSTMs have been successfully applied in various fields beyond accident prevention. In the realm of natural language processing, they are used to generate coherent and contextually relevant text by considering the order of words in a sentence. This application highlights the versatility of LSTMs in capturing sequential patterns not only in video data but also in textual information.

The ability of LSTMs to capture temporal dependencies makes them invaluable tools for analyzing sequential data, whether it be in the form of video frames or textual information. By delving into the sequential nature of data, these models offer insights that can enhance safety measures, improve predictive capabilities, and drive advancements in various domains.

3.3.Real-Time Processing

Real-time processing is essential for timely accident detection and response:

3.3.1.Edge Computing

To achieve real-time performance, AI systems often utilize edge computing, a strategy where data processing occurs in proximity to the data source, such as on local devices or nearby servers, rather than being transmitted to a centralized cloud server. This approach significantly reduces latency, the delay between data input and output, and facilitates quicker decision-making processes.

One practical example of edge computing in action is in autonomous vehicles. These vehicles rely on real-time data processing to make split-second decisions while on the road. By processing data on-board or through nearby edge servers, autonomous vehicles can react swiftly to changing road conditions, ensuring passenger safety.

Additionally, edge computing is increasingly being adopted in the healthcare industry. Medical devices equipped with AI capabilities can analyze patient data locally, allowing for immediate insights and faster diagnosis without the need to transfer sensitive information to external servers. This not only enhances patient privacy but also expedites critical healthcare decisions.

Edge computing plays a crucial role in the Internet of Things (IoT) ecosystem. Smart home devices, such as thermostats and security cameras, leverage edge computing to process data locally and respond promptly to user commands. This decentralized approach enhances user experience by reducing response times and ensuring seamless device operation.

Edge computing's ability to process data closer to the source, whether in autonomous vehicles, healthcare devices, or IoT applications, is instrumental in achieving real-time performance, reducing latency, and enabling faster decision-making across various industries.

3.3.2.Parallel Processing

AI models, especially deep learning models, rely heavily on substantial computational power to function effectively. This computational power is essential for handling complex algorithms and processing vast amounts of data efficiently. In particular, the utilization of parallel processing techniques, such as GPUs or specialized hardware like TPUs, plays a crucial role in enhancing the performance of these models.

For example, when analyzing video data for real-time accident detection, the ability to utilize GPUs or TPUs enables AI models to process frames rapidly and identify potential hazards promptly. This speed and efficiency are paramount in critical situations where immediate action is required.

The parallel processing capabilities provided by GPUs and TPUs allow AI models to distribute tasks effectively, leading to optimized performance and faster computations. By harnessing the power of parallel processing, AI systems can handle intricate calculations and data manipulations with ease, resulting in more accurate and timely insights.

The integration of parallel processing technologies into AI systems significantly enhances their capabilities, enabling them to analyze data more swiftly and accurately. This, in turn, contributes to the overall effectiveness and reliability of AI applications in various domains, including real-time accident detection.

3.4.Multi-Modal Fusion

Accurate accident detection often requires the integration of data from multiple sources:

3.4.1.Sensor Fusion

Combining video data with other sensor inputs, such as radar, LiDAR, or GPS, can significantly improve the accuracy of accident detection. By integrating different types of sensor data, a more comprehensive understanding of the surrounding environment can be achieved. For instance, radar data can offer precise details about the speed and distance of vehicles involved in an accident. When this radar information is coupled with video analysis, a more detailed and complete picture of the incident can be obtained.

In practical terms, imagine a scenario where a vehicle suddenly swerves on a highway. Through the use of radar, the exact speed and proximity of the swerving vehicle can be accurately determined. Concurrently, video footage from nearby cameras can capture the visual context of the event, such as road conditions and surrounding traffic. By combining these two sources of information, it becomes easier to reconstruct the sequence of events leading up to the accident.

The integration of LiDAR technology can add another layer of depth to accident detection. LiDAR sensors can provide detailed 3D mapping of the environment, including the position of objects and obstacles in real-time. When synchronized with video data, this can offer a more comprehensive understanding of the spatial dynamics during an accident. Additionally, GPS data can be used to track the precise location and movement patterns of vehicles, further enhancing the accuracy of accident reconstruction.

