Surround View Camera Technology for Advanced Collision Detection

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INTRODUCTION

- The Surround View Camera based Vehicle collision detection system uses computer vision to detect and predict collisions by analyzing real-time video from a vehicle's 360° camera. It identifies objects like cars and pedestrians, calculates distances, and predicts the likelihood of a collision based on their movement.
- If a potential collision is detected, the system alerts the driver with visual and audio warnings. This solution aims to enhance safety by providing timely alerts to help detecting accidents. In case of any accident, the system sends alert to the nearest hospital for emergency services.

RESEARCH GAP

S.No	Author, Title & Year	Methodology	Merits	De-Merits
1	A. Rocky, Q. J. Wu and W. Zhang, "Review of Accident Detection Methods Using Dashcam Videos for Autonomous Driving Vehicles," in IEEE Transactions on Intelligent Transportation Systems, vol. 25, no. 8, pp. 8356-8374, Aug. 2024.	The paper reviews existing accident detection methods using dashcam videos	Dashcams offer cost-effective data, enhance autonomous vehicle safety, and enable extended autonomous operation.	Data limitations, computational complexity, and environmental factors impacting performance.
2	Y. Sui, S. Zhou, Z. Ju and H. Zhang, "A Vision-Based System Design and Implementation for Accident Detection and Analysis via Traffic Surveillance Video," in IEEE Canadian Journal of Electrical and Computer Engineering, vol. 45, no. 2, pp. 171-181, Spring 2022.	This paper uses motion interaction field, YOLO v3, UFIR filtering, and perspective transformation to detect and analyze accidents.	Effective accident detection, trajectory recovery, adaptable to AI boards.	Identification accuracy can decrease if a vehicle is blocked.
3	H. A. Yawovi, M. Kikuchi and T. Ozono, "Responsibility Evaluation in Vehicle Collisions From Driving Recorder Videos Using Open Data," in *IEEE Access*, vol. 12, pp. 49962-49975, 2024.	Image detection, open data, and rule-based system for responsibility..	Accurate, quick evaluation, applicable to diverse scenarios and users	Internet dependent, device vulnerable, limited scenario coverage.

RESEARCH GAP

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4	J. Fang, J. Qiao, J. Xue and Z. Li, "Vision-Based Traffic Accident Detection and Anticipation: A Survey," in *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 34, no. 4, pp. 1983-1999, April 2024.	The paper uses deep learning to detect and anticipate traffic accidents.	Vision-based accident detection and anticipation improve road safety.	Limited data and complex environments can impact performance
5	R. Vijithasena and W. Herath, "Data Visualization and Machine Learning Approach for Analysing Severity of Road Accidents," *2022 International Conference for Advancement in Technology (ICONAT)*, Goa, India, 2022, pp. 1-6.	Descriptive analysis and Random Forest to predict accident severity.	High accuracy (97.2%) in predicting road traffic accident severity.	Descriptive analysis might not capture complex relationships.
6	I. E. Mallahi, A. Dlia, J. Riffi, M. A. Mahraz and H. Tairi, "Prediction of Traffic Accidents using Random Forest Model," *2022 International Conference on Intelligent Systems and Computer Vision (ISCV)*, Fez, Morocco, 2022, pp. 1-7.	Uses Random Forest, SVM, and ANN to classify accident severity from historical data and achieves maximum accuracy in random forest model.	Accurate accident severity prediction aids emergency logistics, with Random Forest achieving 93% accuracy	Limited adaptability to new patterns. Static Dataset is being used

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7	G. A. Senthil, R. V. Lakshmi Priya, S. Geerthik, G. Karthick and R. Lavanya, "Safe Road AI: Real-Time Smart Accident Detection for Multi-Angle Crash Videos using Deep Learning Techniques and Computer Vision," *2024 3rd International Conference on Applied Artificial Intelligence and Computing (ICAAIC)*, Salem, India, 2024, pp. 617-622.	Uses multi-angle video analysis from sources like surveillance cameras, dashcams, and drones.	Multi-angle video analysis enhances detection accuracy, provides comprehensive incident insights, and enables prompt emergency alerts.	High data processing demands, requires extensive infrastructure, and may face privacy concerns due to extensive video monitoring.
8	S. R. Chandra Goud Bandi, V. G. Bezawada, M. P. Selvan, V. A. Mary, M. Posonia and A. Praveena, "Real Time Vehicle Collision Using Bounding Box Methodology with Alert System," *2024 International Conference on Science Technology Engineering and Management (ICSTEM)*, Coimbatore, India, 2024, pp.1-6.	The system uses YOLOv3, fine-tuned on a custom accident image dataset from sources like traffic cameras, to detect rollovers, rear-end, and head-on collisions, enabling accurate, real-time accident detection.	YOLOv3 provides fast, accurate accident detection, handles diverse accident types, and is adaptable through fine-tuning.	Requires extensive labeled data, is computationally intensive, and may face challenges with rare accident scenarios or complex environmental factors.