The fusion of video data with radar, LiDAR, and GPS inputs presents a powerful synergy that can revolutionize accident detection and analysis. By leveraging the strengths of each sensor technology, a more holistic and detailed perspective of accidents can be achieved, ultimately leading to improved safety measures and prevention strategies on the road.

3.4.2.Multi-Angle Video Integration

AI systems play a crucial role in modern accident analysis by integrating and synchronizing video feeds from various angles. This process ensures that every aspect of the accident is captured comprehensively, providing investigators with a detailed understanding of the event. For instance, when a car collision occurs, these AI systems can combine footage from multiple cameras to reconstruct the sequence of events accurately.

One of the techniques utilized in this process is 3D reconstruction, where the AI system creates a three-dimensional model of the accident scene. This model allows investigators to virtually explore the scene, analyze different perspectives, and gather more insights into what transpired. Additionally, stereo vision technology can be employed to enhance the depth perception of the footage, providing a more realistic representation of the accident.

By utilizing these advanced technologies, the accuracy of accident analysis is significantly improved. Investigators can delve deeper into the details of the incident, identify potential causes more effectively, and ultimately enhance safety measures to prevent similar accidents in the future. The integration of AI systems in accident analysis not only streamlines the investigation process but also enhances the overall understanding of complex events.

3.5.Machine Learning-Based Decision Making

Once an accident is detected, AI systems use machine learning to assess the severity of the incident and make decisions:

3.5.1.Classification Algorithms

After detecting an accident, classification algorithms play a crucial role in categorizing it based on severity, which can range from minor to moderate to severe. For instance, in the case of a minor accident, it could involve a fender bender with minimal damage to vehicles and no injuries. On the other hand, a severe accident may result in significant damage, multiple injuries, or even fatalities.

The classification process is essential as it assists in prioritizing emergency response efforts and allocating resources effectively. For example, if an accident is classified as severe, emergency medical services and rescue teams would be dispatched promptly to the scene to provide immediate assistance. In contrast, a minor accident may not require as urgent of a response, allowing resources to be allocated to more critical situations.

By categorizing accidents based on severity, classification algorithms enable authorities to make informed decisions on how to best manage and respond to each incident. This not only enhances the efficiency of emergency services but also improves overall safety on the roads. In conclusion, the role of classification algorithms in categorizing accident severity is paramount in ensuring timely and appropriate emergency responses.

3.5.2.Predictive Modeling

AI not only has the capability to predict potential outcomes or consequences of an incident, such as likely injuries or disruptions in traffic flow, but it can also play a crucial role in preparing and implementing appropriate emergency responses. Predictive algorithms, which are often based on historical data, are instrumental in this process. For example, in the case of a natural disaster like a hurricane, AI can analyze various factors such as wind speed, precipitation levels, and geographical data to predict the areas most at risk and the potential impact on infrastructure and communities. This information is invaluable for authorities to proactively plan evacuation routes, allocate resources, and coordinate rescue efforts. By leveraging AI technology, emergency responders can enhance their preparedness and efficiency in managing crises effectively.

3.6.Natural Language Processing (NLP) for Alert Generation

In addition to visual data, AI systems may use NLP techniques to generate alerts and reports:

3.6.1.Automated Report Generation

After detecting an accident, NLP algorithms play a crucial role in generating detailed reports that summarize the key events and observations effectively. These reports serve as essential tools in providing comprehensive information to relevant authorities and enhancing overall traffic management systems. For instance, imagine a scenario where a car collision occurs at a busy intersection. The NLP algorithms can swiftly analyze the sequence of events leading up to the accident, including the speed of the vehicles, the timing of the collision, and any contributing factors like weather conditions or road obstructions.

By incorporating such specific details, the generated reports offer a clear and concise overview of the accident, enabling authorities to take appropriate actions promptly. Moreover, these reports can be automatically disseminated to traffic control centers, enabling real-time updates on road conditions and potential hazards. This seamless integration of NLP technology not only streamlines the reporting process but also enhances the overall efficiency of traffic management operations.

3.6.2.Voice-Based Alerts

In some systems, NLP is used to create voice alerts for drivers or emergency responders, providing real-time information about the accident and necessary actions.

3.7.Reinforcement Learning for System Optimization

Reinforcement learning can be employed to continuously improve the performance of AI-based accident detection systems:

3.7.1.Adaptive Learning

By interacting with the environment and receiving feedback, reinforcement learning models can optimize their strategies for accident detection, learning from past successes and failures to enhance future performance.

3.7.2.Traffic Management Integration

AI systems can use reinforcement learning to optimize traffic flow and reduce the likelihood of accidents, by dynamically adjusting traffic signals, rerouting vehicles, or implementing other traffic management measures in real time.

3.8.Ethical AI and Fairness

Ensuring that AI systems for accident detection are fair, transparent, and ethical is critical:

3.8.1.Bias Mitigation

AI models must be trained on diverse datasets to avoid biases that could lead to unequal treatment of different populations or inaccurate accident detection in certain scenarios.

3.8.2.Transparency and Accountability

It is essential to ensure that AI decisions, especially those related to accident detection, are explainable and transparent, allowing for accountability in case of errors or misjudgments.

4.LITERATURE SURVEY

In the section of the literature survey, we have studied the previous research paper related to the accident detection of videos by using different mathod, the summary of the previous paper are given below:

Christophe et al. This paper describes the real time implementation of a simple and robust motion detection algorithm based on Markov random field modeling, based on a hybrid architecture, associating pipeline modules with one asynchronous module to perform the whole process, from video acquisition to moving object masks visualization. Real-time motion detection using MRF modeling with hybrid architecture. Achieved processing rate of 15 images/s, validating the approach. MRF-based motion detection algorithm with hybrid architecture proposed. Real-time implementation achieved with 15 images/s processing rate.

Romuald et al. A new method that allows to accurately detersigned to detect and track the road lane of a vehicle mine the position of the road sides in the image based on the exploitation of a statistical model of the lanes and the management of the number of lanes is described. Method detects and tracks road lanes using statistical model. Implemented on experimental vehicle VELAC, showing robustness and precision. Precision in lane detection despite shadows or sunlight interference. Method can manage multiple lanes and works on marked/unmarked roads.

Margrit et al. Real-time system detects and tracks vehicles on highways. Uses color, edge, motion info for recognition and tracking. Real-time system detects lanes, boundaries, and vehicles on highways. Works well under various conditions, except in congested city traffic.

Dawn. A Mathematical Model for Computerized Car Crash Detection using Computer Vision techniques and a Poisson distribution that predicts the number of accidents in an intersection per week are presented. Automatic car crash detection using computer vision techniques. Mathematical model based on Poisson distribution for crash prediction. Computer vision aids in accident detection at intersections. Potential to save lives by quicker emergency response.

Fekri. The results show that the proposed scheme guarantees record the vehicle accident in the ITS server and has better results in comparison with full time video recording scheme. Novel real-time video and data capture in Intelligent Transportation System. Solves storage issue, records accident efficiently, better than full-time recording. Proposed scheme efficiently captures and saves vehicle accident data. Outperforms full-time video recording scheme in ITS server.

Murat et al. A preliminary real-time autonomous accident-detection system based on computational intelligence techniques is proposed and the results indicate that even though the number of false alarms dominates the real accident cases, the system can still provide useful information that can be used for status verification and early reaction to possible accidents. Real-time accident detection model using computational intelligence techniques. Big data processing for Istanbul City traffic data in 2015. System provides useful information for status verification and early reaction. Number of false alarms dominates real accident cases.

Ankit et al. This special issue concerns computer vision subjects in automated solutions for road safety, but also for the cases where the human factor involved in transportation and safety systems plays a significant role. Computer vision enhances road safety and traffic management. Papers cover driver behavior, vehicle detection, and safety systems. Outcome brings state-of-the-art papers in road safety. Many questions still unanswered, further research needed.

Bhalerao et al. ADIS is a smart system which informs to the emergency contacts through text messages when there is a change in acceleration, rotation and force which is detected by different sensors which are connected to the central system of the car. ADIS informs emergency contacts via text after detecting car changes. Fuzzy logic decides if an accident has occurred. ADIS system detects accidents and notifies emergency contacts immediately. Fuzzy logic in ADIS decides if an accident has occurred.