RESEARCH GAP

S.No	Author, Title & Year	Methodology	Merits	De-Merits
9	N. Vijayan, S. Pandey and P. R M, "Collision Detection and Prevention for Automobiles using Machine Learning," *2024 International Conference on Trends in Quantum Computing and Emerging Business Technologies*, Pune, India, 2024, pp. 1-4.	The proposed system focuses on accident detection by analyzing traffic behavior and identifying vehicles deviating from typical patterns, indicating possible accidents	Uses machine learning for precise differentiation between typical and atypical traffic behavior.	Complex traffic scenarios or unpredictable driver behavior may reduce detection accuracy.
10	A. Verma and M. Khari, "Vision-Based Accident Anticipation and Detection Using Deep Learning," in *IEEE Instrumentation & Measurement Magazine*, vol. 27, no. 3, pp. 22-29, May 2024.	It leverages a Recurrent Neural Network (RNN) combined with Long Short-Term Memory (LSTM) cells to analyze spatial features and detect potential accidents.	Predicts accidents 1.7 seconds before they occur, providing valuable time for prevention.	Dashcam footage quality can vary, affecting detection performance.

NOVELTY & OBJECTIVE

This project involves the usage of 360° cameras of vehicles to detect accidents and provide alerts to the required departments in case of serious accidents.

- To prevent vehicle collision to an extent and save human lives.
- To escalate emergency services in case of a serious accident.
- To automate the process of calling emergency services which can facilitate in remote areas.

ANALYSIS - EXISTING SYSTEM

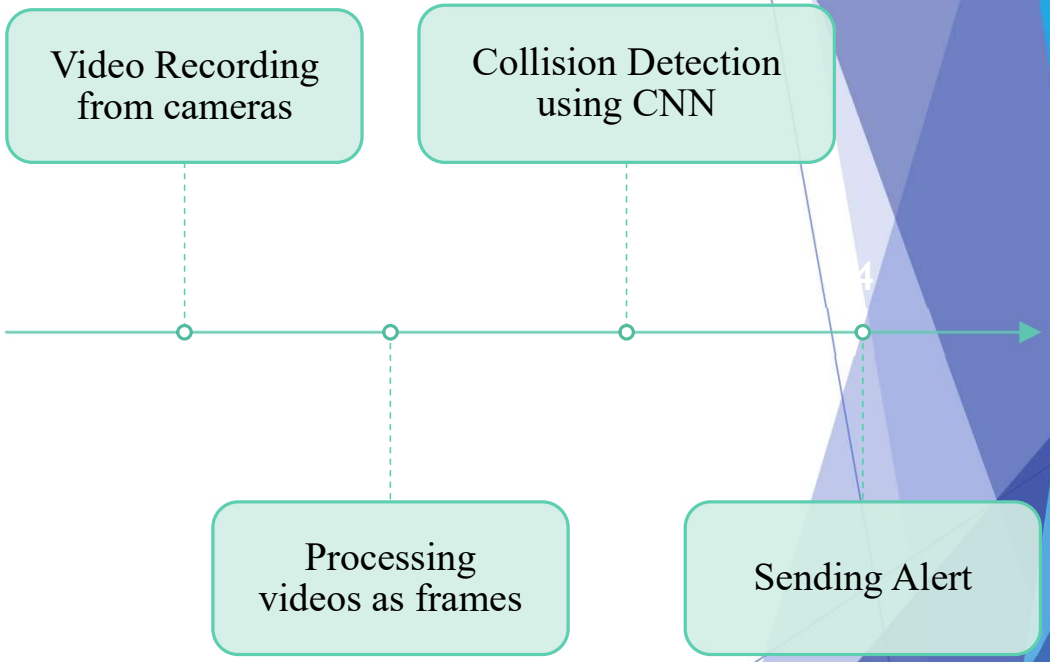
- Currently, accidents are evaluated and identified based on a manual basis, where the public surrounding the accident area make calls to the required department.
- This can be time consuming at remote areas and may result in affecting the life of the individual. In order to overcome this drawback, a new solution has been proposed which will automate this complete process.