Hao et al. This paper combines the model with local normalized pixel-value differencing (NPD) features, trained AdaBoost model by polymorphic complex angle samples, and shows that the method has better detection performance and lower failure rate, and can meet the requirements of real-time vehicle detection in actual scene. Multi-angle vehicle detection method using micro cascading neural network. Improved AdaBoost model with local NPD features for better detection.Improved multi-angle vehicle detection method with micro cascading neural network. Achieved 89.47% detection rate and 199 ms detection time.

Lakshmipraba. An electronic system which is based on embedded and Internet of Things (IoT) with sensors to take actions under emergency conditions and to communicate through wireless protocol is presented. Smart highway systems using IoT for accident prevention. Innovative project using sensors and wireless communication for road safety. Smart system for accident prevention using IoT and sensors. Innovative electronic system based on embedded technology and IoT.

Noor et al. The proposed approach to combine time-domain, frequency- domain, and joint time-frequency features extracted from a class of quadratic time-frequencies distributions (QTFDs) to detect events on roads through audio analysis and processing conforms to the effectiveness of the proposed approach. Audio surveillance system detects hazardous events on roads using audio processing. Combination of time-domain, frequency-domain, and joint time-frequency features improves accuracy. Proposed approach improves accuracy rate by 7% compared to other methods. Combination of time-domain, frequency-domain, and joint time-frequency features enhances detection accuracy.

Lijun et al. In this paper, a 3D reconstruction of the road plane and prediction of trajectories is used to identify and predict car crashes from traffic surveillance cameras, which can accurately monitor the road, with mean errors of 1.80% for distance measurement, 2.77% for speed measurement, 0.24 m for car position prediction, and 2.53 km/h for speed prediction. Traffic danger recognition model for car crashes without training data. Utilizes 3D reconstruction and trajectory prediction for surveillance cameras. Model accurately predicts car crashes without labeled training data. Real-time safety checks for speeds and distances in traffic.

Hadi et al. In this article, an integrated safety system that continuously monitors the driver's attention and vehicle surroundings, and finally decides whether the actual steering control status is safe or not, is proposed. Development of an integrated safety system for semi-autonomous vehicles. System monitors driver's attention and surroundings to prevent accidents caused by fatigue and distraction. The paper proposes an integrated safety system for semi-autonomous vehicles. The system continuously monitors the driver's attention and vehicle surroundings.

Dae. The safety of boarding is improved by checking the signal from the electronic chip, up to "recognition of the emotion from residence time in the sensing area" to the biological electronic chip in a study to secure safety in autonomous vehicles. Study on AI and linkage system for safety in autonomous driving. Focus on minimizing injuries and ensuring safety in autonomous vehicles. Enhancing safety in autonomous vehicles through AI and biochips. Future focus on AI systems and biochips for road safety.

Jaidev et al. Artificial Intelligence (AI) can help in improved awareness of road conditions, driving behaviour of the people and can avoid accidents with the help of improved active safety and improved traffic condition. AI used to predict accidents and improve road safety measures. Focus on detecting unsafe driving patterns and maintaining car health.

Xiao et al. This paper presents an integrated system that accurately detects, tracks, and classifies vehicles using online traffic-camera feed, and focuses on the problem of the automatic detection of anomalous driving behaviors by using the traffic- camera feed that is available online. Real-time traffic monitoring for detecting anomalous driving behaviors using cameras. Focus on automatic detection of speeding or stopping on bike lanes.

Earnest et al. This framework capitalizes on Mask R-CNN for accurate object detection followed by an efficient centroid based object tracking algorithm for surveillance footage to achieve a high Detection Rate and a low False Alarm Rate on general road-traffic CCTV surveillance footage. Proposed framework for computer vision-based accident detection. Utilizes Mask R-CNN for object detection and centroid-based tracking algorithm.

Supriya et al. An intelligent accident detection, location tracking and notification system that detects an accident immediately when it takes place and sends a notification message to the nearest police control room and hospital so that they can visit the link, find out the shortest route of the accident spot and take initiatives to speed up the rescue process. Intelligent system detects accidents, tracks location, notifies authorities immediately. GPS and GSM technologies used for efficient accident response system. Intelligent system detects accidents, notifies police and hospitals immediately. GPS and GSM technologies used for accurate accident location tracking.

Shoaib et al. The main persistence of this system is to identify an accident and find the location of the user, which will help the users in saving their lives within minimal time. IoT framework for accident detection and disaster response. System locates accidents, alerts hospitals, and sends emergency messages. IoT can be utilized for accident detection and disaster response. The system helps in identifying accident location and providing immediate assistance.