Drawbacks :

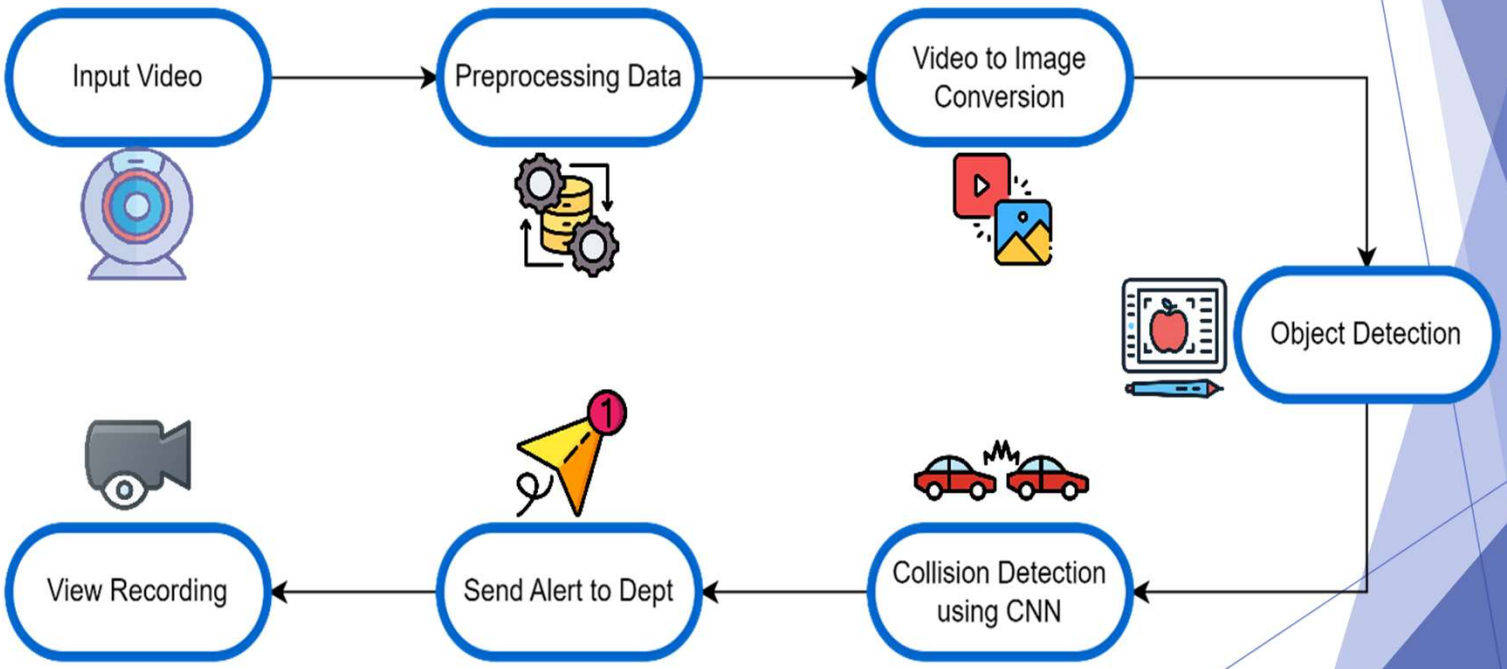
- High Cost: Advanced systems, especially those involving multiple sensors like LiDAR or radar, can be expensive, limiting their adoption in lower-cost vehicles.
- Limited Coverage: Some systems only focus on frontal collisions, leaving rear or side collisions unaddressed unless additional cameras or sensors are installed.
- Over-Reliance on Technology: Drivers may become overly dependent on these systems, potentially leading to complacency or reduced attention to their surroundings.

PROPOSED SOLUTION

- This solution uses the multi-camera setup of the vehicles to identify collision with other vehicle.
- This solution can enhance emergency response, reduce the adverse effects of accidents on public safety, and even save lives.
- It also provides the recording of the collision from 15 seconds before the collision so that it can be used for claiming insurance and other purposes.