Lattanzi et al. This work investigated the fusion of different external sensors, such as a gyroscope and a magnetometer, with in-vehicle sensors, to increase machine learning identification of unsafe driver behavior. Machine learning used to identify unsafe driver behavior. Fusion of external and in-vehicle sensors improves accuracy.

Lu et al. The proposed model is a promising video-based urban traffic crash detection algorithm that could be used in practice in the future and could detect crashes much faster than other feature fusion-based models (e.g., C3D). Video-based crash detection with feature fusion deep learning framework. Balances speed and accuracy for urban traffic crash detection. Proposed model achieves balance between accuracy and speed. ResNet with attention modules captures localized appearance features.

Sehyun et al. The approach of combining AI and HD map techniques is the main contribution of this study, which shows a high chance of improving current traffic monitoring systems. AI-based system for vehicle detection and tracking at intersections. YOLOv4 used for vehicle detection and trajectory estimation.

5.CONCLUSION

The review of "SAFE ROAD AI: Real-Time Accident Detection from Multi-Angle Crash Videos" highlights the significant advancements in the application of AI technologies for enhancing road safety. By leveraging real-time video analysis from multiple angles, the proposed system offers a robust solution for the rapid detection and response to road accidents. The integration of AI in accident detection not only improves the speed and accuracy of incident reporting but also has the potential to reduce emergency response times, ultimately saving lives.

While the technology is promising, the review also identifies several challenges that need to be addressed for widespread adoption. These include the need for extensive datasets to train AI models, potential privacy concerns related to video surveillance, and the requirement for seamless integration with existing traffic management systems. Future research should focus on overcoming these challenges and exploring ways to enhance the scalability and reliability of AI-based accident detection systems.

"SAFE ROAD AI" represents a significant step forward in the quest for safer roads. Its ability to detect accidents in real-time from multi-angle videos holds great promise for reducing road fatalities and improving overall traffic safety. With continued development and refinement, AI-driven accident detection systems have the potential to become a critical component of modern traffic management and emergency response strategies.

REFERENCE

1. A, B. H., J, J. S., & B, J. S. (2017). Accident detection by an intelligent system. IJARCCE, 6(5), 264–268. https://doi.org/10.17148/ijarcce.2017.6547

2. Abduljalil, F. M. (2014). A novel Real-Time video and data capture of vehicular accident in intelligent transportation systems. International Journal of Computer Networks & Communications, 6(2), 49–60. https://doi.org/10.5121/ijcnc.2014.6205

3. Aboah, A. (2023). AI-based framework for automatically extracting high-low features from NDS data to understand driver behavior. https://doi.org/10.32469/10355/94205

4. Almaadeed, N., Asim, M., Al-Maadeed, S., Bouridane, A., & Beghdadi, A. (2018). Automatic detection and classification of audio events for road surveillance applications. Sensors, 18(6), 1858. https://doi.org/10.3390/s18061858

5. Arya, D., Ghosh, S. K., & Toshniwal, D. (2022). AI-Driven Road Condition Monitoring across Multiple Nations. Proceedings of the AAAI Conference on Artificial Intelligence, 36(11), 12868–12869. https://doi.org/10.1609/aaai.v36i11.21571

6. Betke, M., Haritaoglu, E., & Davis, L. S. (2000). Real-time multiple vehicle detection and tracking from a moving vehicle. Machine Vision and Applications, 12(2), 69–83. https://doi.org/10.1007/s001380050126

7. Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., Abbas, S., Ahmad, M., & Khan, M. A. (2021). EdgE AI-Based automated detection and classification of road anomalies in VANET using Deep Learning. Computational Intelligence and Neuroscience, 2021, 1–16. https://doi.org/10.1155/2021/6262194

8. Chaudhary, A., Klette, R., Raheja, J. L., & Jin, X. (2017). Introduction to the special issue on computer vision in road safety and intelligent traffic. EURASIP Journal on Image and Video Processing, 2017(1). https://doi.org/10.1186/s13640-017-0166-5

9. Choi, J. G., Kong, C. W., Kim, G., & Lim, S. (2021). Car crash detection using ensemble deep learning and multimodal data from dashboard cameras. Expert Systems With Applications, 183, 115400. https://doi.org/10.1016/j.eswa.2021.115400