ARCHITECTURE DIAGRAM



ADVANTAGES

- **360° Coverage:** With a multi-camera setup, the system can detect potential collisions from all directions (front, rear, and sides), offering comprehensive protection.
- **Improved Accuracy:** By leveraging advanced object detection models like YOLO, the system provides more precise identification of vehicles, pedestrians, and obstacles, reducing false positives.
- **Response rate:** The response rates of the proposed solution enables sending quicker response to the respective departments.

TECHSTACK USED FOR SIMULATION

- Python3
- OpenCV
- Convolutional Neural Network (CNN)
- Twilio API
- YOLO v8

WORKFLOW

- The distance between the 2 vehicles is calculated frequently in order to identify if there is any collision.
- Once collision is detected, the alert to the respective departments is sent instantly without any delay.
- The major modules in this project include :
  - Object Detection and Distance Evaluation
  - Collision Detection
  - Sending Alerts to emergency services
- These modules together form the neural network model and can help in preventing numerous accidents.

MODULE DESCRIPTION

Object Detection and Distance Evaluation:

- The Object Detection and Distance Evaluation Module in a 360° camera-based collision detection system detects and classifies surrounding objects using advanced computer vision algorithms, such as deep learning models (e.g., YOLO). The system tracks object movement and predicts potential collisions by evaluating their relative speed. Based on proximity and threat level, it triggers alerts (visual, auditory, or haptic) to warn the driver. This module enhances vehicle safety and supports autonomous driving by preventing collisions in real-time.

MODULE DESCRIPTION

Collision Detection Module

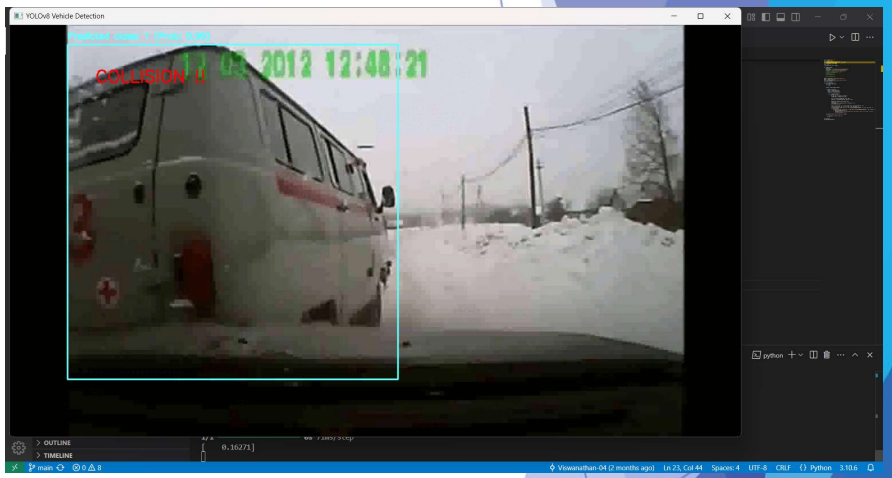
- In the collision prediction module, the data from the object detection system is fed into a Convolutional Neural Network (CNN), which processes the information to determine whether a collision is likely. By analysing factors like the object's size, speed, distance, and trajectory relative to the vehicle, the CNN can predict potential collisions. This module is trained on a large dataset of various collision and non-collision scenarios, enabling it to classify situations where a collision is imminent or already occurring.

Alert System Module

- The system also includes an impact detection module, which evaluates the severity of the predicted collision. This module uses predefined thresholds based on the size and speed of the approaching object, along with the vehicle's movement, to classify the impact as either minor or severe. If the system detects a high-risk, severe collision, it triggers the alert and notification system.

RESULTS / OUTCOMES

- The outcome of this Vehicle Collision Detection and alert system identifies collision of the vehicle immediately and records the duration of 15 seconds before the collision which can be used for further reference.
- This Vehicle Collision Detection and alert system sends an alert to the respective department including hospitals, insurance companies etc..
- The project enhances vehicle safety by accurately detecting and predicting potential collisions in real-time, leading to timely alerts.



Accuracy	90.4%
Precision	94%
Recall	93.1%

FUTURE ENHANCEMENTS

- The detection of collision can be challenging during the night time and also during climate like rainy or foggy day. Robust models will be developed in order to overcome this obstacles and make detections more accurate.
- Future enhancements for the collision detection system also include enhanced pre-collision warnings, post-accident assistance, vehicle damage assessment, weather condition alerts, better accident scene recording etc.. to improve safety and system accuracy.

THANK YOU