10. Dumontier, C., Luthon, F., & Charras, J. P. (1999). Real-time DSP implementation for MRF-based video motion detection. IEEE Transactions on Image Processing, 8(10), 1341–1347. https://doi.org/10.1109/83.791960

11. Gudemupati, S. S. R., Chao, Y. L., Kotikalapudi, L. P., & Ceesay, E. (2022). Prevent car accidents by using AI. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2206.11381

12. Hassan, S. U., Chen, J., Mahmood, T., & Akbar, A. (2020). Accident Detection and Disaster Response Framework utilizing IoT. International Journal of Advanced Computer Science and Applications, 11(3). https://doi.org/10.14569/ijacsa.2020.0110348

13. Ijjina, E. P., Chand, D., Gupta, S., & K, G. (2019). Computer Vision-based Accident Detection in Traffic Surveillance. IEEE. https://doi.org/10.1109/icccnt45670.2019.8944469

14. Khojasteh, H. H. K. A., Alipour, A. A., Ansari, E., & Razzaghi, P. (2020). An intelligent safety system for Human-Centered semi-autonomous vehicles. In Lecture notes on data engineering and communications technologies (pp. 322–336). https://doi.org/10.1007/978-3-030-37309-2_26

15. Lattanzi, E., Castellucci, G., & Freschi, V. (2020). Improving machine learning identification of unsafe driver behavior by means of sensor fusion. Applied Sciences, 10(18), 6417. https://doi.org/10.3390/app10186417

16. Li, H., Su, J., & Lian, J. (2017). A rapid Multi-Angle vehicle detection method in complex scenario. DEStech Transactions on Engineering and Technology Research, iceeac. https://doi.org/10.12783/dtetr/iceeac2017/10706

17. Lu, Z., Zhou, W., Zhang, S., & Wang, C. (2020). A new Video-Based Crash Detection method: balancing speed and accuracy using a feature fusion deep learning framework. Journal of Advanced Transportation, 2020, 1–12. https://doi.org/10.1155/2020/8848874

18. Ozbayoglu, M., Kucukayan, G., & Dogdu, E. (2016). A real-time autonomous highway accident detection model based on big data processing and computational intelligence. IEEE. https://doi.org/10.1109/bigdata.2016.7840798

19. Razi, A., Chen, X., Li, H., Wang, H., Russo, B., Chen, Y., & Yu, H. (2022). Deep learning serves Traffic Safety Analysis: A forward-looking review. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2203.10939

20. Rueß, H., & Burton, S. (2022). Safe AI -- How is this Possible? arXiv (Cornell University). https://doi.org/10.48550/arxiv.2201.10436

21. Sarker, S., Rahman, M. S., & Sakib, M. N. (2019). An Approach Towards Intelligent Accident Detection, Location Tracking and Notification System. IEEE. https://doi.org/10.1109/ictp48844.2019.9041759

22. Seo, D. (2019). A study on the application of AI and linkage system for safety in the autonomous driving. Journal of the Korean Chemical Society, 10(11), 95–100. https://doi.org/10.15207/jkcs.2019.10.11.095

23. Strianese, D. M. (2008). A mathematical model for computerized car crash detection using computer vision techniques. University of Nevada, Las Vegas. https://doi.org/10.25669/ye7b-dra3

24. Tak, S., Lee, J., Song, J., & Kim, S. (2021). Development of AI-Based Vehicle Detection and Tracking System for C-ITS Application. Journal of Advanced Transportation, 2021, 1–15. https://doi.org/10.1155/2021/4438861

25. Yu, L., Zhang, D., Chen, X., & Hauptmann, A. (2018). Traffic Danger Recognition With Surveillance Cameras Without Training Data. IEEE. https://doi.org/10.1109/avss.2018.8639166

26. Zhang, Y., & Sung, Y. (2023). Hybrid traffic accident Classification models. Mathematics, 11(4), 1050. https://doi.org/10.3390/math11041050

27. Zheng, X., Wu, F., Chen, W., Naghizade, E., & Khoshelham, K. (2019). Show me a safer way: detecting anomalous driving behavior using online traffic footage. Infrastructures, 4(2), 22. https://doi.org/10.3390/infrastructures4020